

Testing of a Railway RBC in ERTMS Level 2 using Formal Methods

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Declarations

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Abstract

Railway technology has been evolving over the last few decades, with current technologies offering many possible advancements. With a solid foundation of knowledge the railway system has much potential, as seen with the European Rail Traffic Management System which offers a unified operation across many countries. However with some developmental freedom, the integration of new technologies with well understood systems can provide issues.

With the addition of Radio Block Centres to existing Interlockings, Controllers, Train and Trackside equipment, there is great potential for many new positives to an old industry. Safety is a key issue in adding any new aspect to a system that still has risks, be it down to human or computer errors. The testing of RBCs remains crucial to keeping railways safe and efficient, however that testing can be costly and time consuming.

By modelling with formal methods, we suggest that an auxiliary testing approach could be beneficial. By modelling and verifying an abstracted version of these new systems, errors could be caught in a more time- and cost-effective manner, allowing for the most rigorous testing to give maximum impact. Building on work by James et al. [1] and Berger et al. [2], and a partnership with Siemens Rail Automation we examine the suitability of existing models in relation to current industrial testing methods, then proceed to develop our own approach in CSP||B using a discrete-event modelling approach. Our model is then verified for collision-free safety and simulated, then compared with results from industrial simulations.

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Chapter 1

Introduction

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The research topic for this project is the use of formal models in conjunction with the testing of Siemens Radio Block Centres (RBCs). The primary motivation is the idea that current testing of RBCs is time consuming and expensive - formal models could be used to find errors before reaching this testing stage. The plan is to create a formal model with the same railway topology data as the real-life control components, that displays the relevant properties. From this there is the potential to derive test suites and scripts that can be run on the test environment. This work could potentially lead to automatic test suite derivation and evaluation. Any models and tests generated would need to be created with reference to the System Required Specifications: Subset-026 - the main document containing all detailed technical specifications of ERTMS. Over the duration of the project, its definition being established through repeat discussions and internships with Siemens, though this phase took longer than in a typical PhD project. The project development operated based on a spiral development model - as agreed to by Siemens - consisting of multiple cycles of requirement gathering, prototyping/risk analysis, testing, and evaluation.

1.1 Project Aims

The primary aim of the project is to establish the feasibility and potential benefits of constructing a formal model of the railway domain based on data from ongoing industrial development, and verifying safety properties in a way that is less resource intensive than industrial simulations. The targets include:

- Examine previous modelling in the field, and determine the areas that are key in developing a suitable railway model (Chapters 2 and 3)
- Develop a model based expanding on key real-world elements that are missing from previous work (Chapter 5)
- Abstract from a real-world system while ensuring that an abstracted system will still provide relevant data that corresponds to its source in a meaningful way (Chapter 5)
- Verify the developed model, then match and compare the resulting simulations with those from industrial testing (Chapter 6)
- An evaluation of this methodology by way of case studies (Chapter 5)
- Identify areas that are lacking in the systems analysed (Chapters 6 and 7)

1.2 Collaboration with Siemens

This project is being done in conjunction with Siemens Rail Automation. Along with the design elements, model requirements and data shared with us, multiple internships were held in order to learn directly from those working on the current developmental process. As well we were able to perform tests directly on their equipment in order to get feedback for our own development.

1.3 Modelling Approach

After several discussions with Siemens and work on model requirements, we determined that a discrete-event based modelling approach would be most effective. This allows for abstraction from the extensive real-world design of the railway implementation, allowing focus to be placed on the distinct events within the system where a change takes place, rather than granular steps to get to these events that only serve to bloat the states of the model and hinder verification. The trains within the system can be assumed to move, it is where a change to this movement is required that lies the value of this modelling.

1.4 Chapter Overview

The remainder of this dissertation is outlined as follows:

Background Material:

Chapter 2: Background on the railway domain, model-based testing, and formal specification methods. Detail will be given on the inspiration for the project, and concepts of modelling the railway domain will be presented.

Chapter 3: Previous development towards an ERTMS model in a time-based language. A study of related work and its impact on the development of this project, as well as the decisions behind development choices.

Industrial Partnership

Chapter 4: Detail on the development done in collaboration with Siemens. Details on how the project grew from applying older work to a new concept, to establishing new criteria required for the new goals, as well as aligning the model to industrial standards and requirements via on site knowledge sharing, development, and testing.

Development and Contributions

Chapter 5: The creation and development of a model, and what can be learned from it. The progression of the model from initial requirements to an initial model to develop the logic and feasibility of the model in CSP||B, and the following implementation of real world data into the model to establish correlation between the formal model and industrial testing.

Chapter 6: Using the model to simulate and test a real-world example track plan. Determining requirements of testing and the conditions that will need to be achieved in order to establish a valid correlation. A comparison of traces from the model simulation to the logs of industry implemented simulations.

Conclusions:

Finally, Chapter 7 will summarise the work done, what can be taken away from the project, and the potential for future work.

Part I

Background Material

Chapter 2

The Railway Domain

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2.1 Glossary

Included here are abbreviations relevant throughout the work.

- **ERTMS** *European Railway Traffic Management System*
- **ETCS** *European Train Control System*
- **RBC** *Radio Block Centre*
- **IXL** *Interlocking*
- **MA** *Movement Authority*
- **MB** *Markerboard*
- **EoA** *End of Authority*
- **LoA** *Length of Authority*
- **PA** *Proceed Authority*
- **CSP** *Communicating Sequential Processes*
- **RTM, RT-Maude** *Real-Time Maude*
- **FDR** *Failures-Divergences Refinement*

- **AMN** *Abstract Machine Notation*
- **UES** *Unconditional Emergency Stop*
- **PCA** *Prove Clear Ahead*
- **VPCA** *Verified Prove Clear Ahead*
- **IPCA** *Initial Prove Clear Ahead*
- **BG** *Balise Group*
- **LRBG** *Last Referenced Balise Group*
- **RETS** *Railway Environment and Train Simulator*
- **SMA** *Shortened Movement Authority*
- **CTL** *Computation Tree Logic*

2.2 Background

The railway domain is safety-critical: technical failure can lead to financial loss or the loss of human life. Within railway systems, signalling is an important safety measure. Its objectives include separation of trains to avoid train collisions, setting speed restrictions to avoid train derailment, and the coordination of train and point movement.

Britain has a long history with railway systems going back two centuries, and as a result of this the engineers responsible for their design and implementation have significant experience to draw from. Despite this there is always scope for improvement, and in the correct areas. With the development of new technologies it is important that the railway should also see improvements, becoming faster, more efficient, more reliable, and crucially safe. Ensuring these goals is a key part of any railway signalling system, ensuring the correct separation, speed, and coordination of trains. And while there have been advances in the technologies used in day-to-day life, the operation of trains has remained largely similar - for example we continue to have a reliance on track-side signalling - so a key question is how do we bring improvements and advancements to these systems.

In recent decades there has been the development of the European Rail Traffic Management System (ERTMS) with aims to bring a more unified train control standard across Europe rather than the numerous systems that existed previously. In developing a new system there is also the opportunity to evolve on the previous systems, solving some previous issues and emphasising safe operations. A key difference in ERTMS when compared to previous signalling systems is the inclusion of a Radio Block Centre (RBC) which serves as a point of communication between trains and interlockings.

An aim of ERTMS is more consistent monitoring of trains, making use of on-board equipment to monitor train behaviour, with more reliable calculations of position, acceleration, and braking. This data is used by the RBC to determine further routes

and route extensions for trains, which then is relayed to the interlocking to assess route availability. Interlockings have been used for decades, while RBCs are new entities that are introduced with this system. This means that there is far less experience to draw from for their development and implementation, meaning RBC development must be thorough for efficiency. Our work is an investigation on the suitability of quality control for RBC implementations through specification-based testing, which requires the formal modelling and verification of ERTMS.

Our partner Siemens is working on the recently introduced signalling system, the European Railway Traffic Management System, particularly the Radio Block Centre component. One of their aims is to increase the efficiency of their implementation, finding errors before a model is tested to save time and costs.

2.3 Railway Components

Along the more classic railway components of Controller, Interlocking, and Train/Track-side equipment, the primary addition with ERTMS is the Radio Block Centre. This component communicates with the interlocking in order to determine suitable routes and the movement authorities associated with them, and also communicates with trains, receiving requests for extension of movement authorities and then issuing these authorities where suitable. In effect control computers are added to trains, allowing for more precise and situational control of speed and braking of trains. A controller serves to control the general flow of trains through the railway system, primarily done by requesting routes from the interlocking and cancelling routes if instructed. The messages themselves will be based on the timetabling of the network, along with any current congestion.

The following track plan in figure 2.1 was created in order to develop an initial version of the model, and will be further expanded on in Chapter 5, however it can be used here in order to illustrate concepts relevant to this section.

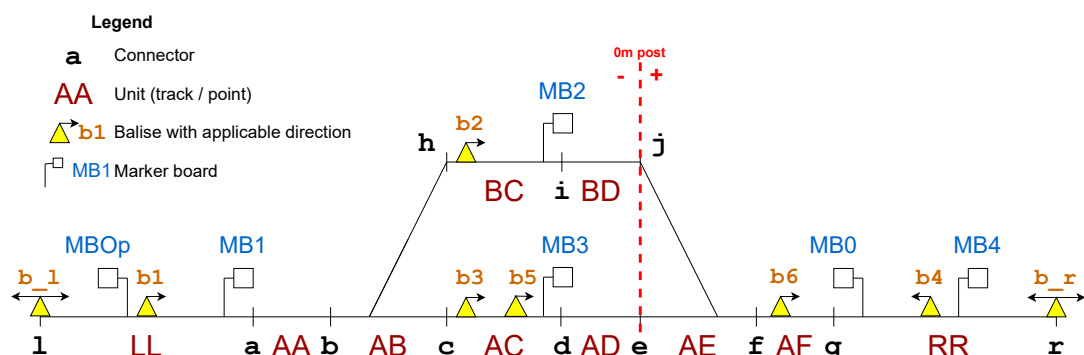


Figure 2.1: Simple example track plan. Includes Tracks, connectors, markerboards, balises, and points

In this figure we see a standard example track, including both a straight line section

and a secondary pass-through section which allows a train to pass the other in the case of differing speeds or bi-directional travel. It includes tracks separated by connectors, with routes governed by markerboards and balises to trigger train positional reports and requests for routes.

Interlockings are specialised equipment, serving as a monitor of the systems layout and state, and ensures any requests received from the controller is valid and safe. They are mainly responsible for setting and granting routes requested by the controller. Interlockings have their own control tables relating to their domain, consisting of the relationships between tracks and their routes, points and their associated lock conditions, and when these elements can be freed and reset. Using the information it contains about the current state of the track occupations and point positions it can determine available routes, which can then be communicated to the RBC, informing it that a route is free, and not yet reserved. The RBC can lock the route by sending a proceed request to the interlocking, which will confirm or deny the setting of the route, which can then be communicated to the train. Trains receive these routes through movement authorities (MA) that represents an area of the railway that a train can move within, up to an end of authority (EoA) value which is the furthest point a train will be allowed to move without requesting further MAs. The EoA contains several details, such as distance to travel, a reference in the form of a markerboard along its path. A train will pass over balises to calculate its position continuously. Trains themselves have set parameters, such as a maximum speed, acceleration, and braking curves [2].

Chapter 3

Formal Specification Methods Used in this Dissertation

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In order to develop our model, we require a tool that can work on event-based triggers, where a level of abstraction for the real-world can be performed, and delivers clear traces. It needs to work with a model-checker, and have the potential for scalability and generalisation of implementation to allow for use across future potential implementations.

3.1 Real-Time Maude

Real-Time Maude is an extension of Maude, which is a language and tool built to support the formal specification and analysis of real-time and hybrid systems. It was developed by Peter Csaba Ölveczky and José Meseguer with early iterations in 2000 and 2001, and has specification formalism based on real-time rewrite theories and an emphasis on ease and generality of specification. It is well suited for specifying distributed real-time systems in an object-oriented style [3].

Specifications in Real-Time Maude are executable under reasonable assumptions such that the initial formal analysis is done by simulating the system's progress in time by timed rewriting which is useful for debugging across individual runs of the system. For more thorough examination of the system design, model-checking techniques can be used to check different behaviours from an initial state. This can be done as a timed search and with time-bounded linear temporal logic in order to model-check all behaviours up to a specified duration from the given initial state. With such restrictions the number of reachable states can be restricted to a finite set for model-checking.

Real-Time Maude offers an approach for providing a precise formal specification of a system that is able to be tested directly as it is executable. The specification can be analysed exhaustively rather than being restricted to a small number of behaviours, and a user can define the systems forms of communication at a high level of abstraction[4].

Real-Time Maude is also complementary to other formal tools, such as Uppaal, HyTech, and Kronos which are based on timed/hybrid automaton, providing a more general specification formalism that supports other systems with differing communications. This is due to the specification language being more expressible with support for real-time object-oriented specification. It's also positive in conjunction with traditional simulation tools as it offers a wide-range of formal analysis techniques, and more abstract specification formalism for modelling different forms of communications more easily. It is also complementary towards tools aimed at modelling and analysing larger real-time systems. The generality of the Real-Time Maude specification language gives it these strengths, along with its dynamic and real-time behaviour.[?]

The timed-rewrite system in Real-Time Maude allows for the simulation of one behaviour of the system up to a specified duration. Syntactically this is represented as

$$(trew\ t\ \text{in time}\ \leq\ limit\ .)$$

where *trew* is the timed-rewrite command, *t* is the initial state to be rewritten, and *limit* is a ground term of sort **Time**. The tool also allows for the tracing of the rewrite steps in a simulation.

Also provided is a variety of search and model checking commands which allow for the further analysing of timed modules by exploring all possible behaviours up to a given number of rewrite steps, duration, or fulfilment of other conditions that can be reached non-deterministically from the initial state. Included in these are a search command extended from the Full Maude search, which uses a breadth first strategy to discover the states reachable from the initial state that match the search pattern and satisfy the search condition, and will search for states and deadlocks reachable within a specified time interval from the initial state.

Commands are also provided for analysing all behaviours from the initial state, and locating the earliest and latest time a state is met for the first time. Through use of a breadth-first search, the first occurrence where a given pattern satisfies the given condition is found. Among the states found, depending on the condition given the state that took shortest or longest (as requested) time is returned. Depending on the provided time limit, this search could result in a loop or an error if the state cannot be reached within the time limit.

3.2 CSP||B

CSP||B takes the approach of combining a state and event based approach to describing complex systems, combining the B-method and CSP process algebra.

A particular advantage of using a combination of CSP and B-Method is the different strengths they have in application. A simple instance of this is useful in this project,

and while CSP is a relatively straightforward language to comprehend, the complexity of an interlocking becomes a challenge to model, whereas B-method offers a different 'simpler' environment for programming an interlocking. As such, though CSP||B is more of a challenge to comprehend, implementing various elements of train control systems becomes less complex. An important drive for this approach is the use of industry established tools: FDR4 for analysing programs written in CSP_M (a machine-readable form of CSP), and ProB which handles both CSP and B-machine files, while also containing a direct facility for simulating CSP||B models[5].

3.2.1 CSP

The process algebra CSP (Communicating Sequential Processes) is a specification language and formal notation for describing interactions in concurrent systems, first described by Hoare[6]. It is designed to be a notation and theory for describing and analysing systems that interact, looking at the level of communication. CSP also has industrial applications to software design, usually focussing on dependable and safety-critical systems. As it is well-suited to modelling and analysing systems incorporating the complex exchange of messages, CSP is also applied to the verification of communications and security protocols. CSP is the description of one or more processes capable of performing events. These processes are built up using operators and are able to call other processes recursively. With the use of parallel operators and synchronisations, these processes can be combined into full systems. CSP is therefore of particular use when describing systems with multiple components that interact with each other.

3.2.2 B-Method

The B-Method is a mathematically rigorous, formal approach to the specification and development of computer software systems. It synthesises formal methods including Z notation, pre- and post-conditions, guarded commands, stepwise refinement, refinement calculus, and data refinement into a unified methodology, based on the Abstract Machine Notation (AMN). AMN provides structuring mechanisms that support modularity and abstraction in an object based style. This makes provable correctness achievable throughout development. The method is based on the layered development concept, where larger components are constructed from collections of smaller ones[7].

The B-method uses components defined as machines, consisting of state and state-supporting operations to develop systems. Operations in B are associated with preconditions, and diverge if called outside of these preconditions. A machine is defined using clauses describing the machines constituent parts:

- The Machine clause declares and names the abstract machine
- The Variables clause declares state variables within the machine, used to carry state information
- The Invariant clause contains constraints on allowable machine states, as well as assigning types to variables

- The Initialisation clause sets the initial state of the machine
- The Operations clause contains the operations provided by the machine, including state queries and updates

Operations are of the format:

$$oo \leftarrow op(u) = \text{PRE } P \text{ THEN } S \text{ END}$$

The operation is declared using $oo \leftarrow op(u)$ the operation in named op , an output list of variables oo , and a list of input variables u . It is possible for lists oo and u to be empty. The operation has a precondition predicate P , which must give the type of any input variables and can give conditions on when the operation can be called. The body of the operation is S , a generalised substitution which can consist of one or more assignment statements in parallel to assign output variables or update the state of the system. [8].

3.3 Why CSP||B?

After discussions with Siemens where the necessity of time in the model was deemed as non-essential and where the functions of balises and level transitions were established, it was decided that developing a model in an alternate tool would be worthwhile. Specifically as the inclusion of time is no longer essential, an environment that does not take timing into account would lead to less complexity in the design when model-checking and simulating, and the saving of state-space, while still being able to scale to an extent that can support industrial-sized designs. To pursue this developmental direction, it was decided that the CSP||B approach would be suitable, as a combination of the mathematically rigorous B-method, and the specification language of CSP. There is already work using this approach in the railway domain, such as by James et al. [1] so relevant resources exist to aid in the next development cycle of the project. In their work they modelled and verified interlockings specifically, using an approach where as much data-rich aspects were incorporated into B machines, while events can then be handled by CSP processes.

While UPPAAL had been considered based on previous experience with the tool, the limitations of channel communication are too restrictive for an approach that prioritises messages sent between components. Locations within UPPAAL are also time-bound and therefore cannot remain static indefinitely unless specifically guarded. In addition when performing model checking to verify the model additional error states will need to be included in order to run a reachability query to ensure they cannot be reached, which provides a possibility of missing specific error configurations.

In the Real-time Maude implementation of ERTMS done by Berger et al. [2] they sought to model all elements of ERTMS in RTM in order to verify safety of their model. In this implementation RTM provided a situation that required inexactness in the model. Due to real-world limitations where the precise locations of trains will never

be fully certain extra leeway between trains had to be implemented to grant a safety buffer. They also required approximations of time values due to the required use of rational numbers thus precise values on train travel time and position were not certain. In CSP||B we will be able to avoid this with our level of abstraction, as we don't look at the positions of the trains precisely, but the messages from balises in known locations as they are triggered by trains passing over them.

Part II

Industrial Partnership

Chapter 4

Siemens Collaboration

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4.1 Siemens Internship - An Exploration of Concepts

During the first round of development an internship was arranged at Siemens in two stages. The first stage was focused on learning the systems used for simulation and testing at an industrial level, studying documentation from their Railway Environment and Train Simulator (RETS), and analysis of example test scripts. The second stage was used for the development and running of scripts created based on test cases done in Real-Time Maude. Both stages lasted a week, and had a week of separation between them for planning.

As an introduction to their systems a simulation was demonstrated on the Moorgate-Holloway testing rig, with basic operation instruction along with an example of the derivation of test cases. The example shown consisted of a single train moving along a track. The software used to run these simulations is known as RETS, described as a PC-based distributed software application whose primary function is to provide an environment for testing Radio Block Centres (RBCs) and an interlocking. It also has the capability to be used for demonstration purposes, performance estimation, scheme design and operational verification. Comprised of multiple separate components it is powered by a scenario manager and using input data from a track layout and component file, an interface for the interlocking, and timetable data. On running a simulation a graphical representation of the current state of the system (e.g. train movements) is provided, and utilising a connected datalogger tool the exchange of messages sent between components is recorded.

A basic test case consisting of the shortening of a movement authority was demonstrated and its script provided. This served as an example of deriving a test case from

4. Siemens Collaboration

the base essential requirements of verifying a movement authority is shortened where required, expanding these requirements to a natural language explanation, creation of applicable test scripts, to finally the resulting output given by the datalogger.

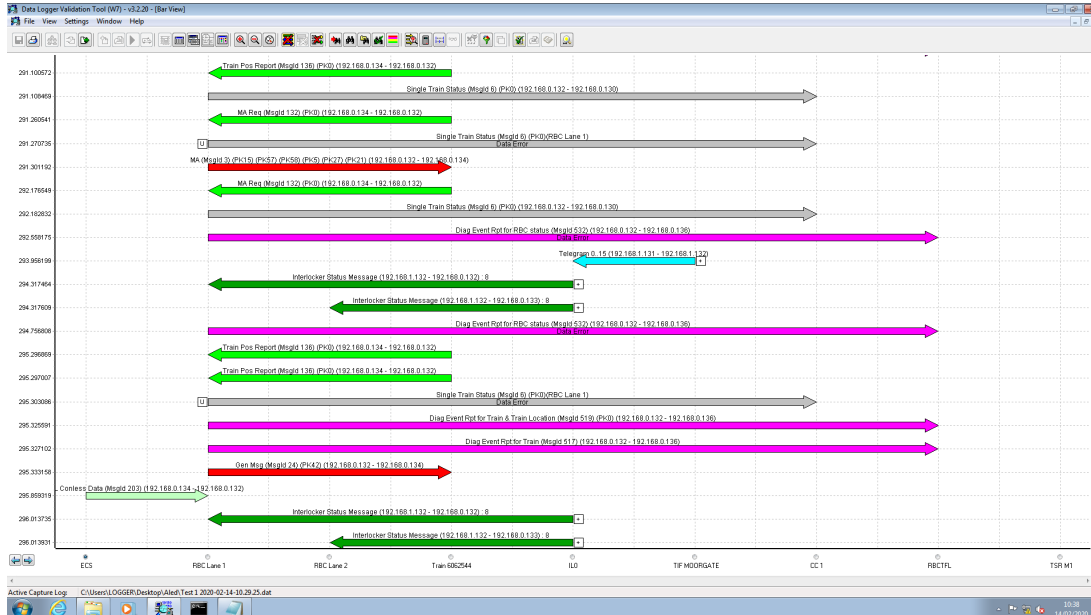


Figure 4.1: Example of datalogger message sequence

4.2 A Siemens Test Case

4.2.1 Deriving a Test Case

In order to conduct tests, objectives must be determined that will fulfil the requirements of the system in development. The process observed in Siemens uses the ETCS specification documents (specifically those provided in Subset-026)[9] to analyse the system requirements, from which a test case is derived that checks that the requirements are met by the system under test in a scenario.

In chapter three - Principles - there are indexed requirements for the system, which are used to derive test cases. One such example demonstrated is the shortening of a movement authority. Some requirements pertaining to this case include:

3.8.6.1 "It shall be possible to shorten a given MA using a special procedure between on-board equipment and RBC. The procedure is as follows:

- (a) The RBC proposes a new MA with an EoA closer to the train than the current EoA/LoA, optionally with a mode profile
- (b) The ERTMS/ETCS on-board equipment shall check the train front end position versus the Indication supervision limit of the proposed shortened MA.

- If it is in rear, the on-board equipment shall accept the new MA.
- If it is in advance, the request shall be rejected and the previously received MA remains valid.

(c) The RBC shall be informed about the decision.”

The description in figure 4.2 also provides supplemental details for the scenario. From these requirements some basic scenarios are constructed to create a test case that can be simulated on a testing rig. These test cases are written in natural language, and include the results expected from the test. An example pertaining to the shortening of a movement authority is as follows:

TEST-03.1

”a. After the RBC has sent a valid MA to the train 1, and that MA has been accepted by the train, the route inside that last sent valid MA is pulled by the interlocking (i.e. a Proceed Authority (PA) is removed within the current MA area) resulting from a signal within the MA changing to a red aspect. The RBC then proposes a shortened MA to train 1, which the train accepts.”

”b. After the RBC has sent a valid MA to the train 2, and that MA has been accepted by the train, the Signal near to the Train inside the last sent valid MA is pulled by the interlocking (i.e. a Proceed Authority is removed within the current MA area) resulting from a signal within the MA changing to a red aspect. The RBC then sends a shortened MA to train 2, which the train rejects causing the RBC to issue train 2 with an Unconditional Emergency Stop (UES).”

Expected Result: a. Train 1

1. When the Train1 is in VPCA of SX, confirm that the RBC sends long MA to the Train1.
2. When the signal towards end of MA is pulled, confirm that the RBC sends SMA request and the SMA is granted by the Train1.
3. Confirm that RBC provides the shortened MA to the train1.
4. Confirm the train1 stops at red signal.
5. When the pulled signal is set again, confirm that the RBC extends MA.
6. Confirm that no other unexpected results occurred.

b. Train 2

1. When the Train is in VPCA of SY, confirm that the RBC sends long MA to the Train2.
2. When the Signal near to start of MA is pulled, confirm that the RBC sends request to SMA and the SMA is rejected by the Train2.

3. Confirm that no other unexpected events occurred.

From this test case, a test script is created for use on the testing environment.

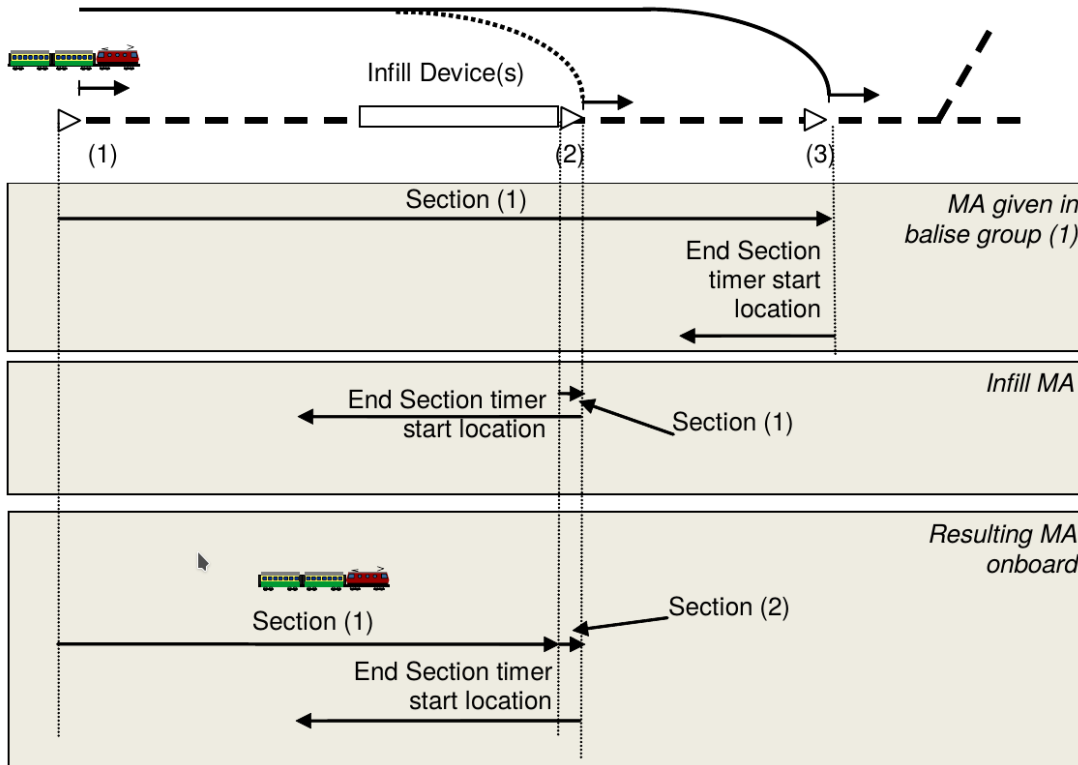


Figure 4.2: Shortening of an MA with Infill information

4.2.2 Running a Test (RETS)

The environment used in Siemens for testing and simulation is the Railway Environment and Train Simulator (RETS) software. It is primarily used for the testing of Radio Block Centres (RBCs) and interlockings, but also has use as a tool for demonstration, design, estimation, and verification purposes. In order to perform a simulation, RETS requires three primary inputs. The first is the track layout, presented in ldl format. The second is the journey file (.rjs), which details the initial state of a train, as well as any changes made to the tracks (occupancies, failures, etc.) that may happen as the train advances. Lastly a scenario file (.rss) which references the journey file, which contains the initialisation for the trains based on the time passed within the simulation along with the general time constraints.

Following the "Shortening of an MA" example, the following test scripts were written:

Figure 4.3: TEST-03.1 ShMA.rss

```

1      00:00:01 StartJourney (6062544, "C:\F2 scripts\SMA\TEST
2      -03.1_ShMA_Train1.rjs", "RETS2", "Desiro City FLU", "
3      Aggressive", "None", 0, true)
4
4      00:05:01 StartJourney (6062545, "C:\F2 scripts\SMA\TEST
5      -03.1_ShMA_Train1.rjs", "RETS2", "Desiro City FLU", "
6      Aggressive", "None", 0, true)
6
6      00:20:00 EndScenario

```

Figure 4.4: TEST-03.1 ShMA.rjs

```

1      WriteLog ("=== Start of Test: SHORTEN MA TEST 03.1 ===")
2      InsertLabel ("S0301")
3      InitTrain ("S5012", 15, "NC", "Apply Brake")
4      OperateTrain
5      ChangeCommsStatus ("C","Valid")
6      SetTrackCctTrigger ("TZAAG", "Occupied", 0)
7      ReleaseRoute(1, "QXS5004", "QXS5004", 5, 2)
8      Wait (Duration, 1)
9      SetTrackCctTrigger ("TZAAD", "Occupied", 0)
10     RequestRoute(1, "QR5004B(M)", "QR5004B(M)", 5, 2)
11     WriteLog ("=== End of Test: SHORTEN MA TEST 03.1 ===")
12     InsertLabel ("E0301")

```

In these scripts two generic trains are initialised at the start of the track 5 minutes apart. The first train receives a movement authority and travels until it reaches a flagged track. After reaching this flag a track ahead of the train is marked as occupied and thus the train must stop so as not to reach this track, and so must receive a shorter movement authority, eventually coming to a stop. Meanwhile the second train will start while the first is in motion, and when the first train slows and stops the second must do the same so as not to infringe on its movement authority or collide. As the second train slows however, it will reach a second flag freeing the occupied track that stopped the first. Both trains can then be granted new movement authorities again as their path is now cleared.

4.2.2.1 Test Results

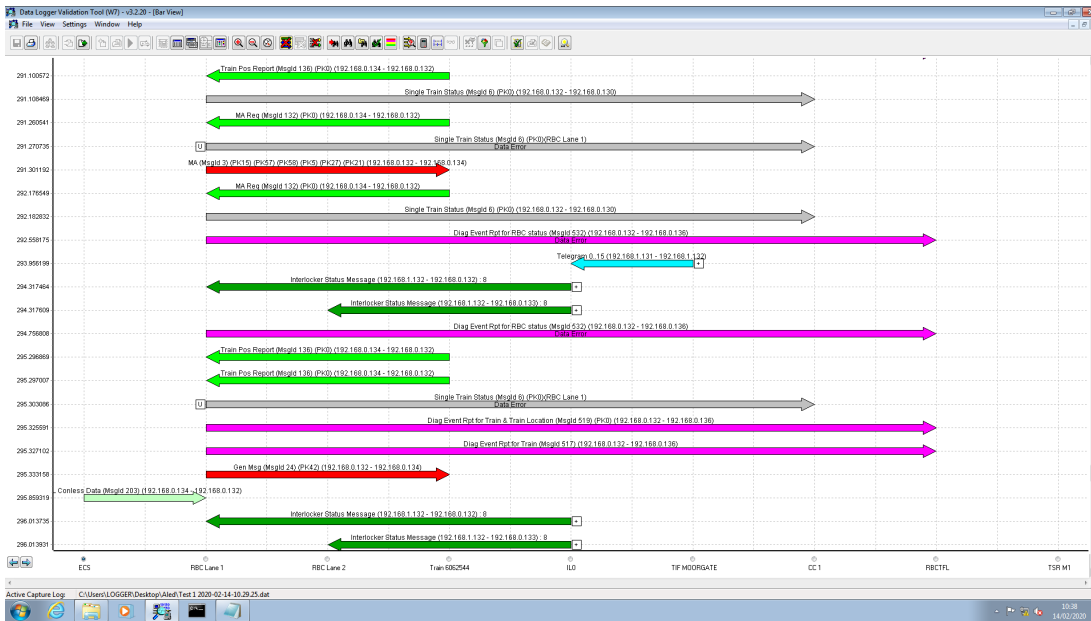


Figure 4.5: Example of Datalogger graphical representation

To determine the results of the test besides direct observation, RETS can be used in conjunction with a Datalogger. This monitors and records the communications sent between the components simulated (e.g. train, interlocking, RBC). The recorded data files can be viewed within the datalogger in a graphical format as in figure 4.5, or in a text format as in figure 4.6, allowing individual messages to be selected and their contents examined. The datalogger can also export the data into various formats (text, tabulated) for separate analysis.

Time	Message Name
0.042777	Telegram 32_47 (192.168.0.132 - 192.168.0.131)
0.050998	Interlocker Status Message (192.168.0.132 - 192.168.0.132 : 8)
0.059142	Interlocker Status Message (192.168.0.132 - 192.168.0.133 : 8)
0.101208	Heartbeat (MsgId 2) (192.168.0.130 - 192.168.0.132)
0.104207	Telegram 32_47 (192.168.0.131 - 192.168.0.132)
0.243499	Telegram 48_63 (192.168.0.132 - 192.168.0.131)
0.204234	Telegram 48_63 (192.168.0.131 - 192.168.0.132)
0.416213	RBC Status Message (192.168.0.132 - 192.168.0.132 : 8)
0.477826	Telegram 0_15 (192.168.0.132 - 192.168.0.131)
0.528672	Heartbeat (MsgId 2) (192.168.0.132 - 192.168.0.130)
0.554258	Telegram 0_15 (192.168.0.131 - 192.168.0.132)
0.678889	Telegram 16_31 (192.168.0.132 - 192.168.0.131)
0.794185	Telegram 16_31 (192.168.0.131 - 192.168.0.132)
0.950158	Heart Beat Request (192.168.0.132 - 192.168.0.138)
0.951351	Heart Beat Answer (192.168.0.138 - 192.168.0.132)
2.156498	Data Error - Diag Event Rpt for RBC status (MsgId 532) (1...
4.354887	Data Error - Diag Event Rpt for RBC status (MsgId 532) (1...
5.054572	Telegram 16_31 (192.168.0.131 - 192.168.0.132)
5.556687	VL Connect Data (MsgId 203) (192.168.0.134 - 192.168.0.132)
5.860116	VL Connect Indication (MsgId 190) (192.168.0.134 - 192.168.0.132)
5.883411	VL Connect Data (MsgId 203) (192.168.0.132 - 192.168.0.134)
5.886193	VL Connect Data (MsgId 203) (192.168.0.134 - 192.168.0.132)
5.924973	Diag Event Rpt for ETCS Val and Channel (MsgId 530) (192.168.0...
5.942676	VL Connect Response (MsgId 21) (192.168.0.132 - 192.168.0.134)
5.995228	Interlocker Status Message (192.168.0.132 - 192.168.0.132 : 8)
5.995374	Interlocker Status Message (192.168.0.132 - 192.168.0.133 : 8)
6.472862	Diag Event Rpt for ETCS Val and Channel (MsgId 530) (192.168.0...
6.554220	Data Error - Diag Event Rpt for RBC status (MsgId 532) (1...
7.043329	Init Comm Session (MsgId 155) (192.168.0.134 - 192.168.0.132)
7.072357	Diag Event Rpt for Train (MsgId 517) (192.168.0.132 - 192.168.0.1...
7.082570	RBC / R31 System Version (MsgId 32) (192.168.0.132 - 192.168.0...
7.657344	Session Est (MsgId 159) (PK2) (192.168.0.134 - 192.168.0.132)
7.887453	SoM Pos Report (MsgId 157) (PK0) (PK5) (192.168.0.134 - 192.16...
7.893383	Data Error - Single Train Status (MsgId 6) (PK0)(RBC Lane 1)
7.923182	Can Msg (MsgId 24) (PK3) (192.168.0.132 - 192.168.0.134)
8.253371	Validated Train Data (MsgId 129) (PK0) (PK1) (192.168.0.134 - 1...
8.258625	Data Error - Single Train Status (MsgId 6) (PK0)(RBC Lane 1)
8.288419	Ack Train Data (MsgId 8) (192.168.0.132 - 192.168.0.134)
8.754137	Data Error - Diag Event Rpt for RBC status (MsgId 532) (1...

Figure 4.6: Example of Datalogger text representation

An example of output messages from the "Shortening of a Movement Authority" case are seen in the following extracts from appendices A3 and A4:

Figure 4.7: A3 Excerpt - Message 132: MA Request

```

1      17:06:54.044094 # MA Req (MsgId 132) (PK0) - Train 6062544
      - Dest:192.168.0.132
2      NID_MESSAGE = 132 (84h) (10000100)
3      L_MESSAGE = 26 (1Ah) (0000011010)
4      T_TRAIN = 28369859 (1BOE3C3h)
      (00000001101100001110001111000011)
5      NID_ENGINE = 6062544 (5C81D0h) (010111001000000111010000)
6      Packet 0 - TrainToTrack - Pos Report
7      NID_LRBG = 33777 (83F1h) (000000001000001111110001)
8      NID_BG = 1009 (3F1h) (00001111110001)
9      D_LRBG = 38.00 (metres) (26h) (000000000100110)
10     V_TRAIN = 10 (Ah) (0001010) "50 km/h"
11     Q_DIRTRAIN = 0 (0h) (00) "Reverse"
12     M_MODE = 0 (0h) (0000) "Full Supervision"
13     M_LEVEL = 3 (3h) (011) "Level 2"

```

Figure 4.8: A4 Excerpt - Message 136: Train Position Report

```

1      17:04:22.036355 # Train Pos Report (MsgId 136) (PK0) -
      Train 6062544 - Dest:192.168.0.132
2      NID_MESSAGE = 136 (88h) (10001000)
3      L_MESSAGE = 26 (1Ah) (0000011010)
4      T_TRAIN = 28354623 (1B0A83Fh)
      (00000001101100001010100000111111)
5      NID_ENGINE = 6062544 (5C81D0h) (010111001000000111010000)
6      Packet 0 - TrainToTrack - Pos Report
7      NID_LRBG = 33783 (83F7h) (000000001000001111110111)
8      NID_BG = 1015 (3F7h) (00001111110111)
9      D_LRBG = 282.00 (metres) (11Ah) (000000100011010)
10     V_TRAIN = 0 (0h) (0000000) "0 km/h"
11     Q_DIRTRAIN = 2 (2h) (10) "Unknown"
12     M_MODE = 0 (0h) (0000) "Full Supervision"
13     M_LEVEL = 3 (3h) (011) "Level 2"

```

These messages match the format described in chapter 8 of Subset-026: Messages, beginning with the time of the message, the message type and ID, the communicating parties, then the raw data sent. The datalogger takes this raw data and breaks it down in order to present it in a more understandable form, matching the packets as described in the requirements.

Once collected, results from the test are compared against the expected results derived in the test case.

In preparation for the second visitation stage, three test cases to run that were replicable in the RT-Maude model were decided on:

- Simple Train Movement: A single train moving from one end of the track plan to the other
- Movement of Two Trains: One train following another along the track plan
- Movement Authority Messages: Observing the messages sent when a train is requesting an extension to its movement authority

These three test cases could be performed on both the RETS testing rig and in RT-Maude, and the comparison of the message logs would provide a close comparison on the similarities of the two, along with what changes the RT-Maude model might require to improve its relevance. For more ease in analysing the log outputs, a parser for extraction of relevant data from the datalogger text outputs and model simulation traces was developed. These three test cases strike a balance of being basic enough to be able to examine and understand the message logs sent and compare them to a model whose similar trace would be a known sequence, while also adding variance in the movement of the train, where no defined position would be the cause of changes to the train movement as they would need to respond to live-occurring changes to the system.

This comparison using RT-Maude was done before the decision was made to move away from RT-Maude and time-based models, with the purpose of this testing and comparison to be a measure of the general concept. If an existing in-depth model could be used to gain comparisons while not being specific to the testing requirements, it would imply great potential for a model designed specifically with the testing requirements in mind, while also giving a good foundation to learn the Siemens methodology while operating with a model that is a known quantity.

The second stage began with finalising the test cases for use in the RT-Maude model, the parser for the datalogger, and scripts for use on the test rig. Once the test scripts were developed access was granted to the rig in order to run the tests and observe the outputs. After running each pre-written test case, time was spent on the rig refining the test scripts, in order to give more relevant or more easily observed output.

- Simple Train Movement:
 - The initial test featured initialising a train at one end of the track, then stopping the simulation and log gathering after it reached a certain point
 - The refined test set a track at the end of the line to be occupied, which would cause the train to come to a stop before the simulation would end, bringing it more in line with the exit track used in the RT-Maude model as a stopping point
- Movement of Two Trains:
 - The initial test featured initialising a train at one end of the track, followed by a second a minute later (allowing for the first train to move clear), then stopping the simulation and log gathering after it reached a certain point
 - The refined test had the same basic setup as the initial, but added conditions for stopping the first train by occupying a track ahead of it that would clear once the second train caught up, allowing observations of the two trains following each other more closely with requests more likely to occur as a result of the other trains action
- Movement Authority Messages:
 - The initial test featured initialising a train at one end of the track with the track beyond its current allocated route set as occupied until it reached the track before, allowing the train to slow first due to the inability to grant an extension request immediately. Once the train reaches the track before the occupation, the occupied track is released, with the track after the route extension being occupied to simulate an end point
 - The refined test was similar to the initial, but the first occupied track would instead be released after a set amount of time, rather than by the train's location. This would allow the train to come to a full stop while continually requesting an extension, until the track is released

4. Siemens Collaboration

After running these tests, the datalogger parser was set to extract the two message types pertaining to movement authority requests and allocation, and the remainder of the week was spent analysing the output of the datalogger for the test cases, and comparing these to the movement authority messages from the RT-Maude model.

One of the test cases tested on RETS was the observation of Movement Authorities. The idea behind the test is as follows:

- The train is initialised on the last track but one before a signal. On initialisation the track after the signal is marked as occupied
- Once the train advances to the next track will trigger a release of the occupied track, and occupation of the track before the next signal in turn
- The train will get its movement authority granted, and travel to before the beginning of the occupied track, slowing to a stop due to the occupation

The scripts used to initiate this test are as follows:

Figure 4.9: Test 2 - MA.rss

```
1      00:00:01 StartJourney (6062544, "C:\Users\Hylia\Desktop\  
2          Siemens\Test Cases\Test 2 - MA Request/Test2.rjs", "  
          RETS2", "Desiro City FLU", "Aggressive", "None", 0, true  
          )  
3  
4      00:20:00 EndScenario
```

Figure 4.10: Test 2 - MA.rjs

```
1      InitTrain ("S5005", 10, "NC", "Apply Brake")  
2  
3      OperateTrain  
4  
5      ChangeCommsStatus ("C","Valid")  
6  
7      FailTC ("TZAAF", "Occupied")  
8  
9      SetTrackCctTrigger ("TZAAE", "Occupied", 0)  
10  
11     FailTC ("TZAAF", "None")  
12  
13     FailTC ("TZAAJ", "Occupied")  
14
```

From the datalogger logs obtained by running these scripts, further analysis was applied. A script was used to enable the extraction of specific messages, in this instance the two message types based on movement authority communications were extracted, an example of which is in appendices A7 and A8, as shown in the following excerpts:

Figure 4.11: A7 Excerpt - Message 132: MA Request

```

1      17:06:54.044094 # MA Req (MsgId 132) (PK0) - Train 6062544
      - Dest:192.168.0.132
2      NID_MESSAGE = 132 (84h) (10000100)
3      L_MESSAGE = 26 (1Ah) (0000011010)
4      T_TRAIN = 28369859 (1BOE3C3h)
      (00000001101100001110001111000011)
5      NID_ENGINE = 6062544 (5C81D0h) (010111001000000111010000)
6      Packet 0 - TrainToTrack - Pos Report
7      NID_LRBG = 33777 (83F1h) (000000001000001111110001)
8      NID_BG = 1009 (3F1h) (00001111110001)
9      D_LRBG = 38.00 (metres) (26h) (000000000100110)
10     L_TRAININT = 248 (F8h) (000000011111000)
11     V_TRAIN = 10 (Ah) (0001010) "50 km/h"
12     Q_DIRTRAIN = 0 (0h) (00) "Reverse"
13     M_MODE = 0 (0h) (0000) "Full Supervision"
14     M_LEVEL = 3 (3h) (011) "Level 2"

```

Figure 4.12: A8 Excerpt - Message 3: Movement Authority

```

1      11:06:05.511138 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (
      PK27) (PK21) - Train 6062544 - Dest:192.168.0.134
2      NID_MESSAGE = 3 (3h) (00000011)
3      L_MESSAGE = 68 (44h) (0001000100)
4      T_TRAIN = 69546308 (4253144h)
      (00000100001001010011000101000100)
5      M_ACK = 0 (0h) (0) "No acknowledgement required"
6      NID_LRBG = 33777 (83F1h) (000000001000001111110001)
7      NID_BG = 1009 (3F1h) (00001111110001)
8      Packet 15 - TrackToTrain - Level 2/3 MA...
9      Packet 57 - TrackToTrain - MA Request Params...
10     Packet 58 - TrackToTrain - Pos Report Params...
11     Packet 5 - TrackToTrain - Linking...
12     Packet 27 - TrackToTrain - International SSP...
13     Packet 21 - TrackToTrain - Gradient Profile...

```

Much of the information obtained in these messages do not correspond to the message contents seen in the RT-Maude model, and can therefore be ignored for the purposes

of this comparison. The relevancies appear in the train position values (calculated in accordance with their last relevant balise group passed) and new movement authorities, among others.

4.3 Outcome of First Iteration when Tested Against Industrial Simulations

The aim for the next iteration of the testing model needs to build on the existing work, while also including the new information provided. More specifically it should consist of an Interlocking, RBC, and a Train. Within these elements there should also be a controller to handle the requesting and releasing of routes. An Interlocking will need to observe track occupancies and route occupations, communicating with the RBC in order to assign available routes and handle proceed requests, while also receiving updates from train status in order to update the topology status. The RBC should act as an intermediate between the Train and the Interlocking, dealing with movement authority requests from the Train, and receiving route availability from the Interlocking. The Train needs to be able to traverse a given topology, which should include points and balises as more complex elements. The Trains could also be able to transition between levels of ERTMS operation, which would be reflected in its communications. The particular are of interest with the model will be within the messages exchanged between the components.

Regarding the use of Real-Time Maude in this case, there is correlation but also remains a disconnect in the information from the traces. The RTM model is implemented using a defined zero position point at the beginning of the track, and does not incorporate balises. In contrast the datalogger trace specifically uses balises as its position references, with a zero point based on where a train transitions into ERTMS level 2, then measures the position of trains based on their distance from the balises they last passed. In general the RTM model is too granular for the message traces required to perform these comparisons, with a further degree of abstraction required to compare test cases most effectively.

After discussions held with Siemens it was decided that including a timed system in the model is not necessary as the primary concern is the order and triggering of messages, rather than the time difference of the messages. As such it was decided that a different modelling language may provide a more effective alternative to RTM, and it was decided to create the next iteration of the model in CSP||B.

Part III

Development and Contribution

Chapter 5

Development and Contribution

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5.1 Initial Concepts behind the model design

For the second developmental stage the model needs to be able to provide the correct messages to and from the RBC. The model must be able to only give out movement authorities to a train in a safe way. An example of this being if a train is approaching the end of its authority but the next possible route is currently occupied, then the RBC should not give out a movement authority. With regards to requesting a route, this should be triggered by a message from a train as it passes a particular balise towards the end of its current authority. The RBC would then need to communicate with the interlocking to determine available routes. This gives examples of multiple messages sent to and from the RBC available for monitoring and comparison. This model should also be verifiable when model-checked for safety features, with collision prevention being a key test.

As mentioned at the end of the previous section the modelling language changed from Real-Time Maude to CSP||B. The main difference in this change will be the switch from a time-based model to an event-based model. As such actions - and more importantly messages - will take place based on the current general state of the actors (i.e. trains, track occupations, and routes) within the system rather than the precise positioning of trains in the system at measured intervals. Using Real-Time Maude, the focus is placed more on the movement and position of the trains themselves. In order to ensure accurate movement our RTM model implemented the equations of motion

to determine the speed and acceleration of trains, and had been built around a design that monitored train position on the track at all times, using the end points of the track as reference. This model focused more on the implementation of ERTMS itself ensuring all main components were implemented. After establishing what our partners at Siemens are looking to test specifically, the focus has moved away from the addition of a new control element into an existing railway control system, and has become the verification of the new element itself. It is already known that the RBC functions within the system, and can handle the allocation of routes to trains, what has now become of interest is to establish whether it is doing so in a way that is correct and safe. The focus as such shift from specific train positioning to RBC communication, and whether the correct information is being sent and received at the correct time. This means a persistent awareness of the entire system is not needed, only the state of the system at specific intervals, allowing us to expand on elements missing from the RTM model such as balises and the triggers and reference positions they allow.

In using CSP||B over Real-Time Maude, we are able to fully examine the state of the system at key intervals. Knowing we seek to examine a flow of information allows us to implement defined information channels between ERTMS components, allowing for clear transmission of data allowing for an approximation of the data exchanged by the real equipment. Given the use of the combination of both CSP and B there will be cases where topological data relating to the track plan will need to be duplicated, and given complexity of real-world layouts a significant effort will be required to ensure the scheme plan is accurately implemented. Despite this, the ability to generalise the setup of a model in CS||B offers a significant opportunity for scalability, as the definition of interactions and control systems alongside a logical system for managing communications means topologies can be kept separate from the operational element of the model. This should allow a simple exchange of the topological files to need little re-integration and allow multiple scheme plans to be tested with one core model. Importantly this will also lead to a reduced number of statespaces within the model which will give improved model-checking validation times.

As to the requirements of the new model a primary inclusion to give it more relevance to the Siemens simulations is the inclusion of balises. These will act as triggers within the system, setting a defined point where trains will send messages. These messages will be what drives the requesting of routes from the RBC, as well as serve as positional reports. These also serve as set events within the system, meaning messages will only need to be sent within the system when a change is required, thus leading to an event-based system which operates on a key event basis.

Previous work exists with regards to modelling trains and Interlockings within CSP||B [1], and there is concurrent work being done in simulating key event-based Train movements. As such a pooling of resources provides a good starting point for development. Using a previously designed Interlocking system as a basis for state changes within the B-machine section of the model, and collaboration in the development of a CSP-based event-driven Train, more attention can be given to the development of an RBC that communicates with both elements. As the RBC is the particular aspect under test, this developmental approach also echoes the introduction of RBCs in general into

the railway industry, where they are required to cooperate with pre-existing systems.

In initial development the model will be created using a simple track layout, smaller than the one that will be tested in future. Once the model is operational and model-checked in this simple form, it can be changed to reflect the real-world Moorgate-Holloway track plan provided by Siemens. This will be accomplished thanks to the modular nature of CSP||B allowing for topology files to be used that contain the details of the track plan, while the operational section of the model can be made generic allowing it to be applicable no matter the layout.

5.2 Final Methodology

A spiral methodology of development was implemented to design the model. It began with discussions with our industry partners. In both our model and in industry simulations we assume the track equipment to function with out mistake. To create a model suitable for this project we begin by using the track plan introduced in figure 2.1. This layout was designed taking into account the specifics required by Siemens, taking into account a zero point to be used as a positional reference for all components, and includes multiple balises to be used as further positional reference for trains, and for triggering reports and requests. For successful implementation a train must be able to enter this layout and travel from one end to the other via either available route, and not exceed its movement authority while doing so. It will need to report its position once passing balises, keeping the interlocking informed of its current track occupation. When passing specific balises a train should send a movement authority extension request to the RBC, which will in turn confirm available routes with the interlocking then either confirm or deny the extension. As the interlocking is responsible for maintaining data on the availability of tracks and routes, it is the first thing to be devised. A simple train and controller can then be implemented to verify the interlocking functionality. Once verified the RBC is incorporated to handle the assignment of routes. After completing the development of this simple layout it can be validated for correctness and verified against safety properties, and once satisfied the next cycle of development can begin with the implementation of the larger track plan.

Once a model is developed the first step is to verify the implementation of the topology. Depending on the scale of the model this may be done by manually observing simulations or by allowing multiple simulations to run randomly and examine their path afterwards. In other cases a model check can be run to ensure the correct sequence of events takes place, and an incorrect one cannot. If a train travels somewhere that it should not, or otherwise does not respond correctly to commands then that error can be analysed. Once satisfied with the implementation of the topology the system can be model checked for safety properties. In our case we look to verify that no two trains can ever occupy the same space concurrently, as safety is the primary concern, specifically in that the trains move as instructed.

5.3 A CSP||B Model of ERTMS

The primary aim of the model is to provide an environment simulating the systems of ERTMS with particular focus on the communications sent to and from the RBC. The CSP elements of the system handle the operation of the system, providing the impetus for the systems operations. This mainly consists of a Train operation in parallel with an RBC operation. Note the RBC has multiple states depending on what stage of route allocation it is at. The B-machine section of the model deals with the logic of the system, as well as the state of the variables of the components. This section will include examples of data to show the structure of the model.

This model will need to contain numerous components of a railway system:

Generic Components

- **Tracks**, which are the identified areas of the scheme plan.
- **Connectors** serve as the joints between track circuits, marking the boundaries of train locations.
- **Balises** serve as areas of note along a track. These can be treated as connectors that break a larger/whole track into segments, with more specific identifiers for before and after balises. These serve as the trigger to numerous messages sent through the system relating to position reports and route requests, and can be directional.
- **Markerboards / Signals** act as route separators and indicators. In a classical railway system (below ERTMS level-2) physical signals are used to indicate to a driver whether a route is safe to proceed along. In ERTMS level-2, markerboards can be considered as digitised versions of signals, used by the RBC to group tracks into routes, and along with the Interlocking determine the availability of said routes. These can be directional.
- **Points** are the splitting of a track into two branches. Two positions are possible for points - normal or reverse - which are set by the Interlocking to determine the track connections. Points are associated with specific tracks, which consist of three connectors.
- **Crossings**, an intersection of two tracks also known as a "diamond crossing". Trains cannot travel across the intersecting tracks, and occupation of both tracks must be considered in relation to the other. Crossings will consist of four connectors, and are tied to four tracks that contain points.
- **Routes**, a group of tracks tied to a markerboard. This designates a path through the system defined by tracks and connectors. Entry and exit routes can approximate operation at level NTC (National Train Control) as they deal with the train entering and leaving the RBC controlled area.

These components are assigned as datatypes within the model. Tracks are first defined as a *Unit* datatype to account for an extra (abandoned) track that exists outside of the main layout as an additional safety check. Tracks can then be categorised into subtypes of *All Tracks* which contains all tracks bar the additional abandoned track, *Whole Tracks* which includes only whole track segments ignoring subdivisions from balises, and *Track Points* which are the tracks in the system that contain a point. *Points* themselves are also assigned as defined datatypes, and also have datatypes for their positions.

```
datatype Unit = AA | AB | AC | AD | ABANDONED_TRACK
subtype ALLTRACK = AA | AB | AC | AD | AC_left_b1 | AC_b1_b2 |
  AC_right_2
WholeTrack = {Track | Track <- {AA, AB, AC, AD}}
subtype trackPoint = AB | AE
datatype POINT = P1 | P2 | nullpoint
datatype PointPosition = NORMAL | REVERSE
```

The splits between tracks *connectors* are also a defined datatype, and are split into two subtypes. *Track Connectors* are connectors that split the *Whole Track* segments as detailed above, while *Balise Connectors* separate these track segments up into before and after balises. *Balises* too are given a defined datatype alongside the connector classifications as well as an identifying directional datatype, to describe which directions of travel a balise should be triggered.

```
datatype Connector = entry | exit | a | b | c | d | e | x | y
  | z | bal_b1 | bal_b2 | bal_b3 | C0
subtype trackConnectors = a | b | c | d | e | x | y | z
subtype baliseConnectors = bal_b1 | bal_b2 | bal_b3
datatype Balise = b1 | b2 | b3
datatype BaliseDirection = leftwards | rightwards |
  bidirectional
```

To handle routes within the system, *Markerboards* are also defined. These are assumed to be in a rightwards facing direction by default, and have a subtyping of *Leftward Marker* to specify those that deviate from this assumption. These markerboards also have two possible states (similar to signals in level NTC) that indicate their availability, again with a defined datatype: *Marker Signal*. These markerboards will denote the starting points of *Routes*, which are themselves given an identifying datatype.

```
datatype Markerboards = MB0 | MB1 | MB2
subtype LeftwardMarker = MB0
datatype MarkerSignal = red | green
datatype Route = Route_0 | Route_1 | Route_2
```

Finally the *Trains* themselves are identified by a datatype. Also required in the model are datatypes that represent the possible information required to calculate and communicate movement. As such, two further datatypes (*Answers* and *Direction*) are

defined.

```
datatype TRAIN = Train_1 | Train_2
datatype ANSWERS = yes | no
datatype DIRECTION = dLeft | dRight
```

With these datatypes defined, functions are also defined to group these into sets for any required calculations. *Entry* and *Exit* tracks can now be classified, connectors can be split into those on separate lines, and tracks with markerboards or points can be defined.

```
lowerConnectors = {a, b, c, d, e, bal_b1, bal_b3, C0}
upperConnectors = {x, y, z, bal_b3}
ENTRY = {entry}
EXIT = {exit}
MARKERBOARDHOMES = {entry, b, z}
BaliseConnectorDistances = {distance(connector) | connector <-
  {bal_b1, bal_b2, bal_b3}}
PointTrack = {a}
```

Train Movement The movement of the train is the driving force of the system. This requires:

- **RBC** - At all points the RBC is able to request the addition of new available routes, and removal of previously requested routes. Both of these operations send a route identifier to the Interlocking, and based on the response will add or remove the specified route from the list of potential routes.
- **RBC (Initial)** - In this stage the RBC is waiting for a MA request from the train. From this request the RBC takes the trains most recent balise identifier and its direction of travel, determines continuing routes corresponding to this information, then moves to its *Requesting* stage.
- **RBC (Requesting)** - In this stage the RBC first establishes whether it has any routes available that match the previously determined continuing routes - if it does not then the MA request is denied and the RBC reverts to its *Initial* stage. If there is a match then the availability of the matching route is confirmed with the Interlocking. If this is confirmed then the trains request is officially accepted and the RBC moves to its *Granted* stage.
- **RBC (Granted)** - In this stage the RBC confirms the parameters of the new route with the Interlocking, then from this confirmation relates the new route constraints to the train, and removes the route from its list of available routes. This finalises the route request process and the RBC returns to its *Initial* stage.
- **Train Entry** - In order to initialise a train in the system, a train ID must be specified along with an entry track. This information is sent to the Interlocking,

and if confirmed will allow the train to be initiated on an entry track with a route that is an approximation of level NTC, with a direction of travel. This route sets the train at the point where it is first required to communicate with the RBC by requesting a route.

- **Train** - This is the main operation that runs the system. The train keeps track of its identifier, direction of travel, current position and end of authority distance in reference to a specified point within the scheme plan ("zero point"), last balise passed, current track, and target connector. This allows for the calculation of movement through specified route allocations, track connections, and messages triggered by balises. There are five possible actions for a train depending on its current variables.
- **Train (Connector)** - If a train is at the position of a connector (that is not a balise) then a message is sent to the Interlocking signalling that it is about to change tracks. The Interlocking will reply with a new track designation and target connector and the train will pass the connector, otherwise the system will stop.
- **Train (Balise)** - If a train's position matches that of a balise it sends a position report. If this position report corresponds to the end of a route then a request is sent to the RBC for a new movement authority, otherwise it will pass the balise. If a train sends a MA request at this point, it will only leave this stage once the request is granted. If the request is denied it will send a new request.
- **Train (Exit)** - If the train's position matches its end of authority then a message is sent to the Interlocking to remove it from the system. In this system the train should only ever reach the end of its movement authority when not under RBC control (i.e. level NTC), otherwise a route will always be requested with a buffer to the EoA.
- **Train (Exceeded)** - If the train is in a configuration where its current position is beyond that of its assigned movement authority, then the system will stop as safety cannot be guaranteed. This should not occur in normal running.
- **Train (Next Action)** - If the train is in none of the other stages, then it is at a point on a track where no actions of note occur. In this situation the train moves to the position of the next connector along its route, as no changes would occur to the system under test until this position is reached.

5.3.1 B-machines

- **Train Entry** - On receipt of an entry request from a train, the Interlocking should be able to confirm the availability of the specified entry track, and relay a confirmation or denial reply to the message. If the requested entry track is occupied, then a train should not be allowed to enter the system.

- **Train Exit** - On receipt of an exit request from a train, the interlocking should remove the train from the system.
- **Route Request** - Once a route availability request is received from the RBC the interlocking should only grant the request if all of the requirements for a clear route are met. The route should be marked as available, and the tracks tied to the route should be free of trains. If these conditions are met, then any points relating to the requested route can be changed to their correct position, and the route marked as set. A denial will be sent if the clear conditions are not met, and there will be no change to the system.
- **Proceed Request** - In order to confirm that a route is available before it is formally granted the Interlocking will need to respond to an RBC message: a positive response will be given if the requested route has been marked as set and it's markerboard is free. This will ensure that the RBC and the Interlocking are matching in their configuration of possible routes, and allows for the rejection of a route if there is an additional requirement from the Interlocking.
- **Route Grant** - On receipt of a route grant request from the RBC the Interlocking may only grant the route if it has previously been set by the Route Request operation. If this is the case, then the points are checked to be in their correct position, then marked as locked. The corresponding markerboard for the route can be assigned the granted status, and the RBC is sent a confirmation of route and the next position of the train can be calculated. On denial there should be no change to the system.
- **Route Release** - If the RBC requests the releasing of a route, then the Interlocking will check the validity of the request. If the route has been set prior to the request but not granted, and the corresponding markerboard is free then the route is marked as released and any related point locks are cleared. Otherwise no change should occur.
- **Clear Route** - The Interlocking should receive a clear request once a train has cleared its assigned route. The Interlocking will then free the markerboard status and point locks relating to the route, and remove the granted status from the route.
- **Track Change** - The Interlocking will monitor the occupation of tracks that move within it's domain. Once a train reaches a connector separating tracks the interlocking should receive a position update. The trains current track occupation will be used along with the current state of the system (accounting for any point positions) and update its registered occupied tracks, while also releasing point locks if the track position is valid. This position update is then confirmed with the train along with a target connector.

5.3.2 Data Assignments

- **Markerboards** - Markerboards are assigned their related route, along with the track they are located on, and the directional configuration of the track balises. This allows for markerboards to relate to specified directions of train travel.
- **Tracks** - Tracks require multiple logical states. Some tracks are specified as entry points to the system, as well as the direction of entry. All tracks must be assigned directions of travel with relation to the track connectors that bound them. If a track allows bi-directional travel or branches at a point or crossing then additional directional configurations must be accounted for.
- **Connectors** - Connectors serve as the main descriptors for the connections between tracks, and as such are crucial to the implementation of a track layout. Connectors corresponding to tracks that do not contain points will have static configurations in relation to the directional capabilities of the track, while those corresponding to tracks with points will need additional configurations defined to account for the branching connections of said tracks.
- **Points** - Routes are required to be assigned to points in order to know their required position when in use, and their status when a route is selected (locked or free). These consist of *normal* and *reverse* designations. The releasing of a point is also defined, with an association to a track on a route.

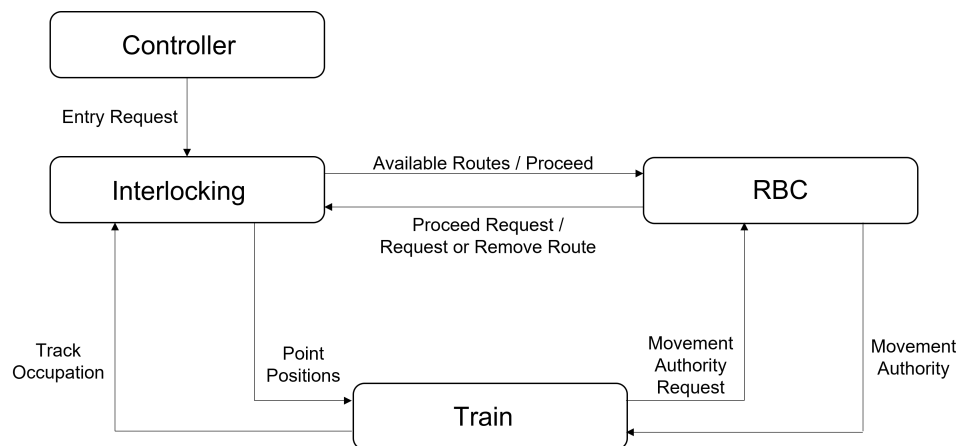


Figure 5.1: Illustration of messages sent through the system by its components

5.4 A Simple Scheme Plan

5.4.1 The Scheme Plan

On establishing a base for the new model a simple track plan becomes useful for smaller-scale testing and simulations, ensuring that the logic of a system is sound before more

complicated data has to be introduced. It is important however to ensure the simple implementation still has enough features to enable for thorough testing of all possible communications and situations. As such it was key to ensure that the simple plan features multiple balises, at least one point to allow for multiple lines, and bi-directional travel. In addition, real-world models tend to have a reference in relation to multiple distance points, so it was also important to encode the track plan such that the distance reference of a train does not simply begin at 0 at one end. Taking this into account the track plan shown in figure 5.2 was developed.

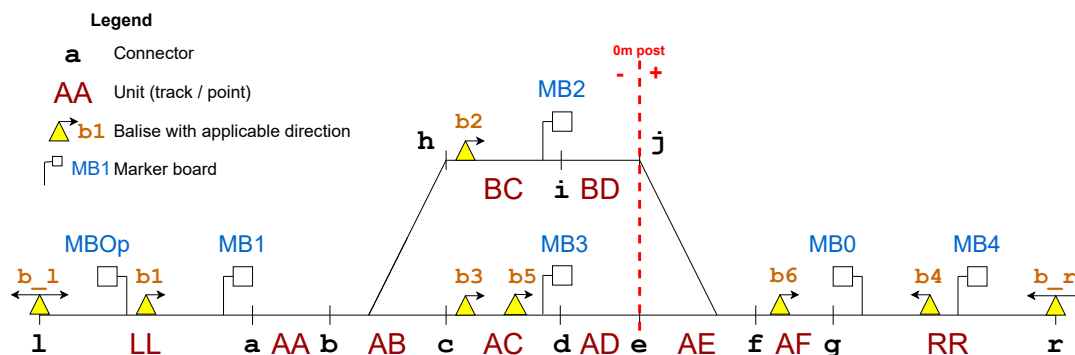


Figure 5.2: Simple track plan used for initial development

By creating a simple plan based on a common station layout instead of a real-world one we can establish the essential elements needed to have a functional system. By establishing the requirements of the model, these can be matched with accepted railway features while not requiring the precision of positional values that comes with real world data. This will lead to advantages in the development of the model as any errors found while developing can be diagnosed more effectively when the precise topographical construction is known. Real-world data can often have quirks brought on by the restrictions of the environment it is being developed for. While this is important to capture, not all of it is essential to the modelling. In the same way that we abstract from the full operation of the industrial simulations, by taking a simple scheme plan when can abstract from real-world data key points to use in our model.

While the system under test is the RBC, it is necessary for a railway simulation to feature other systems in order to operate. These other systems would be the interlocking, controller, and trains. The main control section of the model will be run using CSP code, thus the train and RBC itself would fit best within the CSP aspect. This allows for easy communication between train and RBC, while the overall topology status is maintained in the interlocking logic in the B-machine. As previously mentioned, work was done modelling railway interlockings in CSP||B[1]. In this model the interlocking has a method for determining the next position for a train to move to based on the current state of the track equipment (i.e. point position and occupied tracks). This method of determining movement is entirely sufficient to include in this model as the calculation of the next position would be the main hurdle of an interlocking in the model

development. As it is not the system under test and has been previously validated it is in an ideal place to examine how an RBC under development would communicate with pre-existing interlockings.

A key factor in the development of the new model was that not all interactions are necessary for completeness. Rather than observe the state of the system at every individual metre step taken along a track of length 500m (for example), if it is known that the only messages sent from a train occur as it passes a balise or changes track, then the model can be based around larger jumps to these key areas. This will massively reduce the statespace (and memory) required for both simulating and (more importantly) model-checking the system. By using connectors to represent key fixed points in the track plan (i.e. track transitions and balises) it is known that any time a train is on a connector it should react in some way, while if it is not on a connector then the only action it should take is to move to the next connector based on track conditions and route allocation.

Numerous messages will be sent during the entire simulation, and while a number are useful to monitor for expected proceedings the primary messages of interest in this case are those sent to and from the RBC. There are three of these messages, one of which has bi-directional communication. First is the request from train for an extension of movement authority. On receiving this message, the RBC will check whether it currently has a suitable route available to assign. If this is the case the RBC confirms the route with the interlocking as occupied. Finally it assigns the new route to the train. If there is no available route, or the interlocking denies the occupation then the train receives a rejection, and is able to re-send its extension request.

The model consists of 6 files, 3 each in CSP (Operation, Topology and Control) and B (Context, Topology and Interlocking). On the B machine side the track plan is detailed across the Context and Topology files. The context B-machine is responsible for establishing the variables and types of the track plan, such as defining train id, track names, and other scheme relevant features. The topology B-machine contains the relations between these variables. This includes correspondence between markerboards and routes, tracks and connectors, configurations based on direction of travel, point tables, and more. The interlocking B-machine is what handles the changing of states during simulations, and is the element that communicates with the CSP controller. It is the interlocking that handles the confirmation of route allocations to the RBC, records the movement and position of trains, and deals with the general configuration of the system such as point positions and track occupancies. On the CSP side, the Operations file contains the generic functions that ensure any variables used by the controller are in the correct format, and convert between the data types established by the model. Within the Topology file is once again the model variables and types for use of the CSP components. This also contains information such as route configurations and relations to track components, balise classification, movement authorities, and distance values among others. The Control file contains the Main function used to initialise the model. It also defines the communication channels and contains the function that deals with the movement of the train to the next action. The control file also contains the RBC implementation that uses communication channels to the train and to the interlocking.

The full models can be seen in Appendix A.

5.4.2 Validation

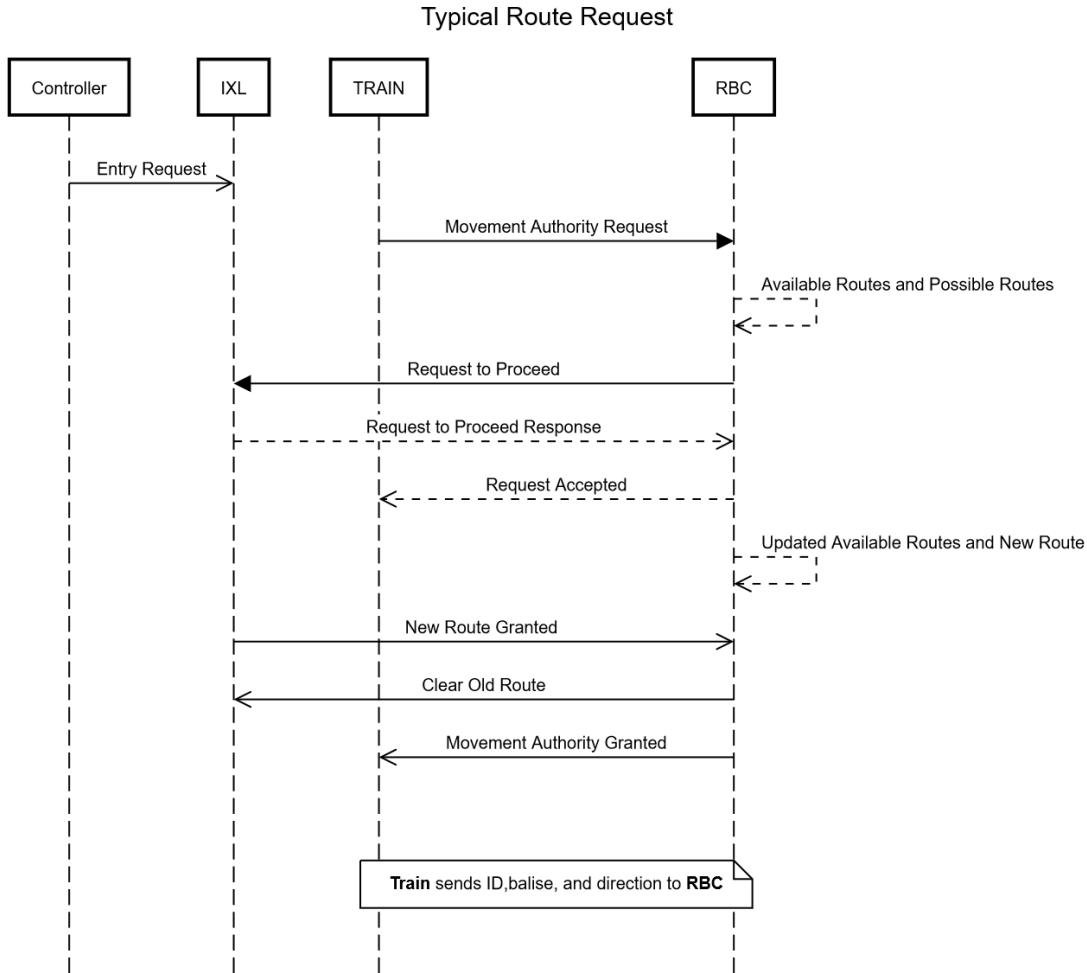


Figure 5.3: Sequence diagram of standard request messages sent through the system

To validate this model, the message sequence as shown in figure 5.3 should be followed as our ultimate test aim is the corroboration of messages between the model and simulations. By ensuring this sequence is followed and the movement of the train is controlled, we can say that the model represents the actual behaviour of the system.

In the model, the train is expected to initially only be added to the system once an *Enter* message is communicated. On adding a train, it will trigger a balise message. This balise message will cause the train to request a new movement authority from the RBC. The RBC will cross-check with the Interlocking to determine the next route for the train, and request it's availability. If available, the movement authority of the new route is communicated to the train. The train can then progress to its next action

of note, i.e. the next connector along its path. If the next connector is a transition between *Tracks*, then the train communicates with the interlocking to determine its next target connector, which the Interlocking will determine based on the current point positions. Once the next connector is confirmed the train will continue along its route, informing the interlocking of its track change. If the connector reached by the train is a balise, then the train reports that it has passed a balise - if the balise is of the VPCA designation, then a new movement authority will be requested, otherwise it is treated as a position report, and the train continues its journey. Once a train reaches the point of the track designated as the exit (as established by a specific exit route) the train is removed from the simulation by the interlocking. In a simulation the train should be able to move across an entire track plan, including track changes with relation to point positions, and reach the exit point. As this matches the expected behaviour of the system, it can be said to be valid and meets our requirements.

In the trace generated by the ProB simulation (Appendix C: Train Across Top Track (Initial Model)) the train can be observed entering at the leftmost entry point, requesting multiple routes, including a route based on a point in reversed position, travelling across the upper section of the split track, before rejoining the lower line and proceeding to the exit.

5.4.3 Verification

One of the primary aims of creating a formal model of a railway scheme plan was to be able to perform model checking and verification in a more efficient environment. While the model can be valid and matches its requirements, in the case of the railway domain safety is critical. It is possible that a train has valid movement but does not move in a safe way. This could be receiving incorrect movement authorities, receiving messages but not acting on them, or receiving messages that are not applicable to its current state. If there are multiple trains in the system this could lead to collision. It is also possible that while route information is communicated between the interlocking and RBC, the track layout and points do not reflect the changes, leading to potential derailment. Therefore it is important to also verify the system to ensure that it operates within strict safety parameters.

As the checking and verification of such a model can usually be performed quicker than performing repeated simulations with industrial testing setups, there is the potential to discover errors and inconsistencies more effectively. A key safety condition of a railway system would be collision-freedom, that is to say multiple trains cannot collide with each other. Within the CSP controller is a communication channel *collision* set up exclusively for error checks using the function *ERR* as a constant listener for the corresponding *collision* channel linked to an operation within the interlocking. The *ERR* operation will only be enabled if multiple trains are in operation and they have matching track position values, thanks to the *pos* function in the interlocking which allows the trains to be mapped to the track segments that they currently occupy (excluding the entry and exit tracks). By use of the computational tree logic (CTL) model checker provided within the ProB tool the validity of the formula:

$$AG(\text{not}(e(\text{collision})))$$

can be checked. This formula will be True if no two trains occupy the same tracks at the same time, and False otherwise (i.e. there is a collision). In this CTL variant AG represents "globally true on all paths", and $e(f)$ represents "event f is enabled". Track occupation is used rather than precise locations as an abstraction, making use of the reduced statespace afforded by focusing only on major actions.

Using Computation Tree Logic (CTL), ProB can run a verification check for a specified state. Using the condition " $AG(\text{not}(e(\text{collision})))$ " the model can be checked whether the collision channel is ever used. Running this verification generates a positive response as seen in Appendix D, "Simple Model". The formula is true and proves that the system is collision-free, and therefore safe. As the model operates on a logical methodology with checks being made on event locations the topology used only impacts the number of states to check, and thus the model is scaleable with this same verification approach. The simple layout also accounts for each of the key features implemented in our real-world scheme, featuring different numbers of tracks within a single movement authority, a branching route option by use of a point, multiple tracks that need to be unavailable when a connecting track is occupied, and the ability for bi-directional movement. By ensuring the simple model still includes more complex elements that are linked together it can still be said to scale its verification to more complex layouts.

5.5 A Real-World Case Study

5.5.1 The Scheme Plan

When growing the model to include the real-world, the major hurdle is the increase in complexity. The reference used for the real-world example provided by Siemens of the Moorgate-Holloway (MH) line is shown by the scheme plan in figure 5.5. In comparing the plans in figure 5.2 and figure 5.5 there is a clear difference in the number of tracks, connectors, balises and markerboards. In increasing the number of variables, the statespace of the model also increases. Abstractions are made with regards to the relative distances of the components, as only the locations where actions take place are required.

5.5.2 Validation

The model with real-world data requires all the same validation properties as the simple scheme, with the primary differences between the plans being the number of components, two full parallel lines, rather than a single line that diverges before reconnecting, as well as a crossing. This crossing provides more complexity than a simple point change, as all four connecting tracks must be considered rather than a single entry with multiple exits. This was done by setting one track, T_ZBBC, as the primary track for the crossing, meaning any routes that cover tracks on the crossing must also include T_ZBBC for their availability. The other notable addition in this scheme plan is that the points

are in pairs, as each live must have a point that can be reversed to connect the two allowing another route to join, rather than acting as a single entry or exit to a line. This is illustrated in figure 5.4

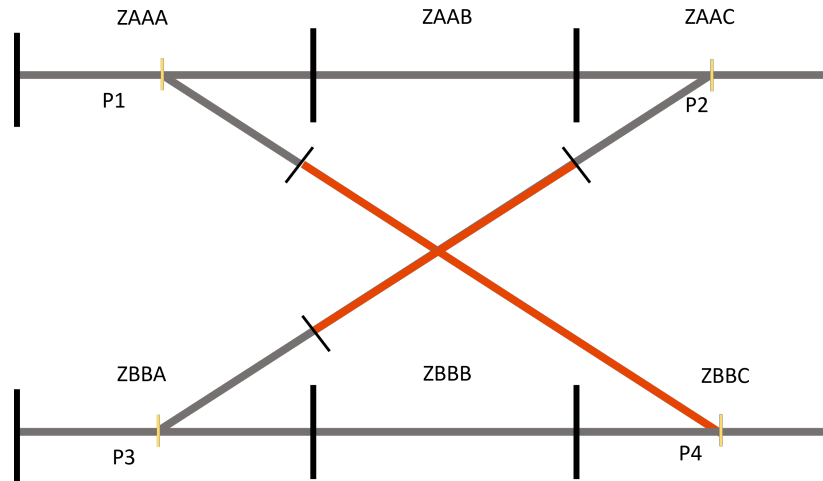


Figure 5.4: An excerpt of the track plan highlighting the crossing implementation. Points for the crossing are shown, and ZBBC is highlighted as being the track representing the crossing

5.5.3 Verification

The primary verification for this larger and more in-depth scheme plan remains the same as in the simple model. The model can be considered safe if at no point there are two trains on the same track. Once again using the ProB CTL verifier, the condition $AG(not(e(collision)))$ is used, and again generates a positive value as seen in Appendix D, "Moorgate-Holloway Model". The formula is proven true, and the system is collision free. Of note is the time difference of the model-checker between the simple model and the larger Moorgate-Holloway one using real-world data.

Time data for simple model verification

```

1   CTL check took 21.770 seconds
2   Witness found:
3   [2]
4   exec(2,[0,1,2],[0,1,2])
5   exec(2,[],[])
6   % size of table for ltl:sat_eu_table/5: 11647
7
8   CTL Formula TRUE.
9   No counter example found for AG(not(e(collision))).
10

```

5. Development and Contribution

```
11  real    0m23.886s
12  user    0m23.444s
13  sys     0m0.198s
```

Time data for real-world model verification

```
1  CTL check took 60.320 seconds
2  Witness found:
3  [2]
4  exec(2,[0,1,2],[0,1,2])
5  exec(2,[],[])
6  % size of table for ltl:sat_eu_table/5: 21909
7
8  CTL Formula TRUE.
9  No counter example found for AG(not(e(collision))).
10
11  real    1m2.964s
12  user    1m4.121s
13  sys     0m0.460s
```

Despite having a significant amount more components, with a large number more tracks, connectors, balises, and the definitions relating to them, the Moorgate-Holloway model can be CTL verified in a little under three times the time of the simple model. While three times the time is not insignificant, at the amount of time taken it gives some scope to be able to scale up models and still verify them in less time than testing for individual scenarios on industrial equipment. Particularly of note is that as the model has been designed with scalability in mind, the core controlling element will remain constant, and should work consistently if the topology is switched out for another. Generalisation was a driving factor behind much of the development, and successfully scaling from the simple layout to a larger more complex layout shows that this target was achieved.

5.5. A Real-World Case Study

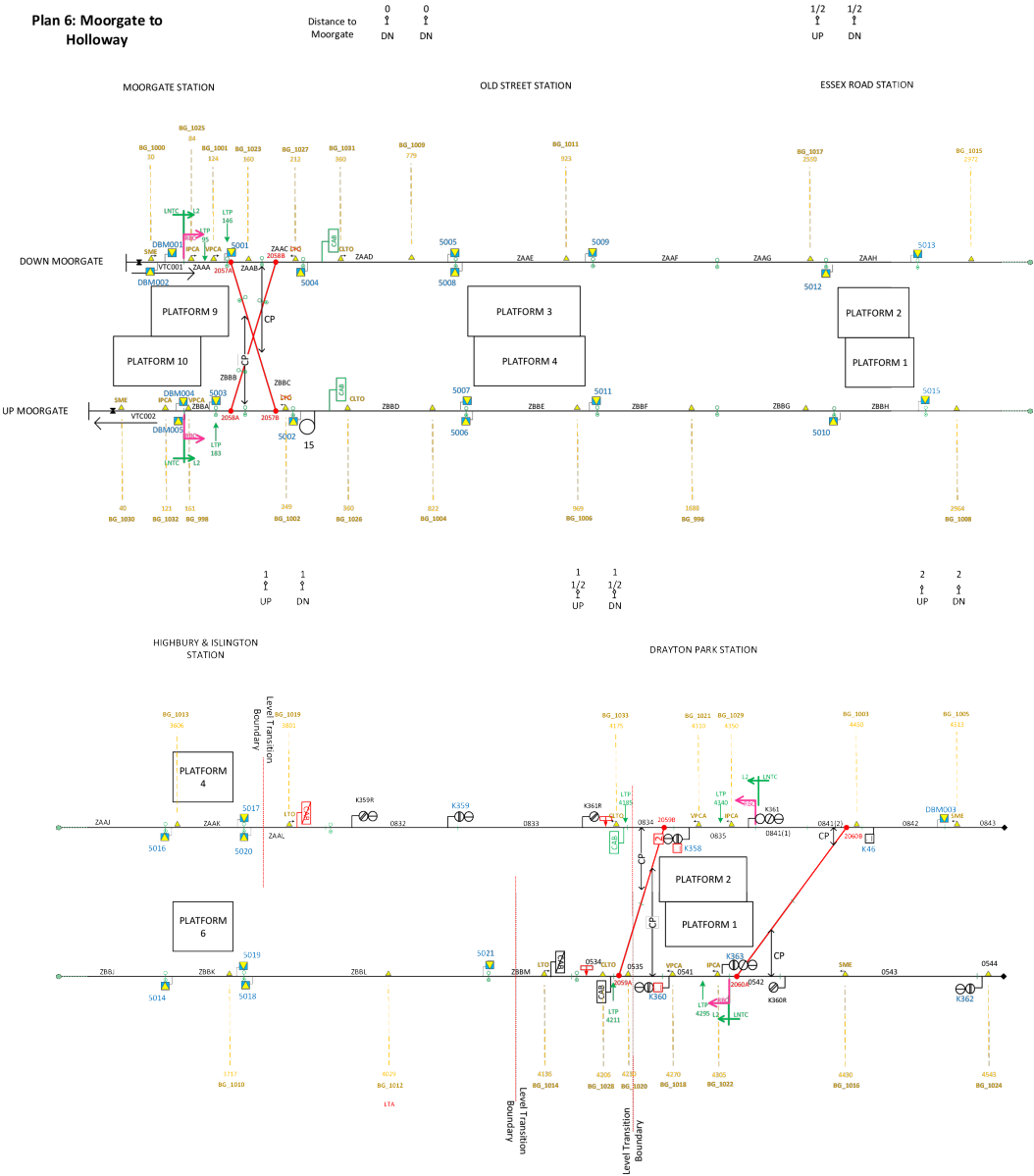


Figure 5.5: Moorgate-Holloway track plan used for real-world implementation

Chapter 6

Simulations and Testing

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6.1 Simulating a Real World Example

When testing a model against an industrial testing implementation using the same data, the test scenario must be consistent in both instances in order to establish correctness. The same test must be run in both implementations in order to ensure the same fields and messages are being generated. Determined simply as either true or false, only if they are the same it the model fit for the purpose of testing or not, making it of vital importance that the requirements are implemented effectively. As such it is important that when designing the model the order of operations is as close as possible within the restrictions of the language. The tests performed must also be carefully selected in order to have the same actions occur in both cases. The basics of train movement within the systems are a simple check that can be done, while another would be ensuring a train stops when a track ahead is obstructed. To verify safety it is also important to check that when multiple trains are in operation on the same line, potentially at different speeds, that they maintain a safe distance from each other. The interlocking and RBC must work in tandem to account for these situations.

6.2 Verification

As the model has been verified to be collision free, the checking of the model against the simulation must be established. The test approach decided on, is illustrated in the diagram shown in figure 6.1. In this diagram the testing environment is the input

provided to the RETS tool, consisting of specific setups given to the interlocking and set parameters on the train equipment. This setup is then used by the interlocking to provide information the RBC, which can then in turn provide data to the train. As the RBC is the system under test, any messages received by or sent to the RBC are merely observed, in order to establish how it operates in the system as a whole. These messages are therefore what we can use to compare the RBC function with the version in the model. As the main observable in the system is the movement of the trains, the messages of interest are those pertaining to movement authority. Movement authority requests are sent by trains to the RBC once they approach the end of their currently assigned MA, while the RBC communicates a new MA (if one is available) to the train. Therefore by observing train movements we can establish the similarity between systems.

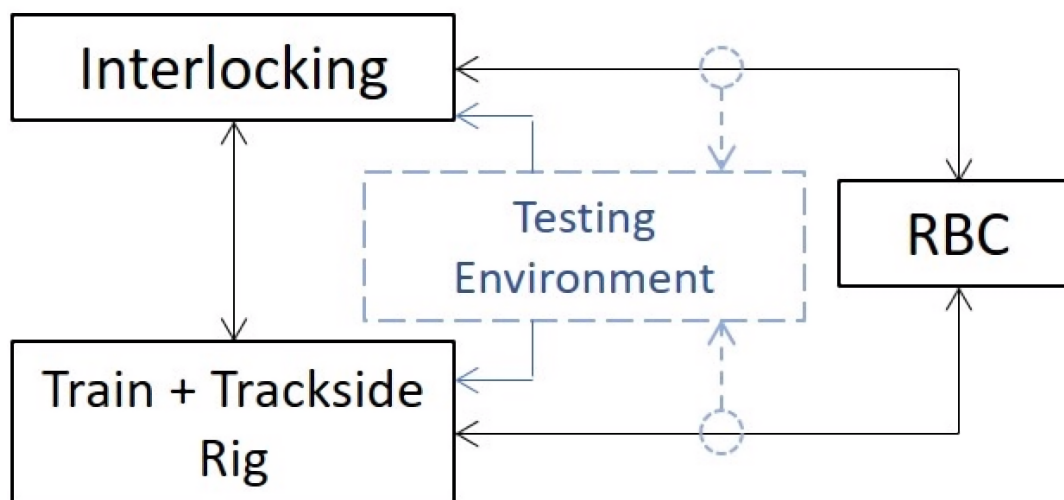


Figure 6.1: Test approach used when comparing the created model against existing industrial testing equipment

6.3 Testing the model against industrial simulations

The key element in testing the model against industrial simulations is the observation of messages. When given access to the testing rig an interesting comparison could immediately be made, one that shows the model made has the potential for more simultaneous route configurations and potential safety advantages. This is due to the industrial interlocking requiring the setting of direction on the lines before beginning the simulation. Of note in the setup of the testing interlocking also was the direct connection made between exits and entries on each end of the scheme - a connection had been simulated so that the entire scheme plan made a loop, essentially automating the exit of a train from one line and the immediate entry of in in the opposite direction on the other line. With directions set for this loop, a train could be simulated theoretically

indefinitely. In this situation if a train was initialised in the reverse order to the set direction of the loop, it would not do so under ERTMS supervision. This meant that simulating a collision on the rig would not be relevant to the model, as it allows for bi-directionality at any time, as long as the RBC and interlocking determine it is safe, with avoiding routes being assigned if changing to an alternate line was possible, and routes being withheld if not, and trains approached each other head-on. What follows are excerpts of the DataLogger logs generated from the tests run on the RETS system initialised by their corresponding entries in Appendix B, along with trace excerpts from matching ProB simulations of the model. The RETS logs were run through a lexer (an example of which can be seen in Appendix E) to extract only the messages relating to movement authority. There is the potential for more test cases to be run exploring both bi-directionality in the system and also both more and less strict management of MA assignment, allowing for longer MAs to be given out if multiple routes are free.

To define the key outcomes required for correctness:

- A train may not exceed its assigned movement authority
- When at or approaching the end of its assigned movement authority, a train requests an extension if still active
- The interlocking must communicate to the RBC which authorities are available for assignment
- Once an RBC assigns a movement authority to a train it must be reflected to the interlocking
- An unavailable movement authority can not be assigned to a train
- Multiple trains cannot hold the same movement authority

There are some variations in messages and their order that can be taken from these statements. The RBC is free to extend the movement authority of a train without the train requesting it, as long as it is a valid move with regards to the interlocking status. In the simulations run this was minimised by restricting the maximum available movement authority based on the current location of the train, simulating shorter connected stretches of track in order to ensure messages were transmitted at a rate that could be comparable with the movement of the model. This abstraction can be done as the fundamentals of train movement can be examined in a more granular setting, while saving state-space by restricting the amount of non-relevant movements and messages. If a train was immediately given full authority to move to the end of the track, it would not need to request further authorities meaning it would not need to send messages. An interlocking can also communicate multiple free authorities to an RBC without it assigning one to a train, as the train may not always require an extension, for example if it is not approaching the authority in question. As such it is expected to see multiple status reports given by the interlocking and RBC without an authority being assigned.

While this can also be done in the model when traces are generated focus can therefore be placed on the train requests, while we can perform verification on the model to ensure the communication between the RBC and Interlocking can continue.

The key test cases we can take from this is primarily that a train requesting a movement authority from an RBC can receive an extension as long as it is a valid and available route communicated to the RBC from the Interlocking. If an obstacle (such as another train or a track closure) exists then an Interlocking will inform the RBC of the unavailability of the obstructed area, and a train will not be able to travel to that location. If an obstruction exists and an alternative route is available, the train can be guided along an alternative free route.

6.3.1 Simple Single Train Movement

In this test, the basic movement of a train is simulated to compare the simplest movement in a system. A train is initialised on the upper track, and simply proceeds along the upper track until the simulation is stopped.

Simple Train Movement Excerpt (Datalogger)

```

1      ...
2      ...
3      NID_MESSAGE = 132 (84h) (10000100)
4      L_MESSAGE = 26 (1Ah) (0000011010)
5      T_TRAIN = 189221192 (B474948h)
        (00001011010001110100100101001000)
6      NID_ENGINE = 6062544 (5C81D0h)
        (010111001000000111010000)
7      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
        the perturbation location reached"
8      Packet 0 - TrainToTrack - Pos Report
9      NID_PACKET = 0 (0h) (00000000)
10     L_PACKET = 129 (81h) (0000010000001)
11     Q_SCALE = 0 (0h) (00) "10 cm scale"
12     NID_LRBG = 33781 (83F5h) (000000001000001111110101)
13     NID_C = 2 (2h) (0000000010)
14     NID_BG = 1013 (3F5h) (00001111110101)
15     D_LRBG = 1441 (5A1h) (000010110100001) "144.1m"
16     Q_DIRLRBG = 0 (0h) (00) "Reverse"
17     Q_DLRBG = 0 (0h) (00) "Reverse"
18     L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
19     L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
20     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
        integrity monitoring device"
21     L_TRAININT = 248 (F8h) (000000011111000)
22     V_TRAIN = 10 (Ah) (0001010) "50 km/h"
23     Q_DIRTRAIN = 0 (0h) (00) "Reverse"
24     M_MODE = 0 (0h) (0000) "Full Supervision"

```

6.3. Testing the model against industrial simulations

```
25 M_LEVEL = 3 (3h) (011) "Level 2"
26
27 09:47:42.169018 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5
    ) (PK27) (PK21) - Train 6062544 - Dest:192.168.0.134
28 00000011 ... 11111000
29 NID_MESSAGE = 3 (3h) (00000011)
30 L_MESSAGE = 68 (44h) (0001000100)
31 T_TRAIN = 189221192 (B474948h)
    (00001011010001110100100101001000)
32 M_ACK = 0 (0h) (0) "No acknowledgement required"
33 NID_LRBG = 33781 (83F5h) (000000001000001111110101)
34 NID_C = 2 (2h) (0000000010)
35 NID_BG = 1013 (3F5h) (00001111110101)
36 Packet 15 - TrackToTrain - Level 2/3 MA
37 NID_PACKET = 15 (Fh) (00001111)
38 Q_DIR = 0 (0h) (00) "Reverse"
39 L_PACKET = 88 (58h) (0000001011000)
40 Q_SCALE = 1 (1h) (01) "1 m scale"
41 V_EMA = 0 (0h) (00000000) "0 km/h"
42 T_EMA = 0 (0h) (0000000000)
43 N_ITER = 0 (0h) (00000)
44 L_ENDSECTION = 368 (170h) (000000101110000) "368m"
45 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
    information"
46 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
    information"
47 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
    follow"
48 D_DP = 0 (0h) (0000000000000000) "0m"
49 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
    calculated release speed"
50 Q_OVERLAP = 0 (0h) (0) "No overlap information"
51 Packet 57 - TrackToTrain - MA Request Params
52 NID_PACKET = 57 (39h) (00111001)
53 Q_DIR = 0 (0h) (00) "Reverse"
54 L_PACKET = 49 (31h) (0000000110001)
55 T_MAR = 25 (19h) (00011001)
56 T_TIMEOUIRQST = 1023 (3FFh) (1111111111) "No MA request
    triggering with regards to this function"
57 T_CYCRQST = 10 (Ah) (00001010)
58 Packet 58 - TrackToTrain - Pos Report Params
59 NID_PACKET = 58 (3Ah) (00111010)
60 Q_DIR = 0 (0h) (00) "Reverse"
61 L_PACKET = 72 (48h) (0000001001000)
62 Q_SCALE = 1 (1h) (01) "1 m scale"
63 T_CYCLOC = 10 (Ah) (00001010)
64 D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The train
    has not to report cyclically its position"
65 M_LOC = 1 (1h) (001) "Every LRBG compliant balise group"
```

6. Simulations and Testing

```
66         N_ITER = 1 (1h) (00001)
67         [0] D_LOC = 111 (6Fh) (000000001101111) "111m"
68         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
69         Packet 5 - TrackToTrain - Linking
70         NID_PACKET = 5 (5h) (00000101)
71         Q_DIR = 0 (0h) (00) "Reverse"
72         L_PACKET = 69 (45h) (0000001000101)
73         Q_SCALE = 1 (1h) (01) "1 m scale"
74         D_LINK = 195 (C3h) (000000011000011) "195m"
75         Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
76         NID_BG = 1019 (3FBh) (00001111111011)
77         Q_LINKORIENTATION = 1 (1h) (1) "The balise group is seen
           by the train in nominal direction"
78         Q_LINKREACTION = 2 (2h) (10) "No reaction"
79         Q_LOCAC = 1 (1h) (000001)
80         N_ITER = 0 (0h) (00000)
81         Packet 27 - TrackToTrain - International SSP
82         NID_PACKET = 27 (1Bh) (00011011)
83         Q_DIR = 0 (0h) (00) "Reverse"
84         L_PACKET = 86 (56h) (0000001010110)
85         Q_SCALE = 1 (1h) (01) "1 m scale"
86         D_STATIC = 0 (0h) (000000000000000) "0m"
87         V_STATIC = 10 (Ah) (0001010) "50 km/h"
88         Q_FRONT = 1 (1h) (1) "No train length delay on validity
           end point of profile element"
89         N_ITER = 0 (0h) (00000)
90         N_ITER = 1 (1h) (00001)
91         [0] D_STATIC = 368 (170h) (000000101110000) "368m"
92         [0] V_STATIC = 127 (7Fh) (1111111) "Non numerical value
           telling that the static speed profile description
           ends at D_STATIC(n)"
93         [0] Q_FRONT = 0 (0h) (0) "Train length delay on validity
           end point of profile element"
94         [0] N_ITER = 0 (0h) (00000)
95         Packet 21 - TrackToTrain - Gradient Profile
96         NID_PACKET = 21 (15h) (00010101)
97         Q_DIR = 0 (0h) (00) "Reverse"
98         L_PACKET = 102 (66h) (0000001100110)
99         Q_SCALE = 1 (1h) (01) "1 m scale"
100        D_GRADIENT = 0 (0h) (000000000000000) "0m"
101        Q_GDIR = 1 (1h) (1) "Uphill"
102        G_A = 5 (5h) (00000101) "5 o/oo"
103        N_ITER = 2 (2h) (00010)
104        [0] D_GRADIENT = 95 (5Fh) (000000001011111) "95m"
105        [0] Q_GDIR = 1 (1h) (1) "Uphill"
106        [0] G_A = 15 (Fh) (00001111) "15 o/oo"
107        [1] D_GRADIENT = 273 (111h) (000000100010001) "273m"
108        [1] Q_GDIR = 0 (0h) (0) "Downhill"
```



```
109 [1] G_A = 255 (FFh) (11111111) "Non numerical value
      telling that the current gradient description ends at
      D_GRADIENT(n) "
```

Simple Train Movement Message Headings Excerpt (Datalogger)

```
1 09:47:41.811835 # Diag Event Rpt for RBC status (MsgId 532) -
  Dest:192.168.0.136
2 09:47:41.897625 # RBC Status Message - Dest:192.168.1.132 SrcP:8
3 09:47:42.107947 # Interlocker Status Message - Dest:192.168.0.132
  SrcP:8
4 09:47:42.108116 # Interlocker Status Message - Dest:192.168.0.133
  SrcP:8
5 09:47:42.140784 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
  :192.168.0.132
6 09:47:42.169018 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
  (PK21) - Train 6062544 - Dest:192.168.0.134
7 09:47:42.409520 # RBC Status Message - Dest:192.168.1.132 SrcP:8
8 09:47:42.542528 # Interlocker Status Message - Dest:192.168.0.132
  SrcP:8
9 09:47:42.542696 # Interlocker Status Message - Dest:192.168.0.133
  SrcP:8
10 09:47:42.922045 # RBC Status Message - Dest:192.168.1.132 SrcP:8
11 09:47:42.956123 # Interlocker Status Message - Dest:192.168.0.132
  SrcP:8
12 09:47:42.956293 # Interlocker Status Message - Dest:192.168.0.133
  SrcP:8
```

Simple Train Movement Excerpt (ProB)

```
1 rbc_to_ixl_Request(ROUTE_5017)-->yes
2 CSP:train_to_rbc_MARequest.Train_1.BG_1013.dRight
3 rbc_to_ixl_RequestToProceed(ROUTE_5017)-->yes
4 CSP:rbc_to_train_RequestAccepted.yes
5 ixl_to_rbc_GrantRoute(ROUTE_5017)-->yes
6 rbc_to_ixl_ClearRoute(ROUTE_5013)
7 CSP:rbc_to_train_MAGrant.8950
```

In examining these messages, the first thing to be noticed is the similarity between message order. The primary observation is that in the RETS system, the system is updated (either in relation to time or by a train position report), then a train sends a movement authority request to the RBC, An MA update is then issued while updating the status within the interlocking. Looking more closely at the information exchanged within the datalogger messages, the train sends an MA request in reference to the last balise group passed (BG_1013), which is accepted and issued by the RBC. This occurs in both the datalogger logs and the ProB model logs. While there is a difference in the main order of the messages, this will be due to the abstraction of the model. As all communications in the model are triggered by events, the continuous communication

between the RBC and interlocking is accounted for differently. In the model messages have an order they must be completed in to ensure the state is accurately monitored, and once a request to proceed is begun, all further messages given in the ProB excerpt must be completed before the simulation can continue, whereas the RETS is handled continuously, along with timed checks. In this example requests in the model are more strictly ordered than in the simulation. In the simulation the interlocking and RBC have a more continuous message exchange, and an RBC may have permission to grant a route without first confirming with the interlocking. The RBC will however have a lock on that route and immediately reports the change to the interlocking once the route has been assigned. In particular we can see the correlation in DL lines 2 and 3 with the ProB request in line 1. The MA messages are clear in DL line 5 and ProB line 2. The MA accepted and assigned in DB lines 6 and 7, in correlation with ProB lines 7 and 5/6.

6.3.2 Lower Train Runs Until Obstruction

This test establishes whether a train will be stopped on reached an obstruction. A train is initialised on the lower track, and proceeds on the same line until it begins to approach a specific section of track that has been marked as occupied. As its progress is blocked, the train should come to a stop. With no condition for the release of the next track, the train can not continue, and the simulation is stopped.

Lower Train Obstruction Excerpt (Datalogger)

```

1  ...
2  11:12:32.289303 # MA Req (MsgId 132) (PK0) - Train 6062544 -
   Dest:192.168.0.132
3  10000100 00000110 10000010 11010011 11000011 01100000 01010111
   00100000 01110100 00000010 00000000 00001000 00010000
   00000010 00001111 11010000 00000110 10110010 10000000
   00110010 00000000 01100100 10000000 11111000 00001110
   10010011
4  NID_MESSAGE = 132 (84h) (10000100)
5  L_MESSAGE = 26 (1Ah) (0000011010)
6  T_TRAIN = 189730177 (B4F0D81h)
   (00001011010011110000110110000001)
7  NID_ENGINE = 6062544 (5C81D0h) (010111001000000111010000)
8  Q_MARQSTREASON = 1 (1h) (00001) "Start selected by driver"
9  Packet 0 - TrainToTrack - Pos Report
10 NID_PACKET = 0 (0h) (00000000)
11 L_PACKET = 129 (81h) (0000010000001)
12 Q_SCALE = 0 (0h) (00) "10 cm scale"
13 NID_LRBG = 33780 (83F4h) (000000001000001111110100)
14 NID_C = 2 (2h) (0000000010)
15 NID_BG = 1012 (3F4h) (00001111110100)
16 D_LRBG = 214 (D6h) (000000011010110) "21.4m"
17 Q_DIRLRBG = 1 (1h) (01) "Nominal"
18 Q_DLRBG = 1 (1h) (01) "Nominal"

```

6.3. Testing the model against industrial simulations

```
19 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"  
20 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"  
21 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by integrity  
    monitoring device"  
22 L_TRAININT = 248 (F8h) (000000011111000)  
23 V_TRAIN = 7 (7h) (0000111) "35 km/h"  
24 Q_DIRTRAIN = 1 (1h) (01) "Nominal"  
25 M_MODE = 2 (2h) (0010) "Staff Responsible"  
26 M_LEVEL = 3 (3h) (011) "Level 2"  
27  
28 11:12:44.256719 # VL Release Request (MsgId 3) - Dest  
    :192.168.0.132  
29 ...  
30  
31 11:13:52.471774 # Interlocker Status Message - Dest  
    :192.168.0.133 SrcP:8  
32 ...
```

Lower Train Obstruction Message Headings Excerpt (Datalogger)

```
1 11:12:32.289303 # MA Req (MsgId 132) (PK0) - Train 6062544 -  
    Dest:192.168.0.132  
2 11:12:44.218288 # Interlocker Status Message - Dest  
    :192.168.0.132 SrcP:8  
3 11:12:44.218456 # Interlocker Status Message - Dest  
    :192.168.0.133 SrcP:8  
4 11:12:44.256719 # VL Release Request (MsgId 3) - Dest  
    :192.168.0.132  
5 11:13:52.471774 # Interlocker Status Message - Dest  
    :192.168.0.133 SrcP:8
```

Lower Train Obstruction Excerpt (ProB)

```
1 CSP:train_PassedBalise.Train_1.BG_1010  
2 CSP:train_to_rbc_MAResponse.Train_1.BG_1010.dRight  
3 rbc_to_ixl_Request(ROUTE_5019)-->yes  
4 rbc_to_ixl_RequestToProceed(ROUTE_5019)-->yes  
5 CSP:rbc_to_train_RequestAccepted.yes  
6 ixl_to_rbc_GrantRoute(ROUTE_5019)-->yes  
7 rbc_to_ixl_ClearRoute(ROUTE_5015)  
8 CSP:rbc_to_train_MAGrant.5450  
9 CSP:train_NextAction.Train_1.C_BK_BL.5000  
10 train_to_ixl_TrackChange(Train_1,T_ZBBK)-->T_ZBBL,C_BL_BM  
11 CSP:train_NextAction.Train_1.C_BG_1012.5250  
12 CSP:train_PassedBalise.Train_1.BG_1012  
13 CSP:train_to_rbc_MAResponse.Train_1.BG_1012.dRight  
14 CSP:rbc_to_train_RequestAccepted.no  
15 CSP:train_PassedBalise.Train_1.BG_1012  
16 CSP:train_to_rbc_MAResponse.Train_1.BG_1012.dRight
```

```

17 CSP:rbc_to_train_RequestAccepted.no
18 CSP:train_PassedBalise.Train_1.BG_1012
19 CSP:train_to_rbc_MARrequest.Train_1.BG_1012.dRight
20 CSP:rbc_to_train_RequestAccepted.no

```

In this comparison, the train can be observed travelling the lower line before reaching a point where a MA request is sent, and no MA given in return. The train stays in that state for over a minute while the rest of the system continues communications, before the simulation is stopped. This is shown more clearly in the ProB trace, where the next route is not (and cannot be) requested, leading to multiple requests for the same extension.

6.3.3 Two Trains on a Single Track

Potentially the most important test is determining whether one train can follow another along the same track, keeping a safe margin between the two. One train is initialised on the first track and moves until a designated stopping point. After the first train has moved clear, a second train is initialised in the same way as the first. This train should approach the first, but once it approaches the route the first train is currently occupying no further MA extension can be given until the first train has also moved to its next route.

Two Trains on a Single Track Excerpt (Datalogger)

```

1      ...
2      12:07:38.853646 # MA Req (MsgId 132) (PK0) - Train 6062545
          - Dest:192.168.0.132
3      10000100 ... 00001011
4      NID_MESSAGE = 132 (84h) (10000100)
5      L_MESSAGE = 26 (1Ah) (0000011010)
6      T_TRAIN = 190060816 (B541910h)
          (00001011010101000001100100010000)
7      NID_ENGINE = 6062545 (5C81D1h) (010111001000000111010001)
8      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching the
          perturbation location reached"
9      Packet 0 - TrainToTrack - Pos Report
10     NID_PACKET = 0 (0h) (00000000)
11     L_PACKET = 129 (81h) (0000010000001)
12     Q_SCALE = 0 (0h) (00) "10 cm scale"
13     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
14     NID_C = 2 (2h) (0000000010)
15     NID_BG = 2017 (7E1h) (00011111100001)
16
17     12:07:39.703988 # MA Req (MsgId 132) (PK0) - Train 6062545
          - Dest:192.168.0.132
18     10000100 ... 00001011
19     NID_MESSAGE = 132 (84h) (10000100)
20     L_MESSAGE = 26 (1Ah) (0000011010)

```

6.3. Testing the model against industrial simulations

```
21 T_TRAIN = 190060914 (B541972h)
      (00001011010101000001100101110010)
22 NID_ENGINE = 6062545 (5C81D1h) (010111001000000111010001)
23 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching the
      perturbation location reached"
24 Packet 0 - TrainToTrack - Pos Report
25 NID_PACKET = 0 (0h) (00000000)
26 L_PACKET = 129 (81h) (0000010000001)
27 Q_SCALE = 0 (0h) (00) "10 cm scale"
28 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
29 NID_C = 2 (2h) (0000000010)
30 NID_BG = 2017 (7E1h) (00011111100001)
31 ...
32
33 12:07:40.575525 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (
      PK27) (PK21) - Train 6062544 - Dest:192.168.0.134
34 00000011 ... 11110000
35 NID_MESSAGE = 3 (3h) (00000011)
36 L_MESSAGE = 90 (5Ah) (0001011010)
37 T_TRAIN = 190060993 (B5419C1h)
      (00001011010101000001100111000001)
38 M_ACK = 0 (0h) (0) "No acknowledgement required"
39 NID_LRBG = 33777 (83F1h) (000000001000001111110001)
40 NID_C = 2 (2h) (0000000010)
41 NID_BG = 1009 (3F1h) (00001111110001)
42 Packet 15 - TrackToTrain - Level 2/3 MA
43 ...
44
45 12:07:49.720960 # MA Req (MsgId 132) (PK0) - Train 6062545
      - Dest:192.168.0.132
46 10000100 ... 00001011
47 NID_MESSAGE = 132 (84h) (10000100)
48 L_MESSAGE = 26 (1Ah) (0000011010)
49 T_TRAIN = 190061915 (B541D5Bh)
      (00001011010101000001110101011011)
50 NID_ENGINE = 6062545 (5C81D1h) (010111001000000111010001)
51 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching the
      perturbation location reached"
52 Packet 0 - TrainToTrack - Pos Report
53 NID_PACKET = 0 (0h) (00000000)
54 L_PACKET = 129 (81h) (0000010000001)
55 Q_SCALE = 0 (0h) (00) "10 cm scale"
56 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
57 NID_C = 2 (2h) (0000000010)
58 NID_BG = 2017 (7E1h) (00011111100001)
59 ...
60 12:07:49.743401 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK80)
      (PK27) (PK21) - Train 6062545 - Dest:192.168.0.134
61 00000011 ... 11111000
```

6. Simulations and Testing

```
62     NID_MESSAGE = 3 (3h) (00000011)
63     L_MESSAGE = 65 (41h) (0001000001)
64     T_TRAIN = 190061915 (B541D5Bh)
        (00001011010101000001110101011011)
65     M_ACK = 0 (0h) (0) "No acknowledgement required"
66     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
67     NID_C = 2 (2h) (0000000010)
68     NID_BG = 2017 (7E1h) (00011111100001)
69     Packet 15 - TrackToTrain - Level 2/3 MA
70     NID_PACKET = 15 (Fh) (00001111)
71     Q_DIR = 0 (0h) (00) "Reverse"
72     L_PACKET = 88 (58h) (0000001011000)
73     Q_SCALE = 1 (1h) (01) "1 m scale"
74     V_EMA = 0 (0h) (0000000) "0 km/h"
75     T_EMA = 0 (0h) (0000000000)
76     N_ITER = 0 (0h) (00000)
77     L_ENDSECTION = 358 (166h) (000000101100110) "358m"
78     ...
79
80     12:07:50.706156 # MA Req (MsgId 132) (PK0) - Train 6062545
        - Dest:192.168.0.132
81     10000100 ... 00001011
82     NID_MESSAGE = 132 (84h) (10000100)
83     L_MESSAGE = 26 (1Ah) (0000011010)
84     T_TRAIN = 190062014 (B541DBEh)
        (00001011010101000001110110111110)
85     NID_ENGINE = 6062545 (5C81D1h) (010111001000000111010001)
86     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching the
        perturbation location reached"
87     Packet 0 - TrainToTrack - Pos Report
88     NID_PACKET = 0 (0h) (00000000)
89     L_PACKET = 129 (81h) (0000010000001)
90     Q_SCALE = 0 (0h) (00) "10 cm scale"
91     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
92     NID_C = 2 (2h) (0000000010)
93     NID_BG = 2017 (7E1h) (00011111100001)
94     ...
95
96     12:07:58.872177 # MA Req (MsgId 132) (PK0) - Train 6062545
        - Dest:192.168.0.132
97     10000100 ... 00001011
98     NID_MESSAGE = 132 (84h) (10000100)
99     L_MESSAGE = 26 (1Ah) (0000011010)
100    T_TRAIN = 190062814 (B5420DEh)
        (00001011010101000010000011011110)
101    NID_ENGINE = 6062545 (5C81D1h) (010111001000000111010001)
102    Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching the
        perturbation location reached"
103    Packet 0 - TrainToTrack - Pos Report
```

```

104     NID_PACKET = 0 (0h) (00000000)
105     L_PACKET = 129 (81h) (0000010000001)
106     Q_SCALE = 0 (0h) (00) "10 cm scale"
107     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
108     NID_C = 2 (2h) (0000000010)
109     NID_BG = 2017 (7E1h) (00011111100001)
110     D_LRBG = 3520 (DC0h) (000110111000000) "352.0m"
111     ...
112
113     12:08:07.748051 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (
          PK27) (PK21) - Train 6062545 - Dest:192.168.0.134
114     00000011 ... 11111111
115     NID_MESSAGE = 3 (3h) (00000011)
116     L_MESSAGE = 94 (5Eh) (0001011110)
117     T_TRAIN = 190063708 (B54245Ch)
          (00001011010101000010010001011100)
118     M_ACK = 0 (0h) (0) "No acknowledgement required"
119     NID_LRBG = 33768 (83E8h) (000000001000001111101000)
120     NID_C = 2 (2h) (0000000010)
121     NID_BG = 1000 (3E8h) (00001111101000)
122     Packet 15 - TrackToTrain - Level 2/3 MA
123     ...

```

Two Trains on a Single Track Excerpt (ProB)

```

1     CSP:train_to_rbc_MARequest.Train_1.BG_1000.dRight
2     rbc_to_ixl_Request(ROUTE_5001_U)-->yes
3     rbc_to_ixl_RequestToProceed(ROUTE_DBM001)-->yes
4     CSP:rbc_to_train_RequestAccepted.yes
5     ixl_to_rbc_GrantRoute(ROUTE_DBM001)-->yes
6     rbc_to_ixl_ClearRoute(ROUTE_EntryLU)
7     CSP:rbc_to_train_MAGrant.450
8     CSP:TrainEntryDetails.Train_2.T_VTC001
9     rbc_to_ixl_Request(ROUTE_EntryLU)-->no
10    CSP:train_NextAction.Train_1.C_VTC1_AA.0
11    train_to_ixl_TrackChange(Train_1,T_VTC001)-->T_ZAAA,C_AA_AB
12    train_to_ixl_Enter(Train_2,T_VTC001)-->yes
13    CSP:train_PassedBalise.Train_2.BG_LU
14    CSP:train_to_rbc_MARequest.Train_2.BG_LU.dRight
15    rbc_to_ixl_Request(ROUTE_DBM001)-->no
16    CSP:rbc_to_train_RequestAccepted.no

```

In this instance, the RETS trace shows the trailing train (Train 6062545) repeatedly requesting a MA relative to $NID_BG = 2017$, or balise 2017 which corresponds in the model to BG_LU . The fact that this train fails to get a movement authority shows the blockage of the track/route ahead. Once the leading train (Train 6062544) gets its extension granted however, we eventually see a MA sent to the trailing train in reference to $NID_BG = 1000$, showing the train has been granted its new movement authority.

In the ProB trace this can be followed more clearly, where we see *Train_1* requesting routes and receiving them, while *Train_2* has to wait at *BG_LU* (the entry balise) as the next Route (*Route_Entry_LU*) is not available until *Train_1* moves to its next track. Once this movement takes place *Train_2* finally gets to enter.

6.4 Validity of Test Results

To gauge the validity of the results of the tests, the key factor is the ordering of messages. To use the Simple Single Train Movement example in 6.3.1, for a successful extension of a movement authority the ProB trace follows the pattern of:

1. rbc_to_ixl_Request - Response
2. train_to_rbc_MARrequest
3. rbc_to_ixl_RequestToProceed - Response
4. rbc_to_train_RequestAccepted - Response
5. ixl_to_rbc_GrantRoute - Response
6. rbc_to_ixl_ClearRoute
7. rbc_to_train_MAGrant

This is the fundamental order of communication that allows the train to gain a new movement authority successfully - there should be no deviation in this in the model. To be a valid and correct comparison the order of messages from the DataLogger must match this structure with few exceptions. One exception that accounts for the more in depth communications performed by the Siemens simulations is that messages can be repeated, as long as the next new message type in the trace matches the defined order. To account for this the lexer for the datalogger specifically filters out repeat message types to focus on the next new different communication sent. In addition to this, the most important feature for both logs is that trains do not receive a new movement authority without authorisation from the RBC, which in turn requires interlocking data. This logic is explicitly stated in the ProB messages, while the datalogger trace features more generic status reports from both the interlocking and RBC. Messages also occur in real-time in the simulation. Fundamentally, if a train requests a movement authority extension and it is not confirmed by the RBC, it can not continue to a new movement authority. For both traces, a clear fail state would be the continuation of train movement past its assigned movement authority after an unsuccessful request. The spiral development methodology was effective in this case as minimal changes were required to scale up the topology used by the larger scheme plan, which could also be successfully retrofitted to the simple plan.

Part IV

Conclusions

Chapter 7

Related Work, Conclusions, and Future Work

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7.1 Related Work

Formal methods have been used to model and verify railway problems for some time, in particular with regards to interlockings. A generic event-based model implemented in CSP by Winter [10] verifying the two safety properties of Collision Freedom and No Moving Points, but has limited traceability, and has relations that are derived rather than stated. It also contains no interlocking cycle.

The importance of a Domain Specific Language was noted by Haxthausen in [11] where modelling was done using RAISE and the SAL model checker, applying the techniques to a real-world example successfully. Again this work was more focused on interlocking modelling and verification. In [12] Haxthausen et al. use modelling and verification processes developed within research groups and suggest a way to compare different formal approaches with regards to verifying route-based control systems.

Basile et al. [13] perform a formal analysis of the UNISIG Safety Application by applying formal methods to railway standard interfaces, investigating the interoperability and safety of standard interfaces. Using UPPAAL for statistical model checking, errors were identified regarding safety and interoperability in the original specification and quantified costs for learning and developing the analysis. They argue that the use of formal models and their resulting analysis can enrich existing documentation and become a starting point for other model-based development approaches.

Ghosh et al. [14] also studied the issuing of messages from the RBC to trains with particular focus on movement authorities using UPPAAL. They found errors present in the interlocking used and also in movement authorities issues, and argue that aiming to prove the correctness of a system without considering the dynamics of the trains is not enough to guarantee its safety. They take time into account to examine acceleration and deceleration of trains, and are looking into automated tool flows for translating control tables to timed automata.

7.2 Conclusions

This project began with the aim of creating tests using formal modelling techniques to provide an alternate means of testing RBCs in a more time- and cost-effective manner. We wanted to establish if a formal model could be created with enough fidelity to emulate the logical order of events and communications sent between the multiple components of an ERTMS Level 2 system. The model needed to be safe from collisions, with some means of verification allowing for such safety properties to be automatically checked.

During development, the requirements for the model evolved, adding new elements to the system that had not been modelled in our previous work such as balises, and also lead to abstractions in others, such as focusing on specific moments of activity and removing the requirement for a time-based model. This meant that there could be a large saving in the number of states generated during verification, and the time it would take to do so is certainly less than it would be to run multiple simulations on industrial equipment.

This research culminated in an abstracted model of a train control system featuring an RBC element using CSP||B. This model operated using a simple track plan for base concepts, and was advanced to operate over a real-life track layout provided by Siemens Rail Automation. Test cases were simulated on both the CSP||B model and on Siemens own simulation software to observe how each system executes its logic, with particular focus on messages transmitted between control components. These test cases were derived to observe train movement and responses to scenarios within the movements that would lead to safety issues. The traces gathered from these simulations were then filtered for key messages between components and the correlation of the order and contents of messages examined. It was found that while there is a difference in the format and quantity of information sent between the two systems under test, the logical order of the messages and the key information transmitted correlates to an extent that gives us confidence in the correctness of the developed model and its ability to perform verification on the safety of the system when performing assertions on its states.

This project has shown there is potential with regards to using formal models to in concurrence with industrial testing in order to improve development of RBCs. In particular the exchange of messages sent in the model gave a timeline of events easier to comprehend quickly than with RETS DataLogger outputs. This is in no small part thanks to the abstraction of the model, providing manual updating of the system that can

be done through ProB simulations rather than the constant automated communications in RETS, though that has the benefit of more granular details, with more accurate data. CSP||B has proven to be a suitable language for a system as complex as a railway, allowing for a combination of functional and process based computations that can be adjusted to fit elements of different complexity and functionality, and ProB has proven a useful tool for simulation and verification.

Fundamentally, this approach had to deal with a fair amount of abstraction, however that it performed as well as it did despite that shows clear potential for development.

7.3 Project Reflection

The experience of this project is one I am ultimately very glad to have undertaken, though through a combination of world events and what I view as personal shortcomings I believe the project did not see its full potential realised. In particular the beginning of the UK lockdown in March 2020 due to COVID 19 significantly impacted the project. This occurred as I feel the project was beginning to gather momentum with regards to its target and development path, but a result of this was a change in development direction, rebuilding the model using a different approach in an alternative tool and language. The change in approach coupled with the change in work environment, along with health issues that persisted throughout most of the project led to delays in implementation, further internships to continue testing, and ultimately re-evaluating the ultimate goals of the project. An additional development cycle would ideally have been incorporated once development reached its current level in order to incorporate some automation and improve its usability.

7.4 Future Work

There are various areas that this work could expand into with future research and development. A key inclusion would be the addition of explicit level transitions, to expand on the implication of transitions that exist in the model currently by entry and exit routes. There remains potential or improved saving in statespace and verification time, with the potential of expanding into Linear Temporal Logic (LTL) verification, as well as the verification of additional safety features such as derailment (that no point will change position while a train is occupying it) and run through freedom (that a point will always be set in the correct position for a train that travels over it). An ultimate goal would be the automatic generation of test cases from the model simulations which could feed directly into testing on the RETS system. The implementation of another scheme plan with additional complexity would also be a fascinating experiment.

Any comparison done in the future of this project will primarily rely on the scheme plan used in comparison, in particular as this is a significantly complex step of the model. The scheme plan would be relevant to elements of the comparison: The design of the interlocking, the design of the RBC and RETS, and the formal model implementation. A tool could be designed to pull identifiers and values from the scheme plan in order

to generate a significant portion of the topology, though it would likely require human verification to ensure the logic is correct. By establishing essential test cases that will be applicable in all or most scenarios it would be feasible to generate scripts for tests to be run on Siemens equipment. Further development of the lexer for both the model trace and the test logs would provide the means to compare the two results, and a correctness score could be implemented in order to assess their correlation. To improve the usability of the model for engineers, a GUI with positional representation for the state of the model could be developed. The ultimate aim would be to run the formal model checking first using the data from the scheme plan, identify any likely issues with safety and correctness before implementing full testing, and revising the scheme plan to reflect this. Once the model is satisfied then it could be tested by Siemens with more confidence, with a correctness score still produced at the end to determine the closeness of the two.

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All files listed in the appendices are linked where relevant, with all files available at:
<https://rb.gy/1f679z>

Appendix A

The CSP||B Model

In the following, the full CSP||B models are included. It consists of three B machines and three CSP files.

The complete model files can be viewed at: <https://rb.gy/ougjkj>

Initial Model

The Context B-Machine

```
1 MACHINE Context
2
3 SETS
4     TRACKSTATUS = {occ,empty};
5     ASPECT = {unavailable,granted};
6     ALLTRACK = {nullTrack, AA, AB, AC, BC, AD, BD, AE, AF, RR, LL
7         , LL_left_b1, LL_right_b1, AC_left_b3, AC_b3_b5,
8         AC_right_b5, AF_left_b6, AF_right_b6, RR_left_b4,
9         RR_right_b4, BC_left_b2, BC_right_b2};
10    ALLCONNECTOR = {1, a, b, c, d, e, f, g, h, i, j, r, bal_b1,
11        bal_b2, bal_b3, bal_b4, bal_b5, bal_b6, C0};
12    MARKERBOARD = {MB0, MB1, MB2, MB3, MB4, MB0p, MB1, MBr};
13    TRAIN = {Train_1,Train_2};
14    POINT = {P1,P2,nullpoint};
15    POINTPOSITION = {NORMAL,REVERSE};
16    POINTSTATUS = {locked, unlocked};
17    ROUTE = {Route_1A, Route_1B, Route_2, Route_3, Route_4,
18        Route_EntryR, Route_EntryL, Route_ExitL, Route_ExitR2,
19        Route_ExitR3, Route_null};
20
21    DIRECTION = {dLeft, dRight}
22
23 CONSTANTS
24     MARKERBOARDSTATUS,
```

```

19     TRACK ,
20     CONNECTOR ,
21     ENTRY ,
22     EXIT ,
23     TESTING
24
25 PROPERTIES
26     MARKERBOARDSTATUS = ASPECT &
27     TRACK = ALLTRACK - {nullTrack} &
28     CONNECTOR = ALLCONNECTOR - { } &
29     ENTRY = { LL, RR } &
30     EXIT = { RR, LL } &
31     TESTING = {AC, BC, AD, BD, AE, AF, nullTrack}
32
33 END

```

The Topology B-Machine

```

1 MACHINE Topology
2
3 SEES Context
4
5 CONSTANTS
6     markerBoard ,
7     homeMarkerBoard ,
8     homePoint ,
9     direction ,
10    staticDirection ,
11    dynamicDirection ,
12    entryDirection ,
13    entryTable ,
14    normalTable ,
15    reverseTable ,
16    clearTable ,
17    lockTable ,
18    releaseTable
19
20 PROPERTIES
21     markerBoard : ROUTE <-> MARKERBOARD &
22     markerBoard = { (Route_1A |-> MB1), (Route_1B |-> MB1), (
23         Route_2 |-> MB2), (Route_3 |-> MB3), (Route_4 |-> MB0), (
24         Route_EntryL |-> MB1), (Route_EntryR |-> MBr), (Route_null
25         |-> MB1), (Route_ExitL |-> MB1), (Route_ExitR2 |-> MBr),
26         (Route_ExitR3 |-> MBr)} &
27
28     homeMarkerBoard : MARKERBOARD >-> ALLTRACK * (CONNECTOR*
29         CONNECTOR) &
30     homeMarkerBoard = { MBOp |-> (LL,(a,l)), MBO |-> (AF,(g,f)),
31         MBr |-> (RR,(r,g)), MB1 |-> (LL,(l,a)), MB1 |-> (AA,(a,b))

```

```

    , MB2 |-> (BC,(h,i)), MB3 |-> (AC,(c,d)), MB4 |-> (RR,(g,r
    )) } &
26 homePoint : POINT --> ALLTRACK &
27 homePoint = {(P1 |-> AB), (P2 |-> AE), (nullpoint |->
    nullTrack)} &
28
29 entryDirection : ENTRY --> CONNECTOR*CONNECTOR &
30 entryDirection = {
31     LL |-> (l,a),
32     RR |-> (r,g)
33 } &
34
35 direction : TRACK <-> CONNECTOR * CONNECTOR &
36 direction = {
37     LL |-> (l,a),
38     LL |-> (a,l),
39     AA |-> (a,b),
40     AA |-> (b,a),
41     AB |-> (b,h),
42     AB |-> (h,b),
43     AB |-> (b,c),
44     AB |-> (c,b),
45     AC |-> (c,d),
46     AC |-> (d,c),
47     BC |-> (h,i),
48     BC |-> (i,h),
49     AD |-> (d,e),
50     AD |-> (e,d),
51     BD |-> (i,j),
52     BD |-> (j,i),
53     AE |-> (j,f),
54     AE |-> (f,j),
55     AE |-> (e,f),
56     AE |-> (f,e),
57     AF |-> (f,g),
58     AF |-> (g,f),
59     RR |-> (g,r),
60     RR |-> (r,g)
61 } &
62
63 staticDirection : CONNECTOR <-> CONNECTOR &
64 staticDirection = {
65     (l,a),
66     (a,b),
67     (c,d),
68     (d,e),
69     (f,g),
70     (g,r),
71     (h,i),

```

```

72     (i,j),
73     (a,l),
74     (b,a),
75     (d,c),
76     (e,d),
77     (g,f),
78     (r,g),
79     (i,h),
80     (j,i)
81 } &
82
83 dynamicDirection : POINT * POINTPOSITION <-> CONNECTOR *
      CONNECTOR &
84 dynamicDirection = {
85     (P1,NORMAL)  |-> (b,c),
86     (P1,NORMAL)  |-> (c,b),
87     (P1,REVERSE) |-> (b,h),
88     (P2,NORMAL)  |-> (e,f),
89     (P2,NORMAL)  |-> (f,e),
90     (P2,REVERSE) |-> (j,f)
91 } &
92
93 entryTable: ENTRY --> POW(TRACK) &
94 entryTable = { LL |-> {LL, AA},
95               RR |-> {RR, AF} } &
96
97 normalTable : ROUTE <-> POINT &
98 normalTable = {Route_1A |-> P1, Route_3 |-> P2, Route_4 |->
99               P1, Route_4 |-> P2 } &
100
101 reverseTable : ROUTE <-> POINT &
102 reverseTable = {Route_1B |-> P1, Route_2 |-> P2} &
103
104 clearTable : ROUTE <-> POW(TRACK) &
105 clearTable = {
106     Route_EntryL |-> {LL},
107     Route_EntryR |-> {RR},
108     Route_1B |-> {AA, AB, BC},
109     Route_1A |-> {AA, AB, AC, AD, AE, AF, RR},
110     Route_ExitR2 |-> {},
111     Route_ExitR3 |-> {},
112     Route_ExitL |-> {},
113     Route_2 |-> {BD, AE, AF, RR},
114     Route_3 |-> {AD, AE, AF, RR},
115     Route_4 |-> {LL, AA, AB, AC, AD, AE, AF},
116     Route_null |-> {} } &
117
118 lockTable : ROUTE <-> POINT &
119 lockTable = {Route_1A |-> P1, Route_2 |-> P2, Route_4 |-> P1,

```

```

119         Route_4 |-> P2, Route_1B |-> P1, Route_3 |-> P2} &
120         lockTable = normalTable \/ reverseTable &
121
122         releaseTable : TRACK <-> (ROUTE*POINT) &
123         releaseTable = { BC |-> (Route_1B,P1),
124                         AC |-> (Route_1A,P1),
125                         AF |-> (Route_2,P2),
126                         AF |-> (Route_3,P2),
127                         AD |-> (Route_4,P2),
128                         AA |-> (Route_4,P1)}
129
130     END

```

The Interlocking B-Machine

```

1  MACHINE Interlocking
2
3  SEES  Topology, Context
4  SETS
5      ANSWERS = {yes,no}
6
7  VARIABLES
8      pos, nextd, markerBoardStatus, normalPoints, reversePoints,
9      currentLocks, setRoutes, grantedRoutes, occupiedTracks,
10     nextConnector, errorOccured
11
12  INVARIANT
13     pos : TRAIN
14         +-> ALLTRACK*(ALLCONNECTOR*ALLCONNECTOR) &
15     nextd :
16         ALLTRACK*(ALLCONNECTOR*ALLCONNECTOR)
17         +-> ALLTRACK*(ALLCONNECTOR*ALLCONNECTOR) &
18     normalPoints <: POINT &
19     reversePoints <: POINT &
20     normalPoints /\ reversePoints = {} &
21     normalPoints \/ reversePoints = POINT &
22     currentLocks : ROUTE <-> POINT &
23     currentLocks <: lockTable &
24     markerBoardStatus : MARKERBOARD --> MARKERBOARDSTATUS &
25     occupiedTracks : POW(TRACK) &
26     setRoutes : POW(ROUTE) &
27     grantedRoutes : POW(ROUTE) &
28     nextConnector : TRAIN +-> ALLCONNECTOR &
29     errorOccured : BOOL
30
31  DEFINITIONS
32     ASSERT_LTL_1 == "G((e(collision)))";
33
34  INITIALISATION
35     BEGIN

```

```

34     pos := {} ||
35     errorOccured := FALSE ||
36     markerBoardStatus := MARKERBOARD * {unavailable} ||
37     normalPoints := POINT ||
38     reversePoints := {} ||
39     currentLocks := {} ||
40     occupiedTracks := {} ||
41     nextd := {
42         (p1 |-> p2) |
43         #(t1,d1,t2,d2).
44         (
45             p1 = (t1,d1) & p2 = (t2,d2) &
46             t1 /= t2 &
47             ran({d1}) = dom({d2}) &
48             d1 : direction[{{t1}}] &
49             d1 : staticDirection \/
50                 dynamicDirection[POINT*{NORMAL}] &
51             d2 : direction[{{t2}}] &
52             d2 : staticDirection \/
53                 dynamicDirection[POINT*{NORMAL}]
54         )
55     } ||
56     setRoutes := {} ||
57     grantedRoutes := {} ||
58     nextConnector := {}
59     END
60
61 OPERATIONS
62
63
64 collision =
65 SELECT #(t1,t2).(t1 : TRAIN & t2 : TRAIN &
66     t1:dom(pos) & t2:dom(pos) & t1 /= t2 &
67     (dom({pos(t1)}) - (EXIT \/ ENTRY)) /\ (dom({pos(t2)}) - (EXIT
68     \/ ENTRY)) /= {})
69 THEN skip
70 END;
71
72 bb <-- train_to_ixl_Enter(t,entryPos) =
73 PRE
74     t : TRAIN & entryPos : ENTRY
75 THEN
76     IF {entryPos} <: occupiedTracks
77     THEN
78         bb := no
79     ELSE
80         pos(t) := (entryPos,entryDirection(entryPos)) ||
81         occupiedTracks := occupiedTracks \/ {entryPos} ||
82         bb := yes

```



```

82     END
83 END;
84
85 train_to_ixl_Exit(t,exitPos) =
86 PRE t : TRAIN &
87   dom({pos(t)}) = {exitPos} & exitPos : EXIT
88 THEN
89   pos := {t} <<| pos
90 END;
91
92 bb <-- rbc_to_ixl_Request(route) =
93 PRE route : ROUTE THEN
94   LET occTracks,emptyTracks BE
95     occTracks = dom(ran(pos)) &
96     emptyTracks = TRACK - occTracks IN
97     IF ((markerBoardStatus(markerBoard(route)) = unavailable) &
98         (clearTable(route) <: emptyTracks )) &
99         {route} /<: setRoutes &
100        {route} /<: grantedRoutes
101     THEN
102       LET unlockedPoints BE
103         unlockedPoints = POINT - ran(currentLocks) IN
104           IF ((normalTable[{route}] <: normalPoints \/  
              unlockedPoints ) &
105              (reverseTable[{route}] <: reversePoints \/  
              unlockedPoints))
106           THEN
107             LET np, rp BE
108               np = (normalPoints \/  
                  normalTable[{route}]) -  
                  reverseTable[{route}] &
109               rp = (reversePoints \/  
                  reverseTable[{route}]) -  
                  normalTable[{route}]
110             IN
111               normalPoints := np ||
112               reversePoints := rp ||
113               setRoutes := setRoutes \/  
                  {route} ||
114               bb := yes
115           END
116         ELSE
117           bb:= no
118         END
119     END
120   ELSE
121     bb:= no
122   END
123 END
124 END;
125
126 bb <-- ixl_to_rbc_GrantRoute(route) =

```

```

127 PRE route : ROUTE THEN
128   LET occTracks, emptyTracks BE
129   occTracks = dom(ran(pos)) &
130   emptyTracks = TRACK - occTracks IN
131   IF {route} <: setRoutes
132     THEN
133       LET np, rp BE
134       np = (normalPoints \/ normalTable[{route}]) -
              reverseTable[{route}] &
135       rp = (reversePoints \/ reverseTable[{route}]) -
              normalTable[{route}]
136       IN
137       currentLocks := currentLocks \/ ({route} <| lockTable)
              ||
138       markerBoardStatus(markerBoard(route)) := granted ||
139       bb := yes ||
140       setRoutes := setRoutes - {route} ||
141       grantedRoutes := grantedRoutes \/ {route} ||
142       nextd := {
143         (p1 |-> p2) |
144         #(t1,d1,t2,d2).
145         (
146           p1 = (t1,d1) &
147           p2 = (t2,d2) & t1 /= t2 &
148           ran({d1}) = dom({d2}) &
149           d1 : direction[{t1}] &
150           d1 : staticDirection \/
151             dynamicDirection[np*{NORMAL} \/
152                               rp*{REVERSE}] &
153           d2 : direction[{t2}] &
154           d2 : staticDirection \/
155             dynamicDirection[np*{NORMAL} \/
156                               rp*{REVERSE}]
157         )
158       }
159     END
160   ELSE
161     bb := no
162   END
163 END
164 END;
165
166 bb <-- rbc_to_ixl_Release(route) =
167 PRE route : ROUTE THEN
168   LET emptyTracks BE emptyTracks = TRACK - dom(ran(pos)) IN
169   IF dom({homeMarkerBoard(markerBoard(route))}) <: emptyTracks
      &
170   {route} <: setRoutes &
171   {route} /<: grantedRoutes

```

```

172         THEN
173             markerBoardStatus(markerBoard(route)) := unavailable ||
174             currentLocks := {route} <<| currentLocks ||
175             bb := yes ||
176             setRoutes := setRoutes - {route}
177         ELSE
178             bb := no
179         END
180     END
181 END;
182
183 rbc_to_ixl_ClearRoute(route) =
184 PRE route : ROUTE
185     THEN
186         markerBoardStatus(markerBoard(route)) := unavailable ||
187         currentLocks := {route} <<| currentLocks ||
188         grantedRoutes := grantedRoutes - {route}
189 END;
190
191 newp, conn <-- train_to_ixl_TrackChange(t, currp) =
192 PRE t : TRAIN & t : dom(pos) &
193     {currp} = dom({pos(t)})
194 THEN
195     IF (pos(t) /\: dom(nextd))
196     THEN
197         pos(t) := (nullTrack, (C0, C0)) ||
198         newp := nullTrack ||
199         conn := C0 ||
200         occupiedTracks := occupiedTracks - {currp}
201     ELSE
202         LET (track, d) BE (track, d) = nextd(pos(t))
203         IN
204             pos(t) := nextd(pos(t)) ||
205             newp := track ||
206             occupiedTracks := (occupiedTracks - {currp}) \/\ {track}
207             ||
208             LET (x, y) BE (x, y) = d
209             IN
210                 conn := y ||
211                 nextConnector(t) := y ||
212                 IF (pos(t) : ran(homeMarkerBoard)) THEN
213                     markerBoardStatus(homeMarkerBoard~(pos(t))) :=
214                         unavailable
215                 END ||
216                 currentLocks := currentLocks - releaseTable[{\{track}}]
217             END
218     END
219 END
220 END;

```

```

219
220 bb <-- rbc_to_ixl_RequestToProceed(route) =
221 PRE route : ROUTE THEN
222   IF ({route} <: setRoutes) &
223     (markerBoardStatus(markerBoard(route)) = unavailable)
224   THEN
225     bb := yes
226   ELSE
227     bb := no
228   END
229 END
230
231 END

```

The CSP Topology file

```

1 datatype Unit = AA | AB | AC | AD | AE | AF | BC | BD | LL | RR |
  LL_left_b1 | LL_right_b1 | AC_left_b3 | AC_b3_b5 |
  AC_right_b5 | AF_left_b6 | AF_right_b6 | RR_left_b4 |
  RR_right_b4 | BC_left_b2 | BC_right_b2 | ABANDONED_TRACK
2 subtype ALLTRACK = AA | AB | AC | AD | AF | BC | BD | LL | RR |
  LL_left_b1 | LL_right_b1 | AC_left_b3 | AC_b3_b5 | AC_right_b5
  | AF_left_b6 | AF_right_b6 | RR_left_b4 | RR_right_b4 |
  BC_left_b2 | BC_right_b2
3
4 WholeTrack = {Track | Track <- {AA, AB, AC, AD, AE, AF, BC, BD,
  LL, RR}}
5
6 subtype trackPoint = AB | AE
7 datatype POINT = P1 | P2 | nullpoint
8 datatype Connector = a | b | c | d | e | f | g | h | i | j | l |
  r | bal_b1 | bal_b2 | bal_b3 | bal_b4 | bal_b5 | bal_b6 | CO
9 subtype trackConnectors = a | b | c | d | e | f | g | h | i | j |
  l | r
10 subtype baliseConnectors = bal_b1 | bal_b2 | bal_b3 | bal_b4 |
  bal_b5 | bal_b6
11 datatype Marker = MBOp | MB0 | MB1 | MB2 | MB3 | MB4 | MBr | MB1
12 subtype LeftwardMarker = MB0 | MBOp
13 datatype Balise = b1 | b2 | b3 | b4 | b5 | b6 | b_l | b_r
14 datatype Route = Route_1A | Route_1B | Route_2 | Route_3 |
  Route_4 | Route_null | Route_EntryR | Route_EntryL |
  Route_ExitL | Route_ExitR2 | Route_ExitR3
15 datatype TRAIN = Train_1 | Train_2
16 datatype MARKERBOARD = red | green
17 datatype ANSWERS = yes | no
18 datatype DIRECTION = dLeft | dRight
19 datatype PointPosition = NORMAL | REVERSE
20 datatype BaliseDirection = leftwards | rightwards | bidirectional
21

```

```

22 lowerConnectors = {a, b, c, d, e, f, g, l, r, bal_b1, bal_b3,
    bal_b4, bal_b5, bal_b6, C0}
23 upperConnectors = {h, i, j, bal_b2}
24
25 ENTRY = {RR,LL}
26 EXIT = {RR,LL}
27 MARKERBOARDHOMES = {LL, BC, AC, RR}
28
29 BaliseConnectorDistances = {distance(connector) | connector <- {
    bal_b1, bal_b2, bal_b3, bal_b4, bal_b5, bal_b6,r,l}}
30 PointTrack = {track | track <- {AB,AE}}
31
32 routeMaDistances = {RouteMA(Route) | Route <- {Route_EntryL,
    Route_EntryR,Route_1A,Route_1B,Route_2,Route_3,Route_4,
    Route_null,Route_ExitL,Route_ExitR2,Route_ExitR3}}
33
34 nextRoutes(loc,bal,dir) =
35   if (((loc >= distance(bal_b1)) and (loc < mbLocation(MB1)))
    and (bal == b1) and (dir == dRight))
36     then {Route_1A,Route_1B,Route_2,Route_3}
37   else if (((loc >= distance(bal_b2)) and (loc < mbLocation(MB2)
    )) and (bal == b2) and (dir == dRight))
38     then {Route_2}
39   else if (((loc >= distance(bal_b3)) and (loc < mbLocation(MB3)
    )) and ((bal == b3) or (bal == b5)) and (dir == dRight))
40     then {Route_3}
41   else if (((loc >= distance(bal_b6)) and (loc < mbLocation(MBr)
    )) and ((bal == b6) and (dir == dRight)))
42     then {Route_ExitR2,Route_ExitR3}
43   else if (((loc >= mbLocation(MB1)) and (loc < distance(bal_b6)
    )) and (bal == b1) and (dir == dLeft))
44     then {Route_ExitL}
45   else if (((loc >= mbLocation(MB0)) and (loc <= distance(
    bal_b4))) and (bal == b4) and (dir == dLeft))
46     then {Route_4}
47   else if (((loc >= distance(bal_b4)) and (loc <= distance(r))
    and (bal == b_r) and (dir == dLeft))
48     then {Route_EntryR}
49   else if (((loc >= distance(l)) and (loc < distance(bal_b1)))
    and (bal == b_l) and (dir == dRight))
50     then {Route_EntryL}
51   else if (((loc >= distance(bal_b4)) and (loc < distance(r))
    and (bal == b_r) and (dir == dLeft))
52     then {Route_EntryR}
53   else {Route_null}
54
55 baliseDirectionCheck(b1) = bidirectional
56 baliseDirectionCheck(b2) = rightwards
57 baliseDirectionCheck(b3) = rightwards

```

```

58 baliseDirectionCheck(b4) = leftwards
59 baliseDirectionCheck(b5) = rightwards
60 baliseDirectionCheck(b6) = rightwards
61 baliseDirectionCheck(b_r) = bidirectional
62 baliseDirectionCheck(b_l) = bidirectional
63
64 pointToTrack(P1) = AB
65 pointToTrack(P2) = AE
66
67 trackToPoint(AB) = P1
68 trackToPoint(AE) = P2
69 trackToPoint(_) = nullpoint
70
71 RouteMA(Route_1A) = (distance(d) - 50)
72 RouteMA(Route_1B) = (distance(i) - 50)
73 RouteMA(Route_2) = (distance(r) - 50)
74 RouteMA(Route_3) = (distance(r) - 50)
75 RouteMA(Route_4) = (distance(l) + 50)
76 RouteMA(Route_EntryL) = (distance(a) - 50)
77 RouteMA(Route_EntryR) = (distance(g) - 50)
78 RouteMA(Route_null) = 0
79 RouteMA(Route_ExitR2) = distance(r)
80 RouteMA(Route_ExitR3) = distance(r)
81 RouteMA(Route_ExitL) = distance(l)
82
83 relevantPoint(x) =
84     if ((x == AB) or (x == AC) or (x == BC))
85         then AB
86     else if ((x == BD) or (x == AD) or (x == AE))
87         then AE
88     else x
89
90 routePointPos(Route_1A) = NORMAL
91 routePointPos(Route_1B) = REVERSE
92 routePointPos(Route_2) = REVERSE
93 routePointPos(Route_3) = NORMAL
94 routePointPos(Route_4) = NORMAL
95 routePointPos(Route_null) = NORMAL
96 routePointPos(Route_EntryL) = NORMAL
97 routePointPos(Route_EntryR) = NORMAL
98 routePointPos(Route_null) = NORMAL
99 routePointPos(Route_ExitL) = NORMAL
100 routePointPos(Route_ExitR2) = NORMAL
101 routePointPos(Route_ExitR3) = NORMAL
102
103 pointConnectors(AB,NORMAL) = {c,bal_b3,bal_b5,d,e}
104 pointConnectors(AB,REVERSE) = {h,bal_b2,i,j}
105 pointConnectors(AE,NORMAL) = {c,bal_b3,bal_b5,d,e}
106 pointConnectors(AE,REVERSE) = {h,bal_b2,i,j}

```

```

107
108 trackBaliseLeft(LL) = LL_left_b1
109 trackBaliseLeft(AC) = AC_left_b3
110 trackBaliseLeft(AF) = AF_left_b6
111 trackBaliseLeft(RR) = RR_left_b4
112 trackBaliseLeft(BC) = BC_left_b2
113 trackBaliseLeft(LL_left_b1) = LL_left_b1
114 trackBaliseLeft(AC_left_b3) = AC_left_b3
115 trackBaliseLeft(AF_left_b6) = AF_left_b6
116 trackBaliseLeft(RR_left_b4) = RR_left_b4
117 trackBaliseLeft(BC_left_b2) = BC_left_b2
118 trackBaliseLeft(AA) = AA
119 trackBaliseLeft(AB) = AB
120 trackBaliseLeft(AD) = AD
121 trackBaliseLeft(AE) = AE
122 trackBaliseLeft(AF) = AF
123 trackBaliseLeft(BD) = BD
124 trackBaliseLeft(LL_right_b1) = LL_right_b1
125 trackBaliseLeft(AC_right_b5) = AC_right_b5
126 trackBaliseLeft(AF_right_b6) = AF_right_b6
127 trackBaliseLeft(RR_right_b4) = RR_right_b4
128 trackBaliseLeft(BC_right_b2) = BC_right_b2
129 trackBaliseLeft(AC_b3_b5) = AC_b3_b5
130
131 trackBaliseRight(LL) = LL_right_b1
132 trackBaliseRight(AC) = AC_right_b5
133 trackBaliseRight(AF) = AF_right_b6
134 trackBaliseRight(RR) = RR_right_b4
135 trackBaliseRight(BC) = BC_right_b2
136 trackBaliseRight(LL_right_b1) = LL_right_b1
137 trackBaliseRight(AC_right_b5) = AC_right_b5
138 trackBaliseRight(AF_right_b6) = AF_right_b6
139 trackBaliseRight(RR_right_b4) = RR_right_b4
140 trackBaliseRight(BC_right_b2) = BC_right_b2
141 trackBaliseRight(AA) = AA
142 trackBaliseRight(AB) = AB
143 trackBaliseRight(AD) = AD
144 trackBaliseRight(AE) = AE
145 trackBaliseRight(AF) = AF
146 trackBaliseRight(BD) = BD
147 trackBaliseRight(LL_left_b1) = LL_left_b1
148 trackBaliseRight(AC_left_b3) = AC_left_b3
149 trackBaliseRight(AF_left_b6) = AF_left_b6
150 trackBaliseRight(RR_left_b4) = RR_left_b4
151 trackBaliseRight(BC_left_b2) = BC_left_b2
152 trackBaliseRight(AC_b3_b5) = AC_b3_b5
153
154 baliseTrack(LL_left_b1) = LL
155 baliseTrack(LL_right_b1) = LL

```

```

156 baliseTrack(AC_left_b3) = AC
157 baliseTrack(AC_b3_b5) = AC
158 baliseTrack(AC_right_b5) = AC
159 baliseTrack(AF_left_b6) = AF
160 baliseTrack(AF_right_b6) = AF
161 baliseTrack(RR_left_b4) = RR
162 baliseTrack(RR_right_b4) = RR
163 baliseTrack(BC_left_b2) = BC
164 baliseTrack(BC_right_b2) = BC
165 baliseTrack(x) = x
166
167 connectors(AA) = {a, b}
168 connectors(AB) = {b, c, h}
169 connectors(AC) = {c, d, bal_b3, bal_b5}
170 connectors(AD) = {d, e}
171 connectors(AE) = {e, f, j}
172 connectors(AF) = {f, g, bal_b6}
173 connectors(BC) = {h, i, bal_b2}
174 connectors(BD) = {i, j}
175 connectors(LL) = {l, a, bal_b1}
176 connectors(RR) = {g, r, bal_b4}
177
178 isConnectorBalise(bal_b1) = true
179 isConnectorBalise(bal_b2) = true
180 isConnectorBalise(bal_b3) = true
181 isConnectorBalise(bal_b4) = true
182 isConnectorBalise(bal_b5) = true
183 isConnectorBalise(bal_b6) = true
184 isConnectorBalise(_) = false
185
186 dirNormal(AB) = {(b, c), (c, b)}
187 dirNormal(AE) = {(e, f), (f, e)}
188 dirReverse(AB) = {(b, h), (h, b)}
189 dirReverse(AE) = {(j, f), (f, j)}
190
191 directions(u) =
192   if member(u, trackPoint)
193     then union(dirNormal(u), dirReverse(u))
194   else {(x, y) | x <- connectors(u), y <- connectors(u), x != y
195         }
196
196 unitLen(AA) = 1300
197 unitLen(AB) = 250
198 unitLen(AC) = 1500
199 unitLen(AD) = 1500
200 unitLen(AE) = 250
201 unitLen(AF) = 1500
202 unitLen(BC) = 1500
203 unitLen(BD) = 1500

```

```

204 unitLen(LL) = 500
205 unitLen(RR) = 500
206 unitLen(LL_left_b1) = 100
207 unitLen(LL_right_b1) = 400
208 unitLen(AC_left_b3) = 100
209 unitLen(AC_b3_b5) = 500
210 unitLen(AC_right_b5) = 900
211 unitLen(AF_left_b6) = 100
212 unitLen(AF_right_b6) = 1400
213 unitLen(BC_left_b2) = 100
214 unitLen(BC_right_b2) = 1400
215 unitLen(RR_left_b4) = 400
216 unitLen(RR_right_b4) = 100
217
218 uPreceding(l) = LL_left_b1
219 uPreceding(a) = AA
220 uPreceding(b) = AB
221 uPreceding(c) = AC_left_b3
222 uPreceding(d) = AD
223 uPreceding(f) = AE
224 uPreceding(g) = AF_right_b6
225 uPreceding(h) = BC_left_b2
226 uPreceding(i) = BD
227 uPreceding(r) = RR_right_b4
228 uPreceding(bal_b1) = LL_right_b1
229 uPreceding(bal_b2) = BC_right_b2
230 uPreceding(bal_b3) = AC_b3_b5
231 uPreceding(bal_b4) = RR_left_b4
232 uPreceding(bal_b5) = AC_right_b5
233 uPreceding(bal_b6) = AF_left_b6
234 uPreceding(C0) = RR
235 uPreceding(e) = AE
236 uPreceding(j) = AE
237
238 cPreceding(l) = bal_b1
239 cPreceding(a) = b
240 cPreceding(b) = c
241 cPreceding(c) = bal_b3
242 cPreceding(d) = e
243 cPreceding(f) = e
244 cPreceding(g) = bal_b6
245 cPreceding(h) = bal_b2
246 cPreceding(i) = j
247 cPreceding(r) = bal_b4
248 cPreceding(bal_b1) = a
249 cPreceding(bal_b2) = i
250 cPreceding(bal_b3) = bal_b5
251 cPreceding(bal_b4) = g
252 cPreceding(bal_b5) = d

```

```

253 cPreceding(bal_b6) = f
254 cPreceding(C0) = r
255
256 ConnectorsLeftOfOrigin = {l, a, b, c, d, h, i, bal_b1, bal_b2,
    bal_b3, bal_b5}
257 ConnectorsRightOfOrigin = {f, g, r, bal_b4, bal_b6}
258
259 distance(j) = 0
260 distance(e) = 0
261 distance(connector) =
262     if member(connector, ConnectorsLeftOfOrigin)
263         then distance(cPreceding(connector)) - unitLen(uPreceding
            (connector))
264     else distance(cPreceding(connector)) + unitLen(uPreceding(
            connector))
265
266 unitsNextTo(l) = (ABANDONED_TRACK, LL_left_b1)
267 unitsNextTo(a) = (LL_right_b1, AA)
268 unitsNextTo(b) = (AA, AB)
269 unitsNextTo(c) = (AB, AC_left_b3)
270 unitsNextTo(d) = (AC_right_b5, AD)
271 unitsNextTo(e) = (AD, AE)
272 unitsNextTo(f) = (AE, AF_left_b6)
273 unitsNextTo(g) = (AF_right_b6, RR_left_b4)
274 unitsNextTo(h) = (AB, BC_left_b2)
275 unitsNextTo(i) = (BC_right_b2, BD)
276 unitsNextTo(j) = (BD, AE)
277 unitsNextTo(r) = (RR_right_b4, ABANDONED_TRACK)
278 unitsNextTo(bal_b1) = (LL_left_b1, LL_right_b1)
279 unitsNextTo(bal_b2) = (BC_left_b2, BC_right_b2)
280 unitsNextTo(bal_b3) = (AC_left_b3, AC_b3_b5)
281 unitsNextTo(bal_b4) = (RR_left_b4, RR_right_b4)
282 unitsNextTo(bal_b5) = (AC_b3_b5, AC_right_b5)
283 unitsNextTo(bal_b6) = (AF_left_b6, AF_right_b6)
284 unitsNextTo(C0) = (ABANDONED_TRACK, ABANDONED_TRACK)
285
286 NormalConnectors = {c, bal_b3, bal_b5, d, e}
287 ReverseConnectors = {h, bal_b2, i, j}
288 LoopStart = distance(b) + 1
289 LoopEnd = distance(f) - 1
290
291 offset(mb) =
292     if (member(mb, LeftwardMarker))
293         then 10
294     else -10
295
296 mbConnector(MB1) = a
297 mbConnector(MB2) = i
298 mbConnector(MB3) = d

```

```

299 mbConnector(MB4) = r
300 mbConnector(MB0) = g
301 mbConnector(MB0p) = l
302 mbConnector(MB1) = l
303 mbConnector(MBr) = r
304
305 mbLocation(mb) = distance(mbConnector(mb)) + offset(mb)
306 mbLocation(MB1) = distance(mbConnector(MB1))
307 mbLocation(MBr) = distance(mbConnector(MBr))
308
309 BALISE_OFFSET = 100
310 baliseLoc(b1) = distance(l) + BALISE_OFFSET
311 baliseLoc(b2) = distance(h) + BALISE_OFFSET
312 baliseLoc(b_l) = distance(l)
313 baliseLoc(b3) = distance(c) + BALISE_OFFSET
314 baliseLoc(b4) = distance(r) - BALISE_OFFSET
315 baliseLoc(b5) = baliseLoc(b3) + 500
316 baliseLoc(b6) = distance(f) + BALISE_OFFSET
317 baliseLoc(b_r) = distance(r)
318
319 baliseConnector(b_l) = l
320 baliseConnector(b_r) = r
321 baliseConnector(b1) = bal_b1
322 baliseConnector(b2) = bal_b2
323 baliseConnector(b3) = bal_b3
324 baliseConnector(b4) = bal_b4
325 baliseConnector(b5) = bal_b5
326 baliseConnector(b6) = bal_b6
327
328 connectorBalise(l) = b_l
329 connectorBalise(r) = b_r
330 connectorBalise(bal_b1) = b1
331 connectorBalise(bal_b2) = b2
332 connectorBalise(bal_b3) = b3
333 connectorBalise(bal_b4) = b4
334 connectorBalise(bal_b6) = b6
335 connectorBalise(bal_b5) = b5
336
337 baliseMb(b1) = MB1
338 baliseMb(b2) = MB2
339 baliseMb(b3) = MB3
340 baliseMb(b4) = MB0
341 baliseMb(b5) = MB3
342 baliseMb(b6) = MB4
343
344 nextBalise(b_l) = b1
345 nextBalise(b1) = b3
346 nextBalise(b2) = b6
347 nextBalise(b3) = b5

```

```

348 nextBalise(b4) = b_l
349 nextBalise(b5) = b6
350 nextBalise(b6) = b_r
351 nextBalise(b_r) = b4
352
353 MAX_BALISE_INTERVAL = 7200
354
355 endOfRoute(Route_1A) = MB3
356 endOfRoute(Route_1B) = MB2
357 endOfRoute(Route_2) = MB4
358 endOfRoute(Route_3) = MB4
359 endOfRoute(Route_4) = MB0p
360 endOfRoute(Route_EntryR) = MB0
361 endOfRoute(Route_EntryL) = MB1
362 endOfRoute(Route_ExitR2) = MBr
363 endOfRoute(Route_ExitR3) = MBr
364 endOfRoute(Route_ExitL) = MB1
365
366 nextRoute(Route_1A) = {Route_3}
367 nextRoute(Route_1B) = {Route_2}
368 nextRoute(Route_2) = {Route_ExitR2}
369 nextRoute(Route_3) = {Route_ExitR3}
370 nextRoute(Route_EntryL) = {Route_1A, Route_1B}
371 nextRoute(Route_EntryR) = {Route_4}
372 nextRoute(Route_null) = {Route_EntryL, Route_EntryR}
373 nextRoute(Route_4) = {Route_ExitL}
374 nextRoute(Route_ExitL) = {Route_null}
375 nextRoute(Route_ExitR2) = {Route_null}
376 nextRoute(Route_ExitR3) = {Route_null}
377
378 lastRoute(Route_1A) = {Route_EntryL}
379 lastRoute(Route_1B) = {Route_EntryL}
380 lastRoute(Route_2) = {Route_1B}
381 lastRoute(Route_3) = {Route_1A}
382 lastRoute(Route_4) = {Route_EntryR}
383 lastRoute(Route_EntryL) = {Route_null}
384 lastRoute(Route_EntryR) = {Route_null}
385 lastRoute(Route_ExitL) = {Route_4}
386 lastRoute(Route_ExitR2) = {Route_2}
387 lastRoute(Route_ExitR3) = {Route_3}
388 lastRoute(Route_null) = {Route_ExitR2, Route_ExitR3, Route_ExitL}
389
390 RoutesWithSuccessors = {Route_1A, Route_1B, Route_2, Route_3,
    Route_EntryL, Route_EntryR}
391
392 BottomRoutes = {Route_1A, Route_3, Route_4, Route_EntryR,
    Route_EntryL, Route_ExitL, Route_ExitR2, Route_ExitR3}
393 TopRoutes = {Route_1B, Route_2}
394

```

```

395 BottomTracks = {LL,AA,AB,AC,AD,AE,AF,RR}
396 TopTracks = {BC,BD}
397
398 directionPosMin(dRight) = 1
399 directionPosMin(dLeft) = -1
400
401 baliseType(b3) = false
402 baliseType(_) = true
403
404 connectorRoutePoints(c) = NORMAL
405 connectorRoutePoints(d) = NORMAL
406 connectorRoutePoints(e) = NORMAL
407 connectorRoutePoints(h) = REVERSE
408 connectorRoutePoints(i) = REVERSE
409 connectorRoutePoints(j) = REVERSE
410 connectorRoutePoints(_) = NORMAL

```

The CSP Operations file

```

1 include "Topology.csp"
2
3 nametype Direction = (Connector, Connector)
4 nametype Move = (Unit, Direction)
5 datatype TrainLevel = NTC | L2
6 datatype Orientation = LEFT | RIGHT
7
8 setHead(x) =
9     if empty(x)
10        then {}
11     else
12        {head(seq(x))}
13
14 unwrap({x}) =
15     if card({x}) > 1
16        then unwrap(setHead({x}))
17     else x
18
19 first((x,y)) = x
20 second((x,y)) = y
21
22 isPath((u1, d1), (u2, d2)) =
23     (second(d1) == first(d2))
24     and (u1 != u2)
25     and member(d1, directions(u1))
26     and member(d2, directions(u2))
27
28 successor(move) = {move' | move' <- Move, isPath(move, move')}
29 predecessor(move) = {move' | move' <- Move, isPath(move', move)}
30

```

```

31 getDirFromMove(u, (c1,c2)) = (c1,c2)
32
33 isValidMove((unit, dir)) = member(dir, directions(unit))
34
35 next(move) = unwrap(successor(move))
36 prev(move) = unwrap(predecessor(move))
37
38 unit(direction) = unwrap({ unit | unit <- Unit, isValidMove( (
    unit, direction) ) })
39
40 EntryMoves = { move | move <- Move, isValidMove(move), empty(
    predecessor(move)) }
41 ExitMoves = { move | move <- Move, isValidMove(move), empty(
    successor(move)) }
42
43 abs(x) =
44     if (x < 0)
45         then -x
46     else x
47
48 baliseDiff(x, y) = abs(baliseLoc(x) - baliseLoc(y))
49
50 distConvert(dist, oldBalise, newBalise) = dist - baliseDiff(
    oldBalise, newBalise)
51
52 baliseToNext(balise) = baliseDiff(balise, nextBalise(balise))
53
54 baliseToMb(balise, mb) = abs(mbLocation(mb) - baliseLoc(balise))
55
56 locToNextBalise(curBalise, locDist) = baliseToNext(curBalise) -
    locDist
57
58 isBeyondNextbalise(curBalise, locDist) = locDist >= baliseToNext(
    curBalise)
59
60 connectorDiff(c1, c2) = abs(distance(c1) - distance(c2))
61
62 ConnectorDistances = {distance(connector) | connector <-
    Connector}
63
64 unitLeftOf(connector) = first(unitsNextTo(connector))
65
66 unitRightOf(connector) = second(unitsNextTo(connector))
67
68 connectorsAt(dist) = {x | x <- Connector, distance(x) == dist}
69
70 connectorAt(dist, pointPos) =
71     if ((dist > LoopStart) and (dist < LoopEnd))
72     then (

```

```

73         if (pointPos == NORMAL)
74             then unwrap({x | x <- NormalConnectors, distance(x)
75                          == dist})
76             else unwrap({x | x <- ReverseConnectors, distance(x) ==
77                          dist})
78         ) else (
79             unwrap({x | x <- Connector, distance(x) == dist})
80         )
81 unitsLeftOf(dist) = {unitLeftOf(con) | con <- connectorsAt(dist)}
82 unitsRightOf(dist) = {unitRightOf(con) | con <- connectorsAt(dist)
83                       }
84 connectorRightOf(b, NORMAL) = c
85 connectorRightOf(b, REVERSE) = h
86 connectorRightOf(curConnector, pointPos) =
87     let curUnit = unitRightOf(curConnector)
88         newDistance = distance(curConnector) + unitLen(curUnit)
89         within connectorAt(newDistance, pointPos)
90
91 connectorLeftOf(f, NORMAL) = e
92 connectorLeftOf(f, REVERSE) = j
93 connectorLeftOf(curConnector, pointPos) =
94     let curUnit = unitLeftOf(curConnector)
95         newDistance = distance(curConnector) - unitLen(curUnit)
96         within connectorAt(newDistance, pointPos)
97
98 connectorsRightof(dist) =
99     let curUnits = unitsRightOf(dist)
100         newDistances = { dist + unitLen(u) | u <- curUnits }
101         within Union({ connectorsAt(newDist) | newDist <-
102                       newDistances })
103
104 connectorsLeftOf(dist) =
105     let curUnits = unitsLeftOf(dist)
106         newDistances = { dist - unitLen(u) | u <- curUnits}
107         within Union({ connectorsAt(newDist) | newDist <-
108                       newDistances })
109
110 trackDirectionCheck(dir, dist) =
111     if (dir == RIGHT)
112         then unitsLeftOf(dist)
113         else unitsRightOf(dist)
114
115 posDirectionCheck(dir, pos) =
116     if (dir == RIGHT)
117         then pos+1
118     else pos-1

```

```

117
118 connectorDirectionCheck(dir, pos, pointPos) =
119     if (dir == RIGHT)
120         then connectorPointsCheck(connectorsRightof(pos-1),
121                                 pointPos)
122     else connectorPointsCheck(connectorsLeftOf(pos+1), pointPos)
123
124 connectorPointsCheck(conns, pointPos) =
125     if (pointPos == NORMAL)
126         then {x | x <- inter(conns, lowerConnectors)}
127     else {x | x <- inter(conns, upperConnectors)}
128
129 oldDirectionCheck(dir, pos, pointPos) =
130     if (dir == RIGHT)
131         then unitLeftOf(connectorAt(pos, pointPos))
132     else unitRightOf(connectorAt(pos, pointPos))
133
134 newDirectionCheck(dir, pos, pointPos) =
135     if (dir == RIGHT)
136         then unitRightOf(connectorAt(pos, pointPos))
137     else unitLeftOf(connectorAt(pos, pointPos))
138
139 directionConvert(dir) =
140     if (dir == RIGHT)
141         then dRight
142     else dLeft
143
144 connectorDecision(dir, pos, pointPos, con) =
145     if (card(connectorDirectionCheck(dir, pos, pointPos)) >= 1)
146         then connectorAt(distance(unwrap(setHead(
147             connectorDirectionCheck(dir, pos, pointPos))))), pointPos
148     else con
149
150 baliseDirectionValid(balDir, dir) =
151     if ((balDir == bidirectional) or ((balDir == rightwards) and
152         (dir == dRight)) or ((balDir == leftwards) and (dir ==
153         dLeft)))
154         then true
155     else false

```

The CSP Control file

```

1 include "Operations.csp"
2
3 channel train_NextAction: TRAIN.Connector.Int
4 channel train_to_ixl_TrackChange: TRAIN.WholeTrack.WholeTrack.
   trackConnectors

```



```

5 channel train_PassedBalise: TRAIN.Balise
6 channel train_AtEoA: TRAIN
7 channel train_to_ixl_Enter: TRAIN.ENTRY.ANSWERS
8 channel train_to_ixl_Exit: TRAIN.EXIT
9 channel train_to_rbc_MARequest : TRAIN.Balise.DIRECTION
10 channel rbc_to_train_MAGrant : routeMaDistances
11 channel rbc_to_ixl_RequestToProceed : Route.ANSWERS
12 channel rbc_to_ixl_Request : Route.ANSWERS
13 channel rbc_to_ixl_Release : Route.ANSWERS
14 channel ixl_to_rbc_GrantRoute : Route.ANSWERS
15 channel rbc_to_ixl_ClearRoute : Route
16 channel rbc_to_train_RequestAccepted : ANSWERS
17 channel collision
18 channel exceededEOA : TRAIN
19
20 ERR = collision -> ERR
21
22 RBC(aRoutes) =
23     (train_to_rbc_MARequest?TrainID?lrbg?direction -> RBC1(
24         aRoutes,nextRoutes(distance(baliseConnector(lrbg)),
25             lrbg,direction)))
26
27     []
28     ([[] rt : Route @ rbc_to_ixl_Request!rt?ans
29         -> if (ans == yes)
30             then (RBC(union(aRoutes, {rt})))
31             else RBC(aRoutes))
32
33     []
34     ([[] rt : aRoutes @ rbc_to_ixl_Release!rt?ans
35         -> if (ans == yes)
36             then (RBC(diff(aRoutes, {rt})))
37             else RBC(aRoutes))
38
39 RBC1(aRoutes,nRoutes) =
40     (if (empty(inter(aRoutes,nRoutes)) == false)
41         then (rbc_to_ixl_RequestToProceed!unwrap(setHead(
42             inter(aRoutes,nRoutes)))?ans
43             -> if (ans == yes)
44                 then (rbc_to_train_RequestAccepted!ans
45                     -> RBC2(diff(aRoutes,setHead(inter(
46                         aRoutes,nRoutes))),unwrap(setHead(
47                             inter(aRoutes,nRoutes))))))
48                 else RBC1(aRoutes,nRoutes))
49         else (rbc_to_train_RequestAccepted!no -> RBC(aRoutes)))
50
51     []
52     ([[] rt : Route @ rbc_to_ixl_Request!rt?ans
53         -> if (ans == yes)
54             then (RBC1(union(aRoutes, {rt}),nRoutes))
55             else RBC1(aRoutes,nRoutes))
56
57     []

```

```

49     ([] rt : aRoutes @ rbc_to_ixl_Release!rt?ans
50       -> if (ans == yes)
51           then (RBC1(diff(aRoutes, {rt}),nRoutes))
52           else RBC1(aRoutes,nRoutes))
53
54 RBC2(aRoutes,new_route) =
55     (ixl_to_rbc_GrantRoute.new_route?ans
56       -> rbc_to_ixl_ClearRoute!unwrap(setHead(lastRoute(
57         new_route)))
58       -> rbc_to_train_MAGrant.RouteMA(new_route)
59       -> RBC(diff(aRoutes,{new_route})))
60
61 ([] rt : Route @ rbc_to_ixl_Request!rt?ans
62   -> if (ans == yes)
63       then (RBC2(union(aRoutes, {rt}),new_route))
64       else RBC2(aRoutes,new_route))
65
66 ([] rt : aRoutes @ rbc_to_ixl_Release!rt?ans
67   -> if (ans == yes)
68       then (RBC2(diff(aRoutes, {rt}),new_route))
69       else RBC2(aRoutes,new_route))
70
71
72 UnifiedTrain(train, orientation, pos, eoaDist, lrbg, curTrack,
73   targetConnector) =
74   let oldUnit = oldDirectionCheck(orientation,pos,
75     connectorRoutePoints(targetConnector))
76     newUnit = newDirectionCheck(orientation,pos,
77     connectorRoutePoints(targetConnector))
78   within (
79     if (pos == eoaDist)
80       then (train_AtEoA.train -> train_to_ixl_Exit!train!
81         baliseTrack(uPreceding(targetConnector)) -> STOP)
82     else (if ((orientation == RIGHT )and (pos > eoaDist)) or
83           ((orientation == LEFT )and (pos < eoaDist))
84           then exceededEOA.train -> STOP
85           else(
86             if (member(pos, BaliseConnectorDistances))
87               then (
88                 if (newUnit == ABANDONED_TRACK)
89                   then STOP
90                 else (train_PassedBalise.train.
91                   connectorBalise(connectorAt(pos,
92                     connectorRoutePoints(targetConnector)
93                   )))
94             -> if ((baliseType(connectorBalise(
95               connectorAt(pos,
96                 connectorRoutePoints(

```

```

87         targetConnector)))) == true)
            and baliseDirectionValid(
                baliseDirectionCheck(
                    connectorBalise(
                        connectorAt(pos,
                            connectorRoutePoints(
                                targetConnector))))),
                    directionConvert(
                        orientation)))
88     then (train_to_rbc_MARequest!
            train!connectorBalise(
                connectorAt(pos,
                    connectorRoutePoints(
                        targetConnector)))!
                directionConvert(orientation
            )
89     -> rbc_to_train_RequestAccepted
        ?ans
90     -> if(ans == yes)
91         then (rbc_to_train_MAGrant?
                new_MA
92         -> UnifiedTrain(train,
                orientation,
                posDirectionCheck(
                    orientation, pos),
                new_MA, connectorBalise(
                    connectorAt(pos,
                        connectorRoutePoints(
                            targetConnector))),
                    curTrack,
                    targetConnector))
93         else (UnifiedTrain(train,
                orientation, pos,
                eoaDist, lrbg, curTrack,
                    targetConnector)))
94     else UnifiedTrain(train,
                orientation, posDirectionCheck(
                    orientation, pos), eoaDist,
                connectorBalise(connectorAt(pos
                    , connectorRoutePoints(
                        targetConnector))), curTrack,
                    targetConnector)
95     )
96     )
97     else if (member(pos, ConnectorDistances) and (
        pos != distance(r)) and (pos != distance(l))
        )
98         then (
99             if (newUnit == ABANDONED_TRACK)

```

```

100         then STOP
101         else train_to_ixl_TrackChange!
102             train!baliseTrack(oldUnit)?
103             newpos?con
104             -> UnifiedTrain(train,
105                 orientation,
106                 posDirectionCheck(
107                     orientation, pos), eoaDist,
108                     lrbg, newpos, con)
109         )
110     else(
111         let con = connectorDecision(
112             orientation,pos,
113             connectorRoutePoints(
114                 targetConnector),targetConnector)
115         within train_NextAction.train.con.
116             distance(con)
117         -> UnifiedTrain(train,
118             orientation, distance(con),
119             eoaDist, lrbg, curTrack,
120             targetConnector)
121     )
122 )
123 )
124 )
125
126 EntryRequest(t_id,entry_track) =
127     if (entry_track == LL)
128         then rbc_to_ixl_Request!Route_EntryL?ans
129         -> TrainEntry(t_id,entry_track)
130     else rbc_to_ixl_Request!Route_EntryR?ans
131     -> TrainEntry(t_id,entry_track)
132
133 TrainEntry(t_id,entry_track) =
134     train_to_ixl_Enter!t_id!entry_track?ans
135     -> (if (ans == yes)
136         then (
137             if (entry_track == LL)
138                 then (
139                     UnifiedTrain(t_id,RIGHT,distance(l),
140                         distance(l)+1,b_l, LL, a)
141                 )
142             else (
143                 if (entry_track == RR)
144                     then (
145                         UnifiedTrain(t_id,LEFT,distance(r),
146                             distance(r)-1,b_r, RR, g))
147                     else STOP
148                 )
149             )
150     )

```

```

134         )
135     )
136     else (
137         ([] et:ENTRY @ TrainEntry(t_id,et))
138     )
139 )
140
141
142 MAIN = ((ERR ||| RBC({Route_EntryL,Route_EntryR}))
143         [|{|train_to_rbc_MAResult, rbc_to_train_MAGrant,
144         rbc_to_train_RequestAccepted|}|]
145         (([] et:ENTRY @ EntryRequest(Train_1,et)) ||| ([] et:
146         ENTRY @ EntryRequest(Train_2,et))))

```

Moorgate-Holloway (Real-world data)

The Context B-Machine

```

1 MACHINE Context
2
3 SETS
4     TRACKSTATUS = {occ, empty};
5     ASPECT = {unavailable, granted};
6     ALLTRACK = {T_null, T_VTC001, T_ZAAA, T_ZAAB, T_ZAAC, T_ZAAD,
7     T_ZAAE, T_ZAAF, T_ZAAG, T_ZAAH, T_ZAAJ, T_ZAAK, T_ZAAL,
8     T_0832, T_0833, T_0834, T_0835, T_08411, T_08412, T_0842,
9     T_0843, T_VTC002, T_ZBBA, T_ZBBB, T_ZBBC, T_ZBBD, T_ZBBE,
10    T_ZBBF, T_ZBBG, T_ZBBH, T_ZBBJ, T_ZBBK, T_ZBBL, T_ZBBM,
11    T_0534, T_0535, T_0541, T_0542, T_0543, T_0544,
12    T_VTC001_L_BG_1000, T_VTC001_R_BG_1000, T_ZAAA_L_BG_1025,
13    T_ZAAA_BG_1025_BG_1001, T_ZAAA_R_BG_1001, T_ZAAB_L_BG_1023,
14    T_ZAAB_R_BG_1023, T_ZAAC_L_BG_1027, T_ZAAC_R_BG_1027,
15    T_ZAAD_L_BG_1031, T_ZAAD_BG_1031_BG_1009, T_ZAAD_R_BG_1009,
16    T_ZAAE_L_BG_1011, T_ZAAE_R_BG_1011, T_ZAAG_L_BG_1017,
17    T_ZAAG_R_BG_1017, T_ZAAJ_L_BG_1015, T_ZAAJ_R_BG_1015,
18    T_ZAAK_L_BG_1013, T_ZAAK_R_BG_1013, T_ZAAL_L_BG_1019,
19    T_ZAAL_R_BG_1019, T_0833_L_BG_1033, T_0833_R_BG_1033,
20    T_0835_L_BG_1021, T_0835_BG_1021_BG_1029, T_0835_R_BG_1029,
21    T_08412_L_BG_1003, T_08412_R_BG_1003, T_0843_L_BG_1005,
22    T_0843_R_BG_1005, T_VTC002_L_BG_1030,
23    T_VTC002_BG_1030_BG_1032, T_VTC002_R_BG_1032,
24    T_ZBBA_L_BG_998, T_ZBBA_R_BG_998, T_ZBBC_L_BG_1002,
25    T_ZBBC_R_BG_1002, T_ZBBD_L_BG_1004, T_ZBBD_BG_1026_BG_1004,
26    T_ZBBD_R_BG_1004, T_ZBBE_L_BG_1006, T_ZBBE_R_BG_1006,
27    T_ZBBF_L_BG_996, T_ZBBF_R_BG_996, T_ZBBJ_L_BG_1008,
28    T_ZBBJ_R_BG_1008, T_ZBBK_L_BG_1010, T_ZBBK_R_BG_1010,
29    T_ZBBL_L_BG_1012, T_ZBBL_R_BG_1012, T_ZBBM_L_BG_1014,
30    T_ZBBM_R_BG_1014, T_0534_L_BG_1028, T_0534_R_BG_1028,

```

```

7      T_0535_L_BG_1020 , T_0535_R_BG_1020 , T_0541_L_BG_1018 ,
      T_0541_BG_1018_BG_1022 , T_0541_R_BG_1022 , T_0543_L_BG_1016 ,
      T_0543_R_BG_1016 , T_0544_L_BG_1024 , T_0544_R_BG_1024};
ALLCONNECTOR = {C_VTC1_AA , C_AA_AB , C_AB_AC , C_AC_AD , C_AD_AE
      , C_AE_AF , C_AF_AG , C_AG_AH , C_AH_AJ , C_AJ_AK , C_AK_AL ,
      C_AL_0832 , C_0832_0833 , C_0833_0834 , C_0834_0835 ,
      C_0835_08411 , C_08411_08412 , C_08412_0842 , C_0842_0843 ,
      C_VTC2_BA , C_BA_BB , C_BB_BC , C_BC_BD , C_BD_BE , C_BE_BF ,
      C_BF_BG , C_BG_BH , C_BH_BJ , C_BJ_BK , C_BK_BL , C_BL_BM ,
      C_BM_0534 , C_0534_0535 , C_0535_0541 , C_0541_0542 ,
      C_0542_0543 , C_0543_0544 , C_BG_1000 , C_BG_1001 , C_BG_1002 ,
      C_BG_1003 , C_BG_1004 , C_BG_1005 , C_BG_1006 , C_BG_1008 ,
      C_BG_1009 , C_BG_1010 , C_BG_1011 , C_BG_1012 , C_BG_1013 ,
      C_BG_1014 , C_BG_1015 , C_BG_1016 , C_BG_1017 , C_BG_1018 ,
      C_BG_1019 , C_BG_1020 , C_BG_1021 , C_BG_1022 , C_BG_1023 ,
      C_BG_1024 , C_BG_1025 , C_BG_1026 , C_BG_1027 , C_BG_1028 ,
      C_BG_1029 , C_BG_1030 , C_BG_1031 , C_BG_1032 , C_BG_1033 ,
      C_BG_996 , C_BG_998 , C_BG_LU , C_BG_LD , C_BG_RU , C_BG_RD , CO
      , C_AB_BC , C_BB_AC , C_0535_0834};
8  MARKERBOARD = {MB_DBM001 , MB_DBM002 , MB_DBM003 , MB_DBM004 ,
      MB_DBM005 , MB_5001 , MB_5002 , MB_5003 , MB_5004 , MB_5005 ,
      MB_5006 , MB_5007 , MB_5008 , MB_5009 , MB_5010 , MB_5011 ,
      MB_5012 , MB_5013 , MB_5014 , MB_5015 , MB_5016 , MB_5017 ,
      MB_5018 , MB_5019 , MB_5020 , MB_5021 , MB_LU , MB_LD , MB_RU ,
      MB_RD , MB_null};
9  TRAIN = {Train_1 , Train_2};
10 POINT = {P_2057A , P_2057B , P_2058A , P_2058B , P_2059A , P_2059B
      , P_null};
11 POINTPOSITION = {NORMAL , REVERSE};
12 POINTSTATUS = {locked , unlocked};
13 ROUTE = {ROUTE_DBM001 , ROUTE_DBM002 , ROUTE_DBM003 ,
      ROUTE_DBM004 , ROUTE_DBM005 , ROUTE_5001_U , ROUTE_5001_D ,
      ROUTE_5002_U , ROUTE_5002_D , ROUTE_5003_U , ROUTE_5003_D ,
      ROUTE_5004_U , ROUTE_5004_D , ROUTE_5005 , ROUTE_5006 ,
      ROUTE_5007 , ROUTE_5008 , ROUTE_5009 , ROUTE_5010 , ROUTE_5011
      , ROUTE_5012 , ROUTE_5013 , ROUTE_5014 , ROUTE_5015 ,
      ROUTE_5016 , ROUTE_5017 , ROUTE_5018 , ROUTE_5019 , ROUTE_5020
      , ROUTE_5021_U , ROUTE_5021_D , ROUTE_EntryLU , ROUTE_EntryLD
      , ROUTE_EntryRU_U , ROUTE_EntryRU_D , ROUTE_EntryRD ,
      ROUTE_null};
14 DIRECTION = {dLeft , dRight}
15
16 CONSTANTS
17   MARKERBOARDSTATUS ,
18   TRACK ,
19   CONNECTOR ,
20   ENTRY ,
21   EXIT
22

```

```

23 PROPERTIES
24     MARKERBOARDSTATUS = ASPECT &
25     TRACK = ALLTRACK - {T_null} &
26     CONNECTOR = ALLCONNECTOR - { } &
27     ENTRY = {T_VTC001, T_VTC002, T_0843, T_0544} &
28     EXIT = {T_VTC001, T_VTC002, T_0843, T_0544}
29
30 END

```

The Topology B-Machine

```

1 MACHINE Topology
2
3 SEES Context
4
5 CONSTANTS
6     markerBoard,
7     homeMarkerBoard,
8     homePoint,
9     direction,
10    staticDirection,
11    dynamicDirection,
12    entryDirection,
13    entryTable,
14    normalTable,
15    reverseTable,
16    clearTable,
17    lockTable,
18    releaseTable
19
20 PROPERTIES
21     markerBoard : ROUTE <-> MARKERBOARD &
22     markerBoard = { (ROUTE_null |-> MB_null),
23         (ROUTE_DBM001 |-> MB_DBM001),
24         (ROUTE_DBM002 |-> MB_DBM002),
25         (ROUTE_DBM003 |-> MB_DBM003),
26         (ROUTE_DBM004 |-> MB_DBM004),
27         (ROUTE_DBM005 |-> MB_DBM005),
28         (ROUTE_5001_U |-> MB_5001),
29         (ROUTE_5001_D |-> MB_5001),
30         (ROUTE_5002_U |-> MB_5002),
31         (ROUTE_5002_D |-> MB_5002),
32         (ROUTE_5003_U |-> MB_5003),
33         (ROUTE_5003_D |-> MB_5003),
34         (ROUTE_5004_U |-> MB_5004),
35         (ROUTE_5004_D |-> MB_5004),
36         (ROUTE_5005 |-> MB_5005),
37         (ROUTE_5006 |-> MB_5006),
38         (ROUTE_5007 |-> MB_5007),

```

```

39     (ROUTE_5008 |-> MB_5008),
40     (ROUTE_5009 |-> MB_5009),
41     (ROUTE_5010 |-> MB_5010),
42     (ROUTE_5011 |-> MB_5011),
43     (ROUTE_5012 |-> MB_5012),
44     (ROUTE_5013 |-> MB_5013),
45     (ROUTE_5014 |-> MB_5014),
46     (ROUTE_5015 |-> MB_5015),
47     (ROUTE_5016 |-> MB_5016),
48     (ROUTE_5017 |-> MB_5017),
49     (ROUTE_5018 |-> MB_5018),
50     (ROUTE_5019 |-> MB_5019),
51     (ROUTE_5020 |-> MB_5020),
52     (ROUTE_5021_U |-> MB_5021),
53     (ROUTE_5021_D |-> MB_5021),
54     (ROUTE_EntryLU |-> MB_LU),
55     (ROUTE_EntryLD |-> MB_LD),
56     (ROUTE_EntryRU_U |-> MB_RU),
57     (ROUTE_EntryRU_D |-> MB_RU),
58     (ROUTE_EntryRD |-> MB_RD)
59 } &
60
61 homeMarkerBoard : MARKERBOARD --> ALLTRACK * (CONNECTOR*
62   CONNECTOR) &
63 homeMarkerBoard = {
64   MB_DBM001 |-> (T_VTC001, (C_BG_1000, C_VTC1_AA)),
65   MB_DBM002 |-> (T_VTC001, (C_VTC1_AA, C_BG_LU)),
66   MB_DBM003 |-> (T_0842, (C_08412_0842, C_0842_0843)),
67   MB_DBM004 |-> (T_VTC002, (C_BG_1032, C_VTC2_BA)),
68   MB_DBM005 |-> (T_VTC002, (C_VTC2_BA, C_BG_LD)),
69   MB_5001 |-> (T_ZAAA, (C_VTC1_AA, C_AA_AB)),
70   MB_5002 |-> (T_ZBBB, (C_BD_BE, C_BC_BD)),
71   MB_5003 |-> (T_ZBBA, (C_VTC2_BA, C_BA_BB)),
72   MB_5004 |-> (T_ZAAD, (C_AD_AE, C_AC_AD)),
73   MB_5005 |-> (T_ZAAD, (C_AC_AD, C_AD_AE)),
74   MB_5006 |-> (T_ZBBE, (C_BE_BF, C_BD_BE)),
75   MB_5007 |-> (T_ZBBB, (C_BC_BD, C_BD_BE)),
76   MB_5008 |-> (T_ZAAE, (C_AE_AF, C_AD_AE)),
77   MB_5009 |-> (T_ZAAE, (C_AD_AE, C_AE_AF)),
78   MB_5010 |-> (T_ZBBH, (C_BH_BJ, C_BG_BH)),
79   MB_5011 |-> (T_ZBBE, (C_BD_BE, C_BE_BF)),
80   MB_5012 |-> (T_ZAAH, (C_AH_AJ, C_AG_AH)),
81   MB_5013 |-> (T_ZAAH, (C_AG_AH, C_AH_AJ)),
82   MB_5014 |-> (T_ZBBK, (C_BK_BL, C_BJ_BK)),
83   MB_5015 |-> (T_ZBBH, (C_BG_BH, C_BH_BJ)),
84   MB_5016 |-> (T_ZAAK, (C_AK_AL, C_AJ_AK)),
85   MB_5017 |-> (T_ZAAK, (C_AJ_AK, C_AK_AL)),
86   MB_5018 |-> (T_ZBBL, (C_BL_BM, C_BK_BL)),
87   MB_5019 |-> (T_ZBBK, (C_BJ_BK, C_BK_BL)),

```



```

87     MB_5020 |-> (T_ZAAL,(C_AL_0832,C_AK_AL)),
88     MB_5021 |-> (T_ZBBL,(C_BK_BL,C_BL_BM)),
89     MB_LU  |-> (T_VTC001,(C_BG_LU,C_VTC1_AA)),
90     MB_LD  |-> (T_VTC002,(C_BG_LD,C_VTC2_BA)),
91     MB_RU  |-> (T_ZBBL,(C_BG_RU,C_0842_0843)),
92     MB_RD  |-> (T_ZBBL,(C_BG_RD,C_0543_0544)),
93     MB_null |-> (T_null,(C0,C0))
94 } &
95
96 homePoint : POINT --> ALLTRACK &
97 homePoint = { (P_2057A |-> T_ZAAB),
98             (P_2057B |-> T_ZBBC),
99             (P_2058A |-> T_ZBBB),
100            (P_2058B |-> T_ZAAC),
101            (P_2059A |-> T_0535),
102            (P_2059B |-> T_0834),
103            (P_null |-> T_null)} &
104
105 entryDirection : ENTRY --> CONNECTOR*CONNECTOR &
106 entryDirection = {
107     T_VTC001 |-> (C_BG_LU,C_VTC1_AA),
108     T_VTC002 |-> (C_BG_LD,C_VTC2_BA),
109     T_0843  |-> (C_BG_RU,C_0842_0843),
110     T_0544  |-> (C_BG_RD,C_0543_0544)
111 } &
112
113 direction : TRACK <-> CONNECTOR * CONNECTOR &
114 direction = {
115     T_VTC001 |-> (C_BG_LU,C_VTC1_AA),
116     T_VTC001 |-> (C_VTC1_AA,C_BG_LU),
117     T_ZAAA  |-> (C_VTC1_AA,C_AA_AB),
118     T_ZAAA  |-> (C_AA_AB,C_VTC1_AA),
119     T_ZAAB  |-> (C_AA_AB,C_AB_AC),
120     T_ZAAB  |-> (C_AB_AC,C_AA_AB),
121     T_ZAAC  |-> (C_AB_AC,C_AC_AD),
122     T_ZAAC  |-> (C_AC_AD,C_AB_AC),
123     T_ZAAD  |-> (C_AC_AD,C_AD_AE),
124     T_ZAAD  |-> (C_AD_AE,C_AC_AD),
125     T_ZAAE  |-> (C_AD_AE,C_AE_AF),
126     T_ZAAE  |-> (C_AE_AF,C_AD_AE),
127     T_ZAAF  |-> (C_AE_AF,C_AF_AG),
128     T_ZAAF  |-> (C_AF_AG,C_AE_AF),
129     T_ZAAG  |-> (C_AF_AG,C_AG_AH),
130     T_ZAAG  |-> (C_AG_AH,C_AF_AG),
131     T_ZAAH  |-> (C_AG_AH,C_AH_AJ),
132     T_ZAAH  |-> (C_AH_AJ,C_AG_AH),
133     T_ZAAJ  |-> (C_AH_AJ,C_AJ_AK),
134     T_ZAAJ  |-> (C_AJ_AK,C_AH_AJ),
135     T_ZAAK  |-> (C_AJ_AK,C_AK_AL),

```

```

136     T_ZAAK  |-> (C_AK_AL, C_AJ_AK),
137     T_ZAAL  |-> (C_AK_AL, C_AL_0832),
138     T_ZAAL  |-> (C_AL_0832, C_AK_AL),
139     T_0832  |-> (C_AL_0832, C_0832_0833),
140     T_0832  |-> (C_0832_0833, C_AL_0832),
141     T_0833  |-> (C_0832_0833, C_0833_0834),
142     T_0833  |-> (C_0833_0834, C_0832_0833),
143     T_0834  |-> (C_0833_0834, C_0834_0835),
144     T_0834  |-> (C_0834_0835, C_0833_0834),
145     T_0835  |-> (C_0834_0835, C_0835_08411),
146     T_0835  |-> (C_0835_08411, C_0834_0835),
147     T_08411 |-> (C_0835_08411, C_08411_08412),
148     T_08411 |-> (C_08411_08412, C_0835_08411),
149     T_08412 |-> (C_08411_08412, C_08412_0842),
150     T_08412 |-> (C_08412_0842, C_08411_08412),
151     T_0842  |-> (C_08412_0842, C_0842_0843),
152     T_0842  |-> (C_0842_0843, C_08412_0842),
153     T_0842  |-> (C_0842_0843, C_BG_RU),
154     T_0842  |-> (C_BG_RU, C_0842_0843),
155
156     T_ZAAB  |-> (C_AA_AB, C_AB_BC),
157     T_ZAAB  |-> (C_AB_BC, C_AA_AB),
158     T_ZAAC  |-> (C_BB_AC, C_AC_AD),
159     T_ZAAC  |-> (C_AC_AD, C_BB_AC),
160
161     T_VTC002 |-> (C_BG_LD, C_VTC2_BA),
162     T_VTC002 |-> (C_VTC2_BA, C_BG_LD),
163     T_ZBBA  |-> (C_VTC2_BA, C_BA_BB),
164     T_ZBBA  |-> (C_BA_BB, C_VTC2_BA),
165     T_ZBBB  |-> (C_BA_BB, C_BB_BC),
166     T_ZBBB  |-> (C_BB_BC, C_BA_BB),
167     T_ZBBC  |-> (C_BB_BC, C_BC_BD),
168     T_ZBBC  |-> (C_BC_BD, C_BB_BC),
169     T_ZBBD  |-> (C_BC_BD, C_BD_BE),
170     T_ZBBD  |-> (C_BD_BE, C_BC_BD),
171     T_ZBBE  |-> (C_BD_BE, C_BE_BF),
172     T_ZBBE  |-> (C_BE_BF, C_BD_BE),
173     T_ZBBF  |-> (C_BE_BF, C_BF_BG),
174     T_ZBBF  |-> (C_BF_BG, C_BE_BF),
175     T_ZBBG  |-> (C_BF_BG, C_BG_BH),
176     T_ZBBG  |-> (C_BG_BH, C_BF_BG),
177     T_ZBBH  |-> (C_BG_BH, C_BH_BJ),
178     T_ZBBH  |-> (C_BH_BJ, C_BG_BH),
179     T_ZBBJ  |-> (C_BH_BJ, C_BJ_BK),
180     T_ZBBJ  |-> (C_BJ_BK, C_BH_BJ),
181     T_ZBBK  |-> (C_BJ_BK, C_BK_BL),
182     T_ZBBK  |-> (C_BK_BL, C_BJ_BK),
183     T_ZBBL  |-> (C_BK_BL, C_BL_BM),
184     T_ZBBL  |-> (C_BL_BM, C_BK_BL),

```

```

185     T_ZBBM |-> (C_BL_BM,C_BM_0534),
186     T_ZBBM |-> (C_BM_0534,C_BL_BM),
187     T_0534 |-> (C_BM_0534,C_0534_0535),
188     T_0534 |-> (C_0534_0535,C_BM_0534),
189     T_0535 |-> (C_0534_0535,C_0535_0541),
190     T_0535 |-> (C_0535_0541,C_0534_0535),
191     T_0541 |-> (C_0535_0541,C_0541_0542),
192     T_0541 |-> (C_0541_0542,C_0535_0541),
193     T_0542 |-> (C_0541_0542,C_0542_0543),
194     T_0542 |-> (C_0542_0543,C_0541_0542),
195     T_0543 |-> (C_0542_0543,C_0543_0544),
196     T_0543 |-> (C_0543_0544,C_0542_0543),
197     T_0543 |-> (C_0543_0544,C_BG_RD),
198     T_0543 |-> (C_BG_RD,C_0543_0544),
199
200     T_ZBBB |-> (C_BA_BB,C_BB_AC),
201     T_ZBBB |-> (C_BB_AC,C_BA_BB),
202     T_ZBBC |-> (C_AB_BC,C_BC_BD),
203     T_ZBBC |-> (C_BC_BD,C_AB_BC)
204 } &
205
206 staticDirection : CONNECTOR <-> CONNECTOR &
207 staticDirection = {
208     (C_BG_LU,C_VTC1_AA),
209     (C_VTC1_AA,C_BG_LU),
210     (C_VTC1_AA,C_AA_AB),
211     (C_AA_AB,C_VTC1_AA),
212     (C_AC_AD,C_AD_AE),
213     (C_AD_AE,C_AC_AD),
214     (C_AD_AE,C_AE_AF),
215     (C_AE_AF,C_AD_AE),
216     (C_AE_AF,C_AF_AG),
217     (C_AF_AG,C_AE_AF),
218     (C_AF_AG,C_AG_AH),
219     (C_AG_AH,C_AF_AG),
220     (C_AG_AH,C_AH_AJ),
221     (C_AH_AJ,C_AG_AH),
222     (C_AH_AJ,C_AJ_AK),
223     (C_AJ_AK,C_AH_AJ),
224     (C_AJ_AK,C_AK_AL),
225     (C_AK_AL,C_AJ_AK),
226     (C_AK_AL,C_AL_0832),
227     (C_AL_0832,C_AK_AL),
228     (C_AL_0832,C_0832_0833),
229     (C_0832_0833,C_AL_0832),
230     (C_0832_0833,C_0833_0834),
231     (C_0833_0834,C_0832_0833),
232     (C_0834_0835,C_0835_08411),
233     (C_0835_08411,C_0834_0835),

```

```

234      (C_0835_08411 , C_08411_08412) ,
235      (C_08411_08412 , C_0835_08411) ,
236      (C_08411_08412 , C_08412_0842) ,
237      (C_08412_0842 , C_08411_08412) ,
238      (C_08412_0842 , C_0842_0843) ,
239      (C_0842_0843 , C_08412_0842) ,
240      (C_0842_0843 , C_BG_RU) ,
241      (C_BG_RU , C_0842_0843) ,
242
243      (C_BG_LD , C_VTC2_BA) ,
244      (C_VTC2_BA , C_BG_LD) ,
245      (C_VTC2_BA , C_BA_BB) ,
246      (C_BA_BB , C_VTC2_BA) ,
247      (C_BC_BD , C_BD_BE) ,
248      (C_BD_BE , C_BC_BD) ,
249      (C_BD_BE , C_BE_BF) ,
250      (C_BE_BF , C_BD_BE) ,
251      (C_BE_BF , C_BF_BG) ,
252      (C_BF_BG , C_BE_BF) ,
253      (C_BF_BG , C_BG_BH) ,
254      (C_BG_BH , C_BF_BG) ,
255      (C_BG_BH , C_BH_BJ) ,
256      (C_BH_BJ , C_BG_BH) ,
257      (C_BH_BJ , C_BJ_BK) ,
258      (C_BJ_BK , C_BH_BJ) ,
259      (C_BJ_BK , C_BK_BL) ,
260      (C_BK_BL , C_BJ_BK) ,
261      (C_BK_BL , C_BL_BM) ,
262      (C_BL_BM , C_BK_BL) ,
263      (C_BL_BM , C_BM_0534) ,
264      (C_BM_0534 , C_BL_BM) ,
265      (C_BM_0534 , C_0534_0535) ,
266      (C_0534_0535 , C_BM_0534) ,
267      (C_0535_0541 , C_0541_0542) ,
268      (C_0541_0542 , C_0535_0541) ,
269      (C_0541_0542 , C_0542_0543) ,
270      (C_0542_0543 , C_0541_0542) ,
271      (C_0542_0543 , C_0543_0544) ,
272      (C_0543_0544 , C_0542_0543) ,
273      (C_0543_0544 , C_BG_RD) ,
274      (C_BG_RD , C_0543_0544)
275  } &
276
277  dynamicDirection : POINT * POINTPOSITION <-> CONNECTOR *
      CONNECTOR &
278  dynamicDirection = {
279      (P_2057A , NORMAL) |-> (C_AA_AB , C_AB_AC) ,
280      (P_2057A , NORMAL) |-> (C_AB_AC , C_AA_AB) ,
281      (P_2057A , REVERSE) |-> (C_AA_AB , C_AB_BC) ,

```

```

282         (P_2057A , REVERSE) |-> (C_AB_BC , C_AA_AB) ,
283
284         (P_2057B , NORMAL) |-> (C_BB_BC , C_BC_BD) ,
285         (P_2057B , NORMAL) |-> (C_BC_BD , C_BB_BC) ,
286         (P_2057B , REVERSE) |-> (C_AB_BC , C_BC_BD) ,
287         (P_2057B , REVERSE) |-> (C_BC_BD , C_AB_BC) ,
288
289         (P_2058A , NORMAL) |-> (C_BA_BB , C_BB_BC) ,
290         (P_2058A , NORMAL) |-> (C_BB_BC , C_BA_BB) ,
291         (P_2058A , REVERSE) |-> (C_BA_BB , C_BB_AC) ,
292         (P_2058A , REVERSE) |-> (C_BB_AC , C_BA_BB) ,
293
294         (P_2058B , NORMAL) |-> (C_AB_AC , C_AC_AD) ,
295         (P_2058B , NORMAL) |-> (C_AC_AD , C_AB_AC) ,
296         (P_2058B , REVERSE) |-> (C_BB_AC , C_AC_AD) ,
297         (P_2058B , REVERSE) |-> (C_AC_AD , C_BB_AC) ,
298
299         (P_2059A , NORMAL) |-> (C_0534_0535 , C_0535_0541) ,
300         (P_2059A , NORMAL) |-> (C_0535_0541 , C_0534_0535) ,
301         (P_2059A , REVERSE) |-> (C_0534_0535 , C_0535_0834) ,
302         (P_2059A , REVERSE) |-> (C_0535_0834 , C_0534_0535) ,
303
304         (P_2059B , NORMAL) |-> (C_0833_0834 , C_0834_0835) ,
305         (P_2059B , NORMAL) |-> (C_0834_0835 , C_0833_0834) ,
306         (P_2059B , REVERSE) |-> (C_0535_0834 , C_0834_0835) ,
307         (P_2059B , REVERSE) |-> (C_0834_0835 , C_0535_0834)
308     } &
309
310     entryTable: ENTRY --> POW(TRACK) &
311     entryTable = { T_VTC001 |-> {T_VTC001 , T_ZAAB} ,
312         T_VTC002 |-> {T_VTC002 , T_ZBBA} ,
313         T_0843 |-> {T_0843 , T_0842} ,
314         T_0544 |-> {T_0544 , T_0543}
315     } &
316
317     normalTable : ROUTE <-> POINT &
318     normalTable = {ROUTE_5001_U |-> P_2057A ,
319         ROUTE_5001_U |-> P_2058B ,
320         ROUTE_5002_D |-> P_2057B ,
321         ROUTE_5002_D |-> P_2058A ,
322         ROUTE_5003_D |-> P_2057B ,
323         ROUTE_5003_D |-> P_2058A ,
324         ROUTE_5004_U |-> P_2057A ,
325         ROUTE_5004_U |-> P_2058B ,
326         ROUTE_5021_D |-> P_2059A ,
327         ROUTE_EntryRU_U |-> P_2059B
328     } &
329
330     reverseTable : ROUTE <-> POINT &

```

```

331 reverseTable = {ROUTE_5001_D |-> P_2057A ,
332     ROUTE_5001_D |-> P_2057B ,
333     ROUTE_5002_U |-> P_2057A ,
334     ROUTE_5002_U |-> P_2057B ,
335     ROUTE_5003_U |-> P_2058A ,
336     ROUTE_5003_U |-> P_2058B ,
337     ROUTE_5004_D |-> P_2058A ,
338     ROUTE_5004_D |-> P_2058B ,
339     ROUTE_5021_U |-> P_2059B ,
340     ROUTE_5021_U |-> P_2059A ,
341     ROUTE_EntryRU_D |-> P_2059B ,
342     ROUTE_EntryRU_D |-> P_2059A
343 } &
344
345 clearTable : ROUTE <-> POW(TRACK) &
346 clearTable = {
347     ROUTE_DBM001 |-> {T_ZAAA},
348     ROUTE_DBM002 |-> {T_VTC001},
349     ROUTE_DBM003 |-> {T_0843},
350     ROUTE_DBM004 |-> {T_ZBBA},
351     ROUTE_DBM005 |-> {T_VTC002},
352     ROUTE_5001_U |-> {T_ZAAB , T_ZAAC , T_ZAAD , T_ZBBC},
353     ROUTE_5001_D |-> {T_ZAAB , T_ZBBC , T_ZBBD},
354     ROUTE_5002_U |-> {T_ZBBC , T_ZAAB , T_ZAAA , T_VTC001},
355     ROUTE_5002_D |-> {T_ZBBC , T_ZBBB , T_ZBBA},
356     ROUTE_5003_U |-> {T_ZBBB , T_ZBBC , T_ZAAC , T_ZAAD},
357     ROUTE_5003_D |-> {T_ZBBB , T_ZBBC , T_ZBBD},
358     ROUTE_5004_U |-> {T_ZAAC , T_ZAAB , T_ZAAA , T_VTC001 , T_ZBBC},
359     ROUTE_5004_D |-> {T_ZAAC , T_ZBBC , T_ZBBB , T_ZBBA},
360     ROUTE_5005 |-> {T_ZAAE},
361     ROUTE_5006 |-> {T_ZBBD},
362     ROUTE_5007 |-> {T_ZAAE},
363     ROUTE_5008 |-> {T_ZAAD},
364     ROUTE_5009 |-> {T_ZAAF , T_ZAAG , T_ZAAH},
365     ROUTE_5010 |-> {T_ZBBE , T_ZBBF , T_ZBBG},
366     ROUTE_5011 |-> {T_ZBBF , T_ZBBG , T_ZBBH},
367     ROUTE_5012 |-> {T_ZAAE , T_ZAAF , T_ZAAG},
368     ROUTE_5013 |-> {T_ZAAJ , T_ZAAK},
369     ROUTE_5014 |-> {T_ZBBH , T_ZBBJ},
370     ROUTE_5015 |-> {T_ZBBJ , T_ZBBK},
371     ROUTE_5016 |-> {T_ZBBH , T_ZAAJ},
372     ROUTE_5017 |-> {T_ZAAL , T_0832 , T_0833 , T_0834 , T_0835 , T_08411 ,
        T_08412 , T_0842 , T_0843},
373     ROUTE_5018 |-> {T_ZBBK},
374     ROUTE_5019 |-> {T_ZBBL},
375     ROUTE_5020 |-> {T_ZAAK},
376     ROUTE_5021_U |-> {T_ZBBM , T_0534 , T_0535 , T_0834 , T_0835 ,
        T_08411 , T_08412 , T_0842 , T_0843},
377     ROUTE_5021_D |-> {T_ZBBM , T_0534 , T_0535 , T_0541 , T_0542 , T_0543

```

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    ,T_0544},
378     ROUTE_EntryLU |-> {T_VTC001},
379     ROUTE_EntryLD |-> {T_VTC002},
380     ROUTE_EntryRU_U |-> {T_ZAAL,T_0832,T_0833,T_0834,T_0835,
    T_08411,T_08412,T_0842,T_0843},
381     ROUTE_EntryRU_D |-> {T_ZBBL,T_ZBBM,T_0534,T_0535,T_0834,
    T_0835,T_08411,T_08412,T_0842,T_0843},
382     ROUTE_EntryRD |-> {T_ZBBL,T_ZBBM,T_0534,T_0535,T_0541,
    T_0542,T_0543,T_0544},
383     ROUTE_null |-> {} } &
384
385 lockTable :      ROUTE <-> POINT &
386 lockTable = {
387     ROUTE_5001_U |-> P_2057A ,
388     ROUTE_5001_U |-> P_2058B ,
389     ROUTE_5001_D |-> P_2057A ,
390     ROUTE_5001_D |-> P_2057B ,
391     ROUTE_5002_U |-> P_2057A ,
392     ROUTE_5002_U |-> P_2057B ,
393     ROUTE_5002_D |-> P_2057B ,
394     ROUTE_5002_D |-> P_2058A ,
395     ROUTE_5003_U |-> P_2058A ,
396     ROUTE_5003_U |-> P_2058B ,
397     ROUTE_5003_D |-> P_2057B ,
398     ROUTE_5003_D |-> P_2058A ,
399     ROUTE_5004_U |-> P_2057A ,
400     ROUTE_5004_U |-> P_2058B ,
401     ROUTE_5004_D |-> P_2058A ,
402     ROUTE_5004_D |-> P_2058B ,
403     ROUTE_5021_U |-> P_2059A ,
404     ROUTE_5021_U |-> P_2059B ,
405     ROUTE_5021_D |-> P_2059A ,
406     ROUTE_EntryRU_U |-> P_2059B ,
407     ROUTE_EntryRU_D |-> P_2059A ,
408     ROUTE_EntryRU_D |-> P_2059B
409 } &
410
411 lockTable = normalTable \/ reverseTable &
412
413 releaseTable : TRACK <-> (ROUTE*POINT) &
414 releaseTable = { T_ZAAC |-> (ROUTE_5001_U,P_2057A),
415     T_ZAAD |-> (ROUTE_5001_U,P_2058B),
416     T_ZBBC |-> (ROUTE_5001_D,P_2057A),
417     T_ZBBD |-> (ROUTE_5001_D,P_2057B),
418     T_ZAAB |-> (ROUTE_5002_U,P_2057B),
419     T_ZAAA |-> (ROUTE_5002_U,P_2057A),
420     T_ZBBB |-> (ROUTE_5002_D,P_2057B),
421     T_ZBBA |-> (ROUTE_5002_D,P_2058A),
422     T_ZBBC |-> (ROUTE_5003_D,P_2058A),

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```

423     T_ZBBD |-> (ROUTE_5003_D,P_2057B),
424     T_ZAAA |-> (ROUTE_5004_U,P_2057A),
425     T_ZAAB |-> (ROUTE_5004_U,P_2058B),
426     T_ZBBA |-> (ROUTE_5004_D,P_2058A),
427     T_ZBBB |-> (ROUTE_5004_D,P_2058B),
428     T_0835 |-> (ROUTE_5017,P_2059B),
429     T_0834 |-> (ROUTE_5021_U,P_2059A),
430     T_0835 |-> (ROUTE_5021_U,P_2059B),
431     T_0541 |-> (ROUTE_5021_D,P_2059A),
432     T_0833 |-> (ROUTE_EntryRU_U,P_2059B),
433     T_0535 |-> (ROUTE_EntryRU_D,P_2059B),
434     T_0534 |-> (ROUTE_EntryRU_D,P_2059A),
435     T_0534 |-> (ROUTE_EntryRD,P_2059A) }
436
437 END

```

The Interlocking B-Machine

```

1 MACHINE Interlocking
2
3 SEES Topology, Context
4 SETS
5     ANSWERS = {yes,no}
6
7 VARIABLES
8     pos, nextd, markerBoardStatus, normalPoints, reversePoints,
9     currentLocks, setRoutes, grantedRoutes, occupiedTracks,
10    nextConnector, errorOccured
11
12 INVARIANT
13     pos : TRAIN +-> ALLTRACK*(ALLCONNECTOR*ALLCONNECTOR) &
14     nextd : ALLTRACK*(ALLCONNECTOR*ALLCONNECTOR) +-> ALLTRACK*(
15     ALLCONNECTOR*ALLCONNECTOR) &
16     normalPoints <: POINT &
17     reversePoints <: POINT &
18     normalPoints /\ reversePoints = {} &
19     normalPoints \/ reversePoints = POINT &
20     currentLocks : ROUTE <-> POINT &
21     currentLocks <: lockTable &
22     markerBoardStatus : MARKERBOARD --> MARKERBOARDSTATUS &
23     occupiedTracks : POW(TRACK) &
24     setRoutes : POW(ROUTE) &
25     grantedRoutes : POW(ROUTE) &
26     nextConnector : TRAIN +-> ALLCONNECTOR &
27     errorOccured : BOOL
28
29 DEFINITIONS
30     ASSERT_LTL_1 == "G(not(e(collision)))";

```



```

29 INITIALISATION
30 BEGIN
31   pos := {} ||
32   errorOccured := FALSE ||
33   markerBoardStatus := MARKERBOARD * {unavailable} ||
34   normalPoints := POINT ||
35   reversePoints := {} ||
36   currentLocks := {} ||
37   occupiedTracks := {} ||
38   nextd := {
39     (p1 |-> p2) |
40     #(t1,d1,t2,d2).
41     (
42       p1 = (t1,d1) & p2 = (t2,d2) &
43       t1 /= t2 &
44       ran({d1}) = dom({d2}) &
45       d1 : direction[{t1}] &
46       d1 : staticDirection \/
47       dynamicDirection[POINT*{NORMAL}] &
48       d2 : direction[{t2}] &
49       d2 : staticDirection \/
50       dynamicDirection[POINT*{NORMAL}]
51     )
52   } ||
53   setRoutes := {ROUTE_null} ||
54   grantedRoutes := {} ||
55   nextConnector := {}
56 END
57
58 OPERATIONS
59
60 collision =
61   SELECT #(t1,t2).(t1 : TRAIN & t2 : TRAIN &
62     t1:dom(pos) & t2:dom(pos) & t1 /= t2 &
63     (dom({pos(t1)}) - (EXIT \/ ENTRY)) /\ (dom({pos(t2)}) - (
64       EXIT \/ ENTRY)) /= {})
65   THEN skip
66   END;
67
68 bb <-- train_to_ixl_Enter(t,entryPos) =
69   PRE t : TRAIN & entryPos : ENTRY
70   THEN
71     IF {entryPos} <: occupiedTracks
72     THEN
73       bb := no
74     ELSE
75       pos(t) := (entryPos,entryDirection(entryPos)) ||
76       occupiedTracks := occupiedTracks \/ {entryPos} ||

```

```

77         bb := yes
78     END
79 END;
80
81 train_to_ixl_Exit(t,exitPos) =
82     PRE t : TRAIN & dom({pos(t)}) = {exitPos} & exitPos : EXIT
83     THEN
84         pos := {t} <<| pos
85     END;
86
87
88 bb <-- rbc_to_ixl_Request(route) =
89     PRE route : ROUTE
90     THEN
91         LET occTracks,emptyTracks BE
92             occTracks = dom(ran(pos)) &
93             emptyTracks = TRACK - occTracks IN
94             IF ((markerBoardStatus(markerBoard(route)) =
95                 unavailable) &
96                 (clearTable(route) <: emptyTracks )) &
97                 {route} /<: setRoutes &
98                 {route} /<: grantedRoutes
99             THEN
100
101                 LET unlockedPoints BE
102                     unlockedPoints = POINT - ran(currentLocks) IN
103                     IF ((normalTable[{route}] <: normalPoints \ /
104                         unlockedPoints ) &
105                         (reverseTable[{route}] <: reversePoints \ /
106                             unlockedPoints))
107                     THEN
108                         LET np, rp BE
109                             np = (normalPoints \ / normalTable[{route
110                                 }]) - reverseTable[{route}] &
111                             rp = (reversePoints \ / reverseTable[{route
112                                 }]) - normalTable[{route}]
113                         IN
114                             normalPoints := np ||
115                             reversePoints := rp ||
116                             setRoutes := setRoutes \ / {route} ||
117                             bb := yes
118                         END
119                     ELSE
120                         bb:= no
121                     END
122             END
123         ELSE
124             bb:= no
125         END
126     ELSE
127         bb:= no
128     END
129 END

```

```

121         END
122     END;
123
124
125     bb <-- ixl_to_rbc_GrantRoute(route) =
126     PRE route : ROUTE
127     THEN
128         LET occTracks, emptyTracks BE
129         occTracks = dom(ran(pos)) &
130         emptyTracks = TRACK - occTracks IN
131         IF {route} <: setRoutes
132             THEN
133                 LET np, rp BE
134                 np = (normalPoints \/ normalTable[{route}]) -
135                     reverseTable[{route}] &
136                 rp = (reversePoints \/ reverseTable[{route}]) -
137                     normalTable[{route}]
138             IN
139                 currentLocks := currentLocks \/ ({route} <|
140                     lockTable) ||
141                 markerBoardStatus(markerBoard(route)) :=
142                     granted ||
143                 bb := yes ||
144                 setRoutes := setRoutes - {route} ||
145                 grantedRoutes := grantedRoutes \/ {route} ||
146                 nextd := {
147                     (p1 |-> p2) |
148                     #(t1,d1,t2,d2).
149                     (
150                     p1 = (t1,d1) &
151                     p2 = (t2,d2) & t1 /= t2 &
152                     ran({d1}) = dom({d2}) &
153                     d1 : direction[{t1}] &
154                     d1 : staticDirection \/
155                     dynamicDirection[np*{NORMAL} \/
156                     rp*{REVERSE}] &
157                     d2 : direction[{t2}] &
158                     d2 : staticDirection \/
159                     dynamicDirection[np*{NORMAL} \/
160                     rp*{REVERSE}]
161                     )
162                 }
163             END
164         ELSE
165             bb := no
166         END
167     END
168 END;
169

```

```

166
167 bb <-- rbc_to_ixl_Release(route) =
168   PRE route : ROUTE
169   THEN
170     LET emptyTracks BE emptyTracks = TRACK - dom(ran(pos))
171     IN
172     IF dom({homeMarkerBoard(markerBoard(route))}) <:
173       emptyTracks &
174       {route} <: setRoutes &
175       {route} /<: grantedRoutes
176     THEN
177       markerBoardStatus(markerBoard(route)) :=
178         unavailable ||
179         currentLocks := {route} <<| currentLocks ||
180         bb := yes ||
181         setRoutes := setRoutes - {route}
182     ELSE
183       bb := no
184     END
185   END
186 END;
187
188 rbc_to_ixl_ClearRoute(route) =
189   PRE route : ROUTE
190   THEN
191     markerBoardStatus(markerBoard(route)) := unavailable ||
192     currentLocks := {route} <<| currentLocks ||
193     grantedRoutes := grantedRoutes - {route}
194   END;
195
196 newp,conn <-- train_to_ixl_TrackChange(t,currp) =
197   PRE t : TRAIN & t : dom(pos) &
198   {currp} = dom({pos(t)})
199   THEN
200     IF (pos(t) /: dom(nextd)) THEN
201       pos(t) := (T_null,(CO,CO)) ||
202       newp := T_null ||
203       conn := CO ||
204       occupiedTracks := occupiedTracks - {currp}
205     ELSE
206       LET (track,d) BE (track,d) = nextd(pos(t)) IN
207         pos(t) := nextd(pos(t)) ||
208         newp := track ||
209         occupiedTracks := (occupiedTracks - {currp}) \/{track
210         } ||
211         LET (x,y) BE (x,y) = d IN
212           conn := y ||
213           nextConnector(t) := y ||

```

```

211         IF (pos(t) : ran(homeMarkerBoard)) THEN
212             markerBoardStatus(homeMarkerBoard~(pos(t))) :=
                unavailable
213         END ||
214         currentLocks := currentLocks - releaseTable[{{track}}]
215     END
216 END
217 END
218 END;
219
220 bb <-- rbc_to_ixl_RequestToProceed(route) =
221     PRE route : ROUTE THEN
222         IF ({{route}} <: setRoutes) &
223             (markerBoardStatus(markerBoard(route)) = unavailable)
224         THEN
225             bb := yes
226         ELSE
227             bb := no
228         END
229
230     END
231
232 END

```

The CSP Topology file

```

1 datatype Unit = T_null | T_VTC001 | T_ZAAA | T_ZAAB | T_ZAAC |
    T_ZAAD | T_ZAAE | T_ZAAF | T_ZAAG | T_ZAAH | T_ZAAJ | T_ZAAK |
    T_ZAAL | T_0832 | T_0833 | T_0834 | T_0835 | T_08411 |
    T_08412 | T_0842 | T_0843 | T_VTC002 | T_ZBBA | T_ZBBB |
    T_ZBBC | T_ZBBD | T_ZBBE | T_ZBBF | T_ZBBG | T_ZBBH | T_ZBBJ |
    T_ZBBK | T_ZBBL | T_ZBBM | T_0534 | T_0535 | T_0541 | T_0542
    | T_0543 | T_0544 | T_VTC001_L_BG_1000 | T_VTC001_R_BG_1000 |
    T_ZAAA_L_BG_1025 | T_ZAAA_BG_1025_BG_1001 | T_ZAAA_R_BG_1001 |
    T_ZAAB_L_BG_1023 | T_ZAAB_R_BG_1023 | T_ZAAC_L_BG_1027 |
    T_ZAAC_R_BG_1027 | T_ZAAD_L_BG_1031 | T_ZAAD_BG_1031_BG_1009 |
    T_ZAAD_R_BG_1009 | T_ZAAE_L_BG_1011 | T_ZAAE_R_BG_1011 |
    T_ZAAG_L_BG_1017 | T_ZAAG_R_BG_1017 | T_ZAAJ_L_BG_1015 |
    T_ZAAJ_R_BG_1015 | T_ZAAK_L_BG_1013 | T_ZAAK_R_BG_1013 |
    T_ZAAL_L_BG_1019 | T_ZAAL_R_BG_1019 | T_0833_L_BG_1033 |
    T_0833_R_BG_1033 | T_0835_L_BG_1021 | T_0835_BG_1021_BG_1029 |
    T_0835_R_BG_1029 | T_08412_L_BG_1003 | T_08412_R_BG_1003 |
    T_0843_L_BG_1005 | T_0843_R_BG_1005 | T_VTC002_L_BG_1030 |
    T_VTC002_BG_1030_BG_1032 | T_VTC002_R_BG_1032 |
    T_ZBBA_L_BG_998 | T_ZBBA_R_BG_998 | T_ZBBC_L_BG_1002 |
    T_ZBBC_R_BG_1002 | T_ZBBD_L_BG_1004 | T_ZBBD_BG_1026_BG_1004 |
    T_ZBBD_R_BG_1004 | T_ZBBE_L_BG_1006 | T_ZBBE_R_BG_1006 |
    T_ZBBF_L_BG_996 | T_ZBBF_R_BG_996 | T_ZBBJ_L_BG_1008 |
    T_ZBBJ_R_BG_1008 | T_ZBBK_L_BG_1010 | T_ZBBK_R_BG_1010 |

```

```

T_ZBBL_L_BG_1012 | T_ZBBL_R_BG_1012 | T_ZBBM_L_BG_1014 |
T_ZBBM_R_BG_1014 | T_0534_L_BG_1028 | T_0534_R_BG_1028 |
T_0535_L_BG_1020 | T_0535_R_BG_1020 | T_0541_L_BG_1018 |
T_0541_BG_1018_BG_1022 | T_0541_R_BG_1022 | T_0543_L_BG_1016 |
T_0543_R_BG_1016 | T_0544_L_BG_1024 | T_0544_R_BG_1024

2
3 subtype ALLTRACK = T_VTC001 | T_ZAAA | T_ZAAB | T_ZAAC | T_ZAAD |
  T_ZAAE | T_ZAAF | T_ZAAG | T_ZAAH | T_ZAAJ | T_ZAAK | T_ZAAL
  | T_0832 | T_0833 | T_0834 | T_0835 | T_08411 | T_08412 |
  T_0842 | T_0843 | T_VTC002 | T_ZBBA | T_ZBBB | T_ZBBC | T_ZBBD
  | T_ZBBE | T_ZBBF | T_ZBBG | T_ZBBH | T_ZBBJ | T_ZBBK |
  T_ZBBL | T_ZBBM | T_0534 | T_0535 | T_0541 | T_0542 | T_0543 |
  T_0544 | T_VTC001_L_BG_1000 | T_VTC001_R_BG_1000 |
  T_ZAAA_L_BG_1025 | T_ZAAA_BG_1025_BG_1001 | T_ZAAA_R_BG_1001 |
  T_ZAAB_L_BG_1023 | T_ZAAB_R_BG_1023 | T_ZAAC_L_BG_1027 |
  T_ZAAC_R_BG_1027 | T_ZAAD_L_BG_1031 | T_ZAAD_BG_1031_BG_1009 |
  T_ZAAD_R_BG_1009 | T_ZAAE_L_BG_1011 | T_ZAAE_R_BG_1011 |
  T_ZAAG_L_BG_1017 | T_ZAAG_R_BG_1017 | T_ZAAJ_L_BG_1015 |
  T_ZAAJ_R_BG_1015 | T_ZAAK_L_BG_1013 | T_ZAAK_R_BG_1013 |
  T_ZAAL_L_BG_1019 | T_ZAAL_R_BG_1019 | T_0833_L_BG_1033 |
  T_0833_R_BG_1033 | T_0835_L_BG_1021 | T_0835_BG_1021_BG_1029 |
  T_0835_R_BG_1029 | T_08412_L_BG_1003 | T_08412_R_BG_1003 |
  T_0843_L_BG_1005 | T_0843_R_BG_1005 | T_VTC002_L_BG_1030 |
  T_VTC002_BG_1030_BG_1032 | T_VTC002_R_BG_1032 |
  T_ZBBA_L_BG_998 | T_ZBBA_R_BG_998 | T_ZBBC_L_BG_1002 |
  T_ZBBC_R_BG_1002 | T_ZBBD_L_BG_1004 | T_ZBBD_BG_1026_BG_1004 |
  T_ZBBD_R_BG_1004 | T_ZBBE_L_BG_1006 | T_ZBBE_R_BG_1006 |
  T_ZBBF_L_BG_996 | T_ZBBF_R_BG_996 | T_ZBBJ_L_BG_1008 |
  T_ZBBJ_R_BG_1008 | T_ZBBK_L_BG_1010 | T_ZBBK_R_BG_1010 |
  T_ZBBL_L_BG_1012 | T_ZBBL_R_BG_1012 | T_ZBBM_L_BG_1014 |
  T_ZBBM_R_BG_1014 | T_0534_L_BG_1028 | T_0534_R_BG_1028 |
  T_0535_L_BG_1020 | T_0535_R_BG_1020 | T_0541_L_BG_1018 |
  T_0541_BG_1018_BG_1022 | T_0541_R_BG_1022 | T_0543_L_BG_1016 |
  T_0543_R_BG_1016 | T_0544_L_BG_1024 | T_0544_R_BG_1024

4
5 UpperTracks = {Track | Track <- {T_VTC001, T_ZAAA, T_ZAAB, T_ZAAC
  , T_ZAAD, T_ZAAE, T_ZAAF, T_ZAAG, T_ZAAH, T_ZAAJ, T_ZAAK,
  T_ZAAL, T_0832, T_0833, T_0834, T_0835, T_08411, T_08412,
  T_0842, T_0843, T_VTC001_L_BG_1000, T_VTC001_R_BG_1000,
  T_ZAAA_L_BG_1025, T_ZAAA_BG_1025_BG_1001, T_ZAAA_R_BG_1001,
  T_ZAAB_L_BG_1023, T_ZAAB_R_BG_1023, T_ZAAC_L_BG_1027,
  T_ZAAC_R_BG_1027, T_ZAAD_L_BG_1031, T_ZAAD_BG_1031_BG_1009,
  T_ZAAD_R_BG_1009, T_ZAAE_L_BG_1011, T_ZAAE_R_BG_1011,
  T_ZAAG_L_BG_1017, T_ZAAG_R_BG_1017, T_ZAAJ_L_BG_1015,
  T_ZAAJ_R_BG_1015, T_ZAAK_L_BG_1013, T_ZAAK_R_BG_1013,
  T_ZAAL_L_BG_1019, T_ZAAL_R_BG_1019, T_0833_L_BG_1033,
  T_0833_R_BG_1033, T_0835_L_BG_1021, T_0835_BG_1021_BG_1029,
  T_0835_R_BG_1029, T_08412_L_BG_1003, T_08412_R_BG_1003,
  T_0843_L_BG_1005, T_0843_R_BG_1005}}

```

```

6
7 WholeTrack = {Track | Track <- {T_VTC001, T_ZAAA, T_ZAAB, T_ZAAC,
  T_ZAAD, T_ZAAE, T_ZAAF, T_ZAAG, T_ZAAH, T_ZAAJ, T_ZAAK,
  T_ZAAL, T_0832, T_0833, T_0834, T_0835, T_08411, T_08412,
  T_0842, T_0843, T_VTC002, T_ZBBA, T_ZBBB, T_ZBBC, T_ZBBD,
  T_ZBBE, T_ZBBF, T_ZBBG, T_ZBBH, T_ZBBJ, T_ZBBK, T_ZBBL, T_ZBBM
  , T_0534, T_0535, T_0541, T_0542, T_0543, T_0544}}
8
9 subtype trackPoint = T_ZAAB | T_ZAAC | T_ZBBB | T_ZBBC | T_0834 |
  T_0535
10
11 datatype POINT = P_2057A | P_2057B | P_2058A | P_2058B | P_2059A
  | P_2059B | P_null
12
13 datatype Connector = C_VTC1_AA | C_AA_AB | C_AB_AC | C_AC_AD |
  C_AD_AE | C_AE_AF | C_AF_AG | C_AG_AH | C_AH_AJ | C_AJ_AK |
  C_AK_AL | C_AL_0832 | C_0832_0833 | C_0833_0834 | C_0834_0835
  | C_0835_08411 | C_08411_08412 | C_08412_0842 | C_0842_0843 |
  C_VTC2_BA | C_BA_BB | C_BB_BC | C_BC_BD | C_BD_BE | C_BE_BF |
  C_BF_BG | C_BG_BH | C_BH_BJ | C_BJ_BK | C_BK_BL | C_BL_BM |
  C_BM_0534 | C_0534_0535 | C_0535_0541 | C_0541_0542 |
  C_0542_0543 | C_0543_0544 | C_BG_1000 | C_BG_1001 | C_BG_1002
  | C_BG_1003 | C_BG_1004 | C_BG_1005 | C_BG_1006 | C_BG_1008 |
  C_BG_1009 | C_BG_1010 | C_BG_1011 | C_BG_1012 | C_BG_1013 |
  C_BG_1014 | C_BG_1015 | C_BG_1016 | C_BG_1017 | C_BG_1018 |
  C_BG_1019 | C_BG_1020 | C_BG_1021 | C_BG_1022 | C_BG_1023 |
  C_BG_1024 | C_BG_1025 | C_BG_1026 | C_BG_1027 | C_BG_1028 |
  C_BG_1029 | C_BG_1030 | C_BG_1031 | C_BG_1032 | C_BG_1033 |
  C_BG_996 | C_BG_998 | C_BG_LU | C_BG_LD | C_BG_RU | C_BG_RD |
  C0 | C_AB_BC | C_BB_AC | C_0535_0834
14
15 subtype trackConnectors = C_VTC1_AA | C_AA_AB | C_AB_AC | C_AC_AD
  | C_AD_AE | C_AE_AF | C_AF_AG | C_AG_AH | C_AH_AJ | C_AJ_AK |
  C_AK_AL | C_AL_0832 | C_0832_0833 | C_0833_0834 | C_0834_0835
  | C_0835_08411 | C_08411_08412 | C_08412_0842 | C_0842_0843 |
  C_VTC2_BA | C_BA_BB | C_BB_BC | C_BC_BD | C_BD_BE | C_BE_BF |
  C_BF_BG | C_BG_BH | C_BH_BJ | C_BJ_BK | C_BK_BL | C_BL_BM |
  C_BM_0534 | C_0534_0535 | C_0535_0541 | C_0541_0542 |
  C_0542_0543 | C_0543_0544 | C_BG_LU | C_BG_LD | C_BG_RU |
  C_BG_RD | C0 | C_AB_BC | C_BB_AC | C_0535_0834
16
17 subtype baliseConnectors = C_BG_LU | C_BG_LD | C_BG_RU | C_BG_RD
  | C_BG_1000 | C_BG_1001 | C_BG_1002 | C_BG_1003 | C_BG_1004 |
  C_BG_1005 | C_BG_1006 | C_BG_1008 | C_BG_1009 | C_BG_1010 |
  C_BG_1011 | C_BG_1012 | C_BG_1013 | C_BG_1014 | C_BG_1015 |
  C_BG_1016 | C_BG_1017 | C_BG_1018 | C_BG_1019 | C_BG_1020 |
  C_BG_1021 | C_BG_1022 | C_BG_1023 | C_BG_1024 | C_BG_1025 |
  C_BG_1026 | C_BG_1027 | C_BG_1028 | C_BG_1029 | C_BG_1030 |
  C_BG_1031 | C_BG_1032 | C_BG_1033 | C_BG_996 | C_BG_998

```

```

18
19
20 subtype upperBaliseConnectors = C_BG_LU | C_BG_RU | C_BG_1000 |
    C_BG_1001 | C_BG_1003 | C_BG_1005 | C_BG_1009 | C_BG_1011 |
    C_BG_1013 | C_BG_1015 | C_BG_1017 | C_BG_1019 | C_BG_1021 |
    C_BG_1023 | C_BG_1025 | C_BG_1027 | C_BG_1029 | C_BG_1031 |
    C_BG_1033
21
22
23 subtype lowerBaliseConnectors = C_BG_LD | C_BG_RD | C_BG_1002 |
    C_BG_1004 | C_BG_1006 | C_BG_1008 | C_BG_1010 | C_BG_1012 |
    C_BG_1014 | C_BG_1016 | C_BG_1018 | C_BG_1020 | C_BG_1022 |
    C_BG_1024 | C_BG_1026 | C_BG_1028 | C_BG_1030 | C_BG_1032 |
    C_BG_996 | C_BG_998
24
25 datatype MARKERBOARD = MB_DBM001 | MB_DBM002 | MB_DBM003 |
    MB_DBM004 | MB_DBM005 | MB_5001 | MB_5002 | MB_5003 | MB_5004
    | MB_5005 | MB_5006 | MB_5007 | MB_5008 | MB_5009 | MB_5010 |
    MB_5011 | MB_5012 | MB_5013 | MB_5014 | MB_5015 | MB_5016 |
    MB_5017 | MB_5018 | MB_5019 | MB_5020 | MB_5021 | MB_LU |
    MB_LD | MB_RU | MB_RD | MB_null
26
27 subtype LeftwardMarker = MB_DBM002 | MB_DBM005 | MB_5002 |
    MB_5004 | MB_5006 | MB_5008 | MB_5010 | MB_5012 | MB_5014 |
    MB_5016 | MB_5018 | MB_5020 | MB_LU | MB_LD
28
29 datatype Balise = BG_LU | BG_LD | BG_RU | BG_RD | BG_1000 |
    BG_1001 | BG_1002 | BG_1003 | BG_1004 | BG_1005 | BG_1006 |
    BG_1008 | BG_1009 | BG_1010 | BG_1011 | BG_1012 | BG_1013 |
    BG_1014 | BG_1015 | BG_1016 | BG_1017 | BG_1018 | BG_1019 |
    BG_1020 | BG_1021 | BG_1022 | BG_1023 | BG_1024 | BG_1025 |
    BG_1026 | BG_1027 | BG_1028 | BG_1029 | BG_1030 | BG_1031 |
    BG_1032 | BG_1033 | BG_996 | BG_998
30
31 datatype Route = ROUTE_DBM001 | ROUTE_DBM002 | ROUTE_DBM003 |
    ROUTE_DBM004 | ROUTE_DBM005 | ROUTE_5001_U | ROUTE_5001_D |
    ROUTE_5002_U | ROUTE_5002_D | ROUTE_5003_U | ROUTE_5003_D |
    ROUTE_5004_U | ROUTE_5004_D | ROUTE_5005 | ROUTE_5006 |
    ROUTE_5007 | ROUTE_5008 | ROUTE_5009 | ROUTE_5010 | ROUTE_5011
    | ROUTE_5012 | ROUTE_5013 | ROUTE_5014 | ROUTE_5015 |
    ROUTE_5016 | ROUTE_5017 | ROUTE_5018 | ROUTE_5019 | ROUTE_5020
    | ROUTE_5021_U | ROUTE_5021_D | ROUTE_EntryLU | ROUTE_EntryLD
    | ROUTE_EntryRU_U | ROUTE_EntryRU_D | ROUTE_EntryRD |
    ROUTE_null
32
33 datatype TRAIN = Train_1 | Train_2
34 datatype ANSWERS = yes | no
35 datatype DIRECTION = dLeft | dRight
36 datatype PointPosition = NORMAL | REVERSE

```



```

37 datatype BaliseDirection = leftwards | rightwards | bidirectional
38 datatype TrainLine = upper | lower | pointCon
39
40 ENTRY = {T_VTC001, T_VTC002, T_0843, T_0544}
41 EXIT = {T_VTC001, T_VTC002, T_0843, T_0544}
42 MARKERBOARDHOMES = {T_VTC001, T_ZAAA, T_ZAAD, T_ZAAE, T_ZAAH,
    T_ZAAK, T_ZAAL, T_0842, T_VTC002, T_ZBBA, T_ZBBD, T_ZBBE,
    T_ZBBH, T_ZBBK, T_ZBBL, T_null}
43
44 BaliseConnectorDistances = {distance(connector) | connector <- {
    C_BG_LU, C_BG_LD, C_BG_RU, C_BG_RD, C_BG_1000, C_BG_1001,
    C_BG_1002, C_BG_1003, C_BG_1004, C_BG_1005, C_BG_1006,
    C_BG_1008, C_BG_1009, C_BG_1010, C_BG_1011, C_BG_1012,
    C_BG_1013, C_BG_1014, C_BG_1015, C_BG_1016, C_BG_1017,
    C_BG_1018, C_BG_1019, C_BG_1020, C_BG_1021, C_BG_1022,
    C_BG_1023, C_BG_1024, C_BG_1025, C_BG_1026, C_BG_1027,
    C_BG_1028, C_BG_1029, C_BG_1030, C_BG_1031, C_BG_1032,
    C_BG_1033, C_BG_996, C_BG_998}}
45
46 upperBaliseConnectorDistances = {distance(connector) | connector
    <- {C_BG_LU, C_BG_RU, C_BG_1000, C_BG_1001, C_BG_1003,
    C_BG_1005, C_BG_1009, C_BG_1011, C_BG_1013, C_BG_1015,
    C_BG_1017, C_BG_1019, C_BG_1021, C_BG_1023, C_BG_1025,
    C_BG_1027, C_BG_1029, C_BG_1031, C_BG_1033}}
47
48 lowerBaliseConnectorDistances = {distance(connector) | connector
    <- {C_BG_LD, C_BG_RD, C_BG_1002, C_BG_1004, C_BG_1006,
    C_BG_1008, C_BG_1010, C_BG_1012, C_BG_1014, C_BG_1016,
    C_BG_1018, C_BG_1020, C_BG_1022, C_BG_1024, C_BG_1026,
    C_BG_1028, C_BG_1030, C_BG_1032, C_BG_996, C_BG_998}}
49
50
51 ConnectorDistances = {distance(connector) | connector <- {
    C_VTC1_AA, C_AA_AB, C_AB_AC, C_AC_AD, C_AD_AE, C_AE_AF,
    C_AF_AG, C_AG_AH, C_AH_AJ, C_AJ_AK, C_AK_AL, C_AL_0832,
    C_0832_0833, C_0833_0834, C_0834_0835, C_0835_08411,
    C_08411_08412, C_08412_0842, C_0842_0843, C_VTC2_BA, C_BA_BB,
    C_BB_BC, C_BC_BD, C_BD_BE, C_BE_BF, C_BF_BG, C_BG_BH, C_BH_BJ,
    C_BJ_BK, C_BK_BL, C_BL_BM, C_BM_0534, C_0534_0535,
    C_0535_0541, C_0541_0542, C_0542_0543, C_0543_0544, C_BG_LU,
    C_BG_LD, C_BG_RU, C_BG_RD}}
52
53 PointTrack = {track | track <- {T_ZAAB, T_ZBBB, T_0535}}
54
55
56 routeMaDistances = {RouteMA(Route) | Route <- {ROUTE_DBM001,
    ROUTE_DBM002, ROUTE_DBM003, ROUTE_DBM004, ROUTE_DBM005,
    ROUTE_5001_U, ROUTE_5001_D, ROUTE_5002_U, ROUTE_5002_D,
    ROUTE_5003_U, ROUTE_5003_D, ROUTE_5004_U, ROUTE_5004_D,

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ROUTE_5005, ROUTE_5006, ROUTE_5007, ROUTE_5008, ROUTE_5009,
ROUTE_5010, ROUTE_5011, ROUTE_5012, ROUTE_5013, ROUTE_5014,
ROUTE_5015, ROUTE_5016, ROUTE_5017, ROUTE_5018, ROUTE_5019,
ROUTE_5020, ROUTE_5021_U, ROUTE_5021_D, ROUTE_EntryLU,
ROUTE_EntryLD, ROUTE_EntryRU_U, ROUTE_EntryRU_D, ROUTE_EntryRD
, ROUTE_null}}
57
58
59 nextRoutes(loc,bal,dir) = if (((loc >= baliseLoc(BG_1000)) and (
loc < mbLocation(MB_DBM001))) and (bal == BG_1000) and (dir ==
dRight))
60 then {ROUTE_DBM001}
61 else if (((loc >= baliseLoc(BG_1025)) and (loc <
mbLocation(MB_5001))) and ((bal == BG_1025) or (bal ==
BG_1001)) and (dir == dRight))
62 then {ROUTE_5001_U, ROUTE_5001_D}
63 else if (((loc >= baliseLoc(BG_1023)) and (loc <
mbLocation(MB_5005))) and ((bal == BG_1023) or (
bal == BG_1027) or (bal == BG_1031) or (bal ==
BG_1009)) and (dir == dRight))
64 then {ROUTE_5005}
65 else if (((loc >= baliseLoc(BG_1011)) and (loc <
mbLocation(MB_5009))) and (bal == BG_1011) and (
dir == dRight))
66 then {ROUTE_5009}
67 else if (((loc >= baliseLoc(BG_1017)) and (loc <
mbLocation(MB_5013))) and (bal == BG_1017) and (
dir == dRight))
68 then {ROUTE_5013}
69 else if (((loc >= baliseLoc(BG_1015)) and (loc <
mbLocation(MB_5017))) and ((bal == BG_1015) or (
bal == BG_1013)) and (dir == dRight))
70 then {ROUTE_5017}
71 else if (((loc >= baliseLoc(BG_1019)) and (loc <
mbLocation(MB_DBM003))) and ((bal == BG_1019) or (
bal == BG_1033) or (bal == BG_1021) or (bal ==
BG_1029) or (bal == BG_1003)) and (dir == dRight))
72 then {ROUTE_DBM003}
73 else if (((loc >= baliseLoc(BG_1030)) and (loc <
mbLocation(MB_DBM004))) and ((bal == BG_1030) or (
bal == BG_1032)) and (dir == dRight))
74 then {ROUTE_DBM004}
75 else if (((loc >= baliseLoc(BG_998)) and (loc <
mbLocation(MB_5003))) and (bal == BG_998) and (dir
== dRight))
76 then {ROUTE_5003_U,ROUTE_5003_D}
77 else if (((loc >= baliseLoc(BG_1002)) and (loc <
mbLocation(MB_5007))) and ((bal == BG_1002) or (
bal == BG_1026) or (bal == BG_1004)) and (dir ==

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      dRight))
78       then {ROUTE_5007}
79     else if (((loc >= baliseLoc(BG_1006)) and (loc <
      mbLocation(MB_5011))) and (bal == BG_1006) and (
      dir == dRight))
80       then {ROUTE_5011}
81     else if (((loc >= baliseLoc(BG_996)) and (loc <
      mbLocation(MB_5015))) and (bal == BG_996) and (dir
      == dRight))
82       then {ROUTE_5015}
83     else if (((loc >= baliseLoc(BG_1008)) and (loc <
      mbLocation(MB_5019))) and ((bal == BG_1008) or (
      bal == BG_1010)) and (dir == dRight))
84       then {ROUTE_5019}
85     else if (((loc >= baliseLoc(BG_1012)) and (loc <
      mbLocation(MB_5021))) and (bal == BG_1012) and (
      dir == dRight))
86       then {ROUTE_5021_U,ROUTE_5021_D}
87
88     else if (((loc >= baliseLoc(BG_1021)) and (loc <
      baliseLoc(BG_1005))) and ((bal == BG_1021) or (bal
      == BG_1029) or (bal == BG_1003) or (bal ==
      BG_1005)) and (dir == dLeft))
89       then {ROUTE_5020,ROUTE_5018}
90     else if (((loc >= mbLocation(MB_5020)) and (loc <
      baliseLoc(BG_1033))) and ((bal == BG_1033) or (bal
      == BG_1019)) and (dir == dLeft))
91       then {ROUTE_5020}
92     else if (((loc >= mbLocation(MB_5016)) and (loc <
      baliseLoc(BG_1013))) and (bal == BG_1013) and (dir
      == dLeft))
93       then {ROUTE_5016}
94     else if (((loc >= mbLocation(MB_5012)) and (loc <
      baliseLoc(BG_1015))) and (bal == BG_1015) and (dir
      == dLeft))
95       then {ROUTE_5012}
96     else if (((loc >= mbLocation(MB_5008)) and (loc <
      baliseLoc(BG_1017))) and ((bal == BG_1011) or (bal
      == BG_1017)) and (dir == dLeft))
97       then {ROUTE_5008}
98     else if (((loc >= mbLocation(MB_5004)) and (loc <
      baliseLoc(BG_1009))) and ((bal == BG_1009) or (bal
      == BG_1031)) and (dir == dLeft))
99       then {ROUTE_5004_U,ROUTE_5004_D}
100    else if (((loc >= mbLocation(MB_DBM002)) and (loc <
      baliseLoc(BG_1027))) and ((bal == BG_1027) or (bal
      == BG_1023) or (bal == BG_1001) or (bal ==
      BG_1025)) and (dir == dLeft))
101       then {ROUTE_DBM002}

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102     else if (((loc >= mbLocation(MB_5018)) and (loc <
        baliseLoc(BG_1024))) and ((bal == BG_1024) or (bal
        == BG_1016) or (bal == BG_1022) or (bal ==
        BG_1018) or (bal == BG_1020) or (bal == BG_1028)
        or (bal == BG_1014) or (bal == BG_1012)) and (dir
        == dLeft))
103         then {ROUTE_5018}
104     else if (((loc >= mbLocation(MB_5014)) and (loc <
        baliseLoc(BG_1010))) and (bal == BG_1010) and (dir
        == dLeft))
105         then {ROUTE_5014}
106     else if (((loc >= mbLocation(MB_5010)) and (loc <
        baliseLoc(BG_1008))) and (bal == BG_1008) and (dir
        == dLeft))
107         then {ROUTE_5010}
108     else if (((loc >= mbLocation(MB_5006)) and (loc <
        baliseLoc(BG_996))) and ((bal == BG_996) or (bal
        == BG_1006)) and (dir == dLeft))
109         then {ROUTE_5006}
110     else if (((loc >= mbLocation(MB_5004)) and (loc <
        baliseLoc(BG_1004))) and ((bal == BG_1004) or (bal
        == BG_1026)) and (dir == dLeft))
111         then {ROUTE_5004_U,ROUTE_5004_D}
112     else if (((loc >= mbLocation(MB_DBM005)) and (loc <
        baliseLoc(BG_1002))) and ((bal == BG_1002) or (bal
        == BG_998)) and (dir == dLeft))
113         then {ROUTE_DBM005}
114     else if (((loc >= distance(C_BG_LU)) and (loc <
        baliseLoc(BG_1000))) and (bal == BG_LU) and (dir
        == dRight))
115         then {ROUTE_EntryLU}
116     else if (((loc >= distance(C_BG_LD)) and (loc <
        baliseLoc(BG_1030))) and (bal == BG_LD) and (dir
        == dRight))
117         then {ROUTE_EntryLD}
118     else if (((loc > baliseLoc(BG_1005)) and (loc <=
        distance(C_BG_RU))) and (bal == BG_RU) and (dir ==
        dLeft))
119         then {ROUTE_EntryRU_U,ROUTE_EntryRU_D}
120     else if (((loc > baliseLoc(BG_1024)) and (loc <=
        distance(C_BG_RD))) and (bal == BG_RD) and (dir ==
        dLeft))
121         then {ROUTE_EntryRD}
122
123     else {ROUTE_null}
124
125
126 baliseDirectionCheck(_) = bidirectional
127 baliseDirectionCheck(BG_1000) = rightwards

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128 baliseDirectionCheck(BG_1001) = rightwards
129 baliseDirectionCheck(BG_1002) = leftwards
130 baliseDirectionCheck(BG_1005) = leftwards
131 baliseDirectionCheck(BG_1014) = rightwards
132 baliseDirectionCheck(BG_1016) = leftwards
133 baliseDirectionCheck(BG_1018) = leftwards
134 baliseDirectionCheck(BG_1019) = rightwards
135 baliseDirectionCheck(BG_1021) = leftwards
136 baliseDirectionCheck(BG_1022) = leftwards
137 baliseDirectionCheck(BG_1025) = rightwards
138 baliseDirectionCheck(BG_1027) = leftwards
139 baliseDirectionCheck(BG_1029) = leftwards
140 baliseDirectionCheck(BG_1031) = rightwards
141 baliseDirectionCheck(BG_1033) = leftwards
142
143
144 pointToTrack(P_2057A) = T_ZAAB
145 pointToTrack(P_2057B) = T_ZBBC
146 pointToTrack(P_2058B) = T_ZAAC
147 pointToTrack(P_2058A) = T_ZBBB
148 pointToTrack(P_2059B) = T_0834
149 pointToTrack(P_2059A) = T_0535
150 pointToTrack(_) = T_null
151
152 trackToPoint(T_ZAAB) = P_2057A
153 trackToPoint(T_ZBBC) = P_2057B
154 trackToPoint(T_ZAAC) = P_2058B
155 trackToPoint(T_ZBBB) = P_2058A
156 trackToPoint(T_0834) = P_2059B
157 trackToPoint(T_0535) = P_2059A
158 trackToPoint(_) = P_null
159
160 RouteMA(ROUTE_DBM001) = (distance(C_AA_AB) - 50)
161 RouteMA(ROUTE_DBM002) = (distance(C_BG_LU))
162 RouteMA(ROUTE_DBM003) = (distance(C_BG_RU))
163 RouteMA(ROUTE_DBM004) = (distance(C_BA_BB) - 50)
164 RouteMA(ROUTE_DBM005) = (distance(C_BG_LD))
165 RouteMA(ROUTE_5001_U) = (distance(C_AD_AE) - 50)
166 RouteMA(ROUTE_5001_D) = (distance(C_BD_BE) - 50)
167 RouteMA(ROUTE_5002_U) = (distance(C_BG_LU) + 50)
168 RouteMA(ROUTE_5002_D) = (distance(C_VTC2_BA) + 50)
169 RouteMA(ROUTE_5003_U) = (distance(C_AD_AE) - 50)
170 RouteMA(ROUTE_5003_D) = (distance(C_BD_BE) - 50)
171 RouteMA(ROUTE_5004_U) = (distance(C_BG_LU) + 50)
172 RouteMA(ROUTE_5004_D) = (distance(C_VTC2_BA) + 50)
173 RouteMA(ROUTE_5005) = (distance(C_AE_AF) - 50)
174 RouteMA(ROUTE_5006) = (distance(C_BC_BD) + 50)
175 RouteMA(ROUTE_5007) = (distance(C_BE_BF) - 50)
176 RouteMA(ROUTE_5008) = (distance(C_AC_AD) + 50)

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177 RouteMA(ROUTE_5009) = (distance(C_AH_AJ) - 50)
178 RouteMA(ROUTE_5010) = (distance(C_BD_BE) + 50)
179 RouteMA(ROUTE_5011) = (distance(C_BH_BJ) - 50)
180 RouteMA(ROUTE_5012) = (distance(C_AD_AE) + 50)
181 RouteMA(ROUTE_5013) = (distance(C_AK_AL) - 50)
182 RouteMA(ROUTE_5014) = (distance(C_BG_BH) + 50)
183 RouteMA(ROUTE_5015) = (distance(C_BK_BL) - 50)
184 RouteMA(ROUTE_5016) = (distance(C_AG_AH) + 50)
185 RouteMA(ROUTE_5017) = (distance(C_0842_0843) - 50)
186 RouteMA(ROUTE_5018) = (distance(C_BJ_BK) + 50)
187 RouteMA(ROUTE_5019) = (distance(C_BL_BM) - 50)
188 RouteMA(ROUTE_5020) = (distance(C_AJ_AK) + 50)
189 RouteMA(ROUTE_5021_U) = (distance(C_0842_0843) - 50)
190 RouteMA(ROUTE_5021_D) = (distance(C_BG_RD))
191 RouteMA(ROUTE_EntryLU) = (distance(C_VTC1_AA) - 50)
192 RouteMA(ROUTE_EntryLD) = (distance(C_VTC2_BA) - 50)
193 RouteMA(ROUTE_EntryRU_U) = (distance(C_AK_AL) + 50)
194 RouteMA(ROUTE_EntryRU_D) = (distance(C_BK_BL) + 50)
195 RouteMA(ROUTE_EntryRD) = (distance(C_BK_BL) + 50)
196 RouteMA(ROUTE_null) = 0
197
198 trackBaliseLeft(T_VTC001) = T_VTC001_L_BG_1000
199 trackBaliseLeft(T_ZAAA) = T_ZAAA_L_BG_1025
200 trackBaliseLeft(T_ZAAB) = T_ZAAB_L_BG_1023
201 trackBaliseLeft(T_ZAAC) = T_ZAAC_L_BG_1027
202 trackBaliseLeft(T_ZAAD) = T_ZAAD_L_BG_1031
203 trackBaliseLeft(T_ZAAE) = T_ZAAE_L_BG_1011
204 trackBaliseLeft(T_ZAAG) = T_ZAAG_L_BG_1017
205 trackBaliseLeft(T_ZAAJ) = T_ZAAJ_L_BG_1015
206 trackBaliseLeft(T_ZAAK) = T_ZAAK_L_BG_1013
207 trackBaliseLeft(T_ZAAL) = T_ZAAL_L_BG_1019
208 trackBaliseLeft(T_0833) = T_0833_L_BG_1033
209 trackBaliseLeft(T_0835) = T_0835_L_BG_1021
210 trackBaliseLeft(T_08412) = T_08412_L_BG_1003
211 trackBaliseLeft(T_0843) = T_0843_L_BG_1005
212 trackBaliseLeft(T_VTC002) = T_VTC002_L_BG_1030
213 trackBaliseLeft(T_ZBBA) = T_ZBBA_L_BG_998
214 trackBaliseLeft(T_ZBBC) = T_ZBBC_L_BG_1002
215 trackBaliseLeft(T_ZBBD) = T_ZBBD_L_BG_1004
216 trackBaliseLeft(T_ZBBE) = T_ZBBE_L_BG_1006
217 trackBaliseLeft(T_ZBBF) = T_ZBBF_L_BG_996
218 trackBaliseLeft(T_ZBBJ) = T_ZBBJ_L_BG_1008
219 trackBaliseLeft(T_ZBBK) = T_ZBBK_L_BG_1010
220 trackBaliseLeft(T_ZBBL) = T_ZBBL_L_BG_1012
221 trackBaliseLeft(T_ZBBM) = T_ZBBM_L_BG_1014
222 trackBaliseLeft(T_0534) = T_0534_L_BG_1028
223 trackBaliseLeft(T_0535) = T_0535_L_BG_1020
224 trackBaliseLeft(T_0541) = T_0541_L_BG_1018
225 trackBaliseLeft(T_0543) = T_0543_L_BG_1016

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226 trackBaliseLeft(T_0544) = T_0544_L_BG_1024
227 trackBaliseLeft(x) = x
228
229 trackBaliseRight(T_VTC001) = T_VTC001_R_BG_1000
230 trackBaliseRight(T_ZAAA) = T_ZAAA_R_BG_1001
231 trackBaliseRight(T_ZAAB) = T_ZAAB_R_BG_1023
232 trackBaliseRight(T_ZAAC) = T_ZAAC_R_BG_1027
233 trackBaliseRight(T_ZAAD) = T_ZAAD_R_BG_1009
234 trackBaliseRight(T_ZAAE) = T_ZAAE_R_BG_1011
235 trackBaliseRight(T_ZAAG) = T_ZAAG_R_BG_1017
236 trackBaliseRight(T_ZAAJ) = T_ZAAJ_R_BG_1015
237 trackBaliseRight(T_ZAAK) = T_ZAAK_R_BG_1013
238 trackBaliseRight(T_ZAAL) = T_ZAAL_R_BG_1019
239 trackBaliseRight(T_0833) = T_0833_R_BG_1033
240 trackBaliseRight(T_0835) = T_0835_R_BG_1029
241 trackBaliseRight(T_08412) = T_08412_R_BG_1003
242 trackBaliseRight(T_0843) = T_0843_R_BG_1005
243 trackBaliseRight(T_VTC002) = T_VTC002_R_BG_1032
244 trackBaliseRight(T_ZBBA) = T_ZBBA_R_BG_998
245 trackBaliseRight(T_ZBBC) = T_ZBBC_R_BG_1002
246 trackBaliseRight(T_ZBBD) = T_ZBBD_R_BG_1004
247 trackBaliseRight(T_ZBBE) = T_ZBBE_R_BG_1006
248 trackBaliseRight(T_ZBBF) = T_ZBBF_R_BG_996
249 trackBaliseRight(T_ZBBJ) = T_ZBBJ_R_BG_1008
250 trackBaliseRight(T_ZBBK) = T_ZBBK_R_BG_1010
251 trackBaliseRight(T_ZBBL) = T_ZBBL_R_BG_1012
252 trackBaliseRight(T_ZBBM) = T_ZBBM_R_BG_1014
253 trackBaliseRight(T_0534) = T_0534_R_BG_1028
254 trackBaliseRight(T_0535) = T_0535_R_BG_1020
255 trackBaliseRight(T_0541) = T_0541_R_BG_1022
256 trackBaliseRight(T_0543) = T_0543_R_BG_1016
257 trackBaliseRight(T_0544) = T_0544_R_BG_1024
258 trackBaliseRight(x) = x
259
260 baliseTrack(T_VTC001_L_BG_1000) = T_VTC001
261 baliseTrack(T_VTC001_R_BG_1000) = T_VTC001
262 baliseTrack(T_ZAAA_L_BG_1025) = T_ZAAA
263 baliseTrack(T_ZAAA_BG_1025_BG_1001) = T_ZAAA
264 baliseTrack(T_ZAAA_R_BG_1001) = T_ZAAA
265 baliseTrack(T_ZAAB_L_BG_1023) = T_ZAAB
266 baliseTrack(T_ZAAB_R_BG_1023) = T_ZAAB
267 baliseTrack(T_ZAAC_L_BG_1027) = T_ZAAC
268 baliseTrack(T_ZAAC_R_BG_1027) = T_ZAAC
269 baliseTrack(T_ZAAD_L_BG_1031) = T_ZAAD
270 baliseTrack(T_ZAAD_BG_1031_BG_1009) = T_ZAAD
271 baliseTrack(T_ZAAD_R_BG_1009) = T_ZAAD
272 baliseTrack(T_ZAAE_L_BG_1011) = T_ZAAE
273 baliseTrack(T_ZAAE_R_BG_1011) = T_ZAAE
274 baliseTrack(T_ZAAG_L_BG_1017) = T_ZAAG

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275 baliseTrack(T_ZAAG_R_BG_1017) = T_ZAAG
276 baliseTrack(T_ZAAJ_L_BG_1015) = T_ZAAJ
277 baliseTrack(T_ZAAJ_R_BG_1015) = T_ZAAJ
278 baliseTrack(T_ZAAK_L_BG_1013) = T_ZAAK
279 baliseTrack(T_ZAAK_R_BG_1013) = T_ZAAK
280 baliseTrack(T_ZAAL_L_BG_1019) = T_ZAAL
281 baliseTrack(T_ZAAL_R_BG_1019) = T_ZAAL
282 baliseTrack(T_0833_L_BG_1033) = T_0833
283 baliseTrack(T_0833_R_BG_1033) = T_0833
284 baliseTrack(T_0835_L_BG_1021) = T_0835
285 baliseTrack(T_0835_BG_1021_BG_1029) = T_0835
286 baliseTrack(T_0835_R_BG_1029) = T_0835
287 baliseTrack(T_08412_L_BG_1003) = T_08412
288 baliseTrack(T_08412_R_BG_1003) = T_08412
289 baliseTrack(T_0843_L_BG_1005) = T_0843
290 baliseTrack(T_0843_R_BG_1005) = T_0843
291 baliseTrack(T_VTC002_L_BG_1030) = T_VTC002
292 baliseTrack(T_VTC002_BG_1030_BG_1032) = T_VTC002
293 baliseTrack(T_VTC002_R_BG_1032) = T_VTC002
294 baliseTrack(T_ZBBA_L_BG_998) = T_ZBBA
295 baliseTrack(T_ZBBA_R_BG_998) = T_ZBBA
296 baliseTrack(T_ZBBC_L_BG_1002) = T_ZBBC
297 baliseTrack(T_ZBBC_R_BG_1002) = T_ZBBC
298 baliseTrack(T_ZBBD_L_BG_1004) = T_ZBBD
299 baliseTrack(T_ZBBD_BG_1026_BG_1004) = T_ZBBD
300 baliseTrack(T_ZBBD_R_BG_1004) = T_ZBBD
301 baliseTrack(T_ZBBE_L_BG_1006) = T_ZBBE
302 baliseTrack(T_ZBBE_R_BG_1006) = T_ZBBE
303 baliseTrack(T_ZBBF_L_BG_996) = T_ZBBF
304 baliseTrack(T_ZBBF_R_BG_996) = T_ZBBF
305 baliseTrack(T_ZBBJ_L_BG_1008) = T_ZBBJ
306 baliseTrack(T_ZBBJ_R_BG_1008) = T_ZBBJ
307 baliseTrack(T_ZBBK_L_BG_1010) = T_ZBBK
308 baliseTrack(T_ZBBK_R_BG_1010) = T_ZBBK
309 baliseTrack(T_ZBBL_L_BG_1012) = T_ZBBL
310 baliseTrack(T_ZBBL_R_BG_1012) = T_ZBBL
311 baliseTrack(T_ZBBM_L_BG_1014) = T_ZBBM
312 baliseTrack(T_ZBBM_R_BG_1014) = T_ZBBM
313 baliseTrack(T_0534_L_BG_1028) = T_0534
314 baliseTrack(T_0534_R_BG_1028) = T_0534
315 baliseTrack(T_0535_L_BG_1020) = T_0535
316 baliseTrack(T_0535_R_BG_1020) = T_0535
317 baliseTrack(T_0541_L_BG_1018) = T_0541
318 baliseTrack(T_0541_BG_1018_BG_1022) = T_0541
319 baliseTrack(T_0541_R_BG_1022) = T_0541
320 baliseTrack(T_0543_L_BG_1016) = T_0543
321 baliseTrack(T_0543_R_BG_1016) = T_0543
322 baliseTrack(T_0544_L_BG_1024) = T_0544
323 baliseTrack(T_0544_R_BG_1024) = T_0544

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```

324 baliseTrack(x) = x
325
326 connectors(T_VTC001) = {C_BG_LU, C_BG_1000, C_VTC1_AA}
327 connectors(T_ZAAA) = {C_VTC1_AA, C_BG_1025, C_BG_1001, C_AA_AB}
328 connectors(T_ZAAB) = {C_AA_AB, C_BG_1023, C_AB_AC, C_AB_BC}
329 connectors(T_ZAAC) = {C_AB_AC, C_BG_1027, C_AC_AD, C_BB_AC}
330 connectors(T_ZAAD) = {C_AC_AD, C_BG_1031, C_BG_1009, C_AD_AE}
331 connectors(T_ZAAE) = {C_AD_AE, C_BG_1011, C_AE_AF}
332 connectors(T_ZAAF) = {C_AE_AF, C_AF_AG}
333 connectors(T_ZAAG) = {C_AF_AG, C_BG_1017, C_AG_AH}
334 connectors(T_ZAAH) = {C_AG_AH, C_AH_AJ}
335 connectors(T_ZAAJ) = {C_AH_AJ, C_BG_1015, C_AJ_AK}
336 connectors(T_ZAAK) = {C_AJ_AK, C_BG_1013, C_AK_AL}
337 connectors(T_ZAAL) = {C_AK_AL, C_BG_1019, C_AL_0832}
338 connectors(T_0832) = {C_AL_0832, C_0832_0833}
339 connectors(T_0833) = {C_0832_0833, C_BG_1033, C_0833_0834}
340 connectors(T_0834) = {C_0833_0834, C_0834_0835, C_0535_0834}
341 connectors(T_0835) = {C_0834_0835, C_BG_1021, C_BG_1029,
    C_0835_08411}
342 connectors(T_08411) = {C_0835_08411, C_08411_08412}
343 connectors(T_08412) = {C_08411_08412, C_BG_1003, C_08412_0842}
344 connectors(T_0842) = {C_08412_0842, C_0842_0843}
345 connectors(T_0843) = {C_0842_0843, C_BG_1005, C_BG_RU}
346 connectors(T_VTC002) = {C_BG_LD, C_BG_1030, C_BG_1032, C_VTC2_BA}
347 connectors(T_ZBBA) = {C_VTC2_BA, C_BG_998, C_BA_BB}
348 connectors(T_ZBBB) = {C_BA_BB, C_BB_BC, C_BB_AC}
349 connectors(T_ZBBC) = {C_BB_BC, C_BG_1002, C_BC_BD, C_AB_BC}
350 connectors(T_ZBBD) = {C_BC_BD, C_BG_1026, C_BG_1004, C_BD_BE}
351 connectors(T_ZBBE) = {C_BD_BE, C_BG_1006, C_BE_BF}
352 connectors(T_ZBBF) = {C_BE_BF, C_BG_996, C_BF_BG}
353 connectors(T_ZBBG) = {C_BF_BG, C_BG_BH}
354 connectors(T_ZBBH) = {C_BG_BH, C_BH_BJ}
355 connectors(T_ZBBJ) = {C_BH_BJ, C_BG_1008, C_BJ_BK}
356 connectors(T_ZBBK) = {C_BJ_BK, C_BG_1010, C_BK_BL}
357 connectors(T_ZBBL) = {C_BK_BL, C_BG_1012, C_BL_BM}
358 connectors(T_ZBBM) = {C_BL_BM, C_BG_1014, C_BM_0534}
359 connectors(T_0534) = {C_BM_0534, C_BG_1028, C_0534_0535}
360 connectors(T_0535) = {C_0534_0535, C_BG_1020, C_0535_0541,
    C_0535_0834}
361 connectors(T_0541) = {C_0535_0541, C_BG_1018, C_BG_1022,
    C_0541_0542}
362 connectors(T_0542) = {C_0541_0542, C_0542_0543}
363 connectors(T_0543) = {C_0542_0543, C_BG_1016, C_0543_0544}
364 connectors(T_0544) = {C_0543_0544, C_BG_1024, C_BG_RD}
365
366 isConnectorBalise(x) =
367     if member(x, baliseConnectors)
368         then true
369     else false

```

```

370 dirNormal(T_ZAAB) = {(C_AA_AB, C_AB_AC), (C_AB_AC, C_AA_AB)}
371 dirNormal(T_ZAAC) = {(C_AB_AC, C_AC_AD), (C_AC_AD, C_AB_AC)}
372 dirNormal(T_ZBBB) = {(C_BA_BB, C_BB_BC), (C_BB_BC, C_BA_BB)}
373 dirNormal(T_ZBBC) = {(C_BB_BC, C_BC_BD), (C_BC_BD, C_BB_BC)}
374 dirNormal(T_0834) = {(C_0833_0834, C_0834_0835), (C_0834_0835,
375 C_0833_0834)}
376 dirNormal(T_0535) = {(C_0534_0535, C_0535_0541), (C_0535_0541,
C_0534_0535)}
377 dirReverse(T_ZAAB) = {(C_AA_AB, C_AB_BC), (C_AB_BC, C_AA_AB)}
378 dirReverse(T_ZAAC) = {(C_AB_BC, C_AC_AD), (C_AC_AD, C_AB_BC)}
379 dirReverse(T_ZBBB) = {(C_BA_BB, C_BB_AC), (C_BB_AC, C_BA_BB)}
380 dirReverse(T_ZBBC) = {(C_AB_AC, C_BC_BD), (C_BC_BD, C_AB_AC)}
381 dirReverse(T_0834) = {(C_0535_0834, C_0834_0835), (C_0834_0835,
C_0535_0834)}
382 dirReverse(T_0535) = {(C_0534_0535, C_0535_0834), (C_0535_0834,
C_0534_0535)}
383
384 directions(u) =
385   if member(u, trackPoint)
386     then union(dirNormal(u), dirReverse(u))
387   else {(x, y) | x <- connectors(u), y <- connectors(u), x != y
}
388
389 unitLen(T_VTC001) = 500
390 unitLen(T_VTC001_L_BG_1000) = 250
391 unitLen(T_VTC001_R_BG_1000) = 250
392 unitLen(T_ZAAA) = 500
393 unitLen(T_ZAAA_L_BG_1025) = 150
394 unitLen(T_ZAAA_BG_1025_BG_1001) = 200
395 unitLen(T_ZAAA_R_BG_1001) = 150
396 unitLen(T_ZAAB) = 500
397 unitLen(T_ZAAB_L_BG_1023) = 250
398 unitLen(T_ZAAB_R_BG_1023) = 250
399 unitLen(T_ZAAC) = 500
400 unitLen(T_ZAAC_L_BG_1027) = 250
401 unitLen(T_ZAAC_R_BG_1027) = 250
402 unitLen(T_ZAAD) = 500
403 unitLen(T_ZAAD_L_BG_1031) = 150
404 unitLen(T_ZAAD_BG_1031_BG_1009) = 200
405 unitLen(T_ZAAD_R_BG_1009) = 150
406 unitLen(T_ZAAE) = 500
407 unitLen(T_ZAAE_L_BG_1011) = 250
408 unitLen(T_ZAAE_R_BG_1011) = 250
409 unitLen(T_ZAAF) = 500
410 unitLen(T_ZAAG) = 500
411 unitLen(T_ZAAG_L_BG_1017) = 250
412 unitLen(T_ZAAG_R_BG_1017) = 250
413 unitLen(T_ZAAH) = 500

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414 unitLen(T_ZAAJ) = 500
415 unitLen(T_ZAAJ_L_BG_1015) = 250
416 unitLen(T_ZAAJ_R_BG_1015) = 250
417 unitLen(T_ZAAK) = 500
418 unitLen(T_ZAAK_L_BG_1013) = 250
419 unitLen(T_ZAAK_R_BG_1013) = 250
420 unitLen(T_ZAAL) = 500
421 unitLen(T_ZAAL_L_BG_1019) = 250
422 unitLen(T_ZAAL_R_BG_1019) = 250
423 unitLen(T_0832) = 500
424 unitLen(T_0833) = 500
425 unitLen(T_0833_L_BG_1033) = 250
426 unitLen(T_0833_R_BG_1033) = 250
427 unitLen(T_0834) = 500
428 unitLen(T_0835) = 500
429 unitLen(T_0835_L_BG_1021) = 150
430 unitLen(T_0835_BG_1021_BG_1029) = 200
431 unitLen(T_0835_R_BG_1029) = 150
432 unitLen(T_08411) = 500
433 unitLen(T_08412) = 500
434 unitLen(T_08412_L_BG_1003) = 250
435 unitLen(T_08412_R_BG_1003) = 250
436 unitLen(T_0842) = 500
437 unitLen(T_0843) = 500
438 unitLen(T_0843_L_BG_1005) = 250
439 unitLen(T_0843_R_BG_1005) = 250
440 unitLen(T_VTC002) = 500
441 unitLen(T_VTC002_L_BG_1030) = 150
442 unitLen(T_VTC002_BG_1030_BG_1032) = 200
443 unitLen(T_VTC002_R_BG_1032) = 150
444 unitLen(T_ZBBA) = 500
445 unitLen(T_ZBBA_L_BG_998) = 250
446 unitLen(T_ZBBA_R_BG_998) = 250
447 unitLen(T_ZBBB) = 500
448 unitLen(T_ZBBC) = 500
449 unitLen(T_ZBBC_L_BG_1002) = 250
450 unitLen(T_ZBBC_R_BG_1002) = 250
451 unitLen(T_ZBBD) = 500
452 unitLen(T_ZBBD_L_BG_1004) = 150
453 unitLen(T_ZBBD_BG_1026_BG_1004) = 200
454 unitLen(T_ZBBD_R_BG_1004) = 150
455 unitLen(T_ZBBE) = 500
456 unitLen(T_ZBBE_L_BG_1006) = 250
457 unitLen(T_ZBBE_R_BG_1006) = 250
458 unitLen(T_ZBBF) = 500
459 unitLen(T_ZBBF_L_BG_996) = 250
460 unitLen(T_ZBBF_R_BG_996) = 250
461 unitLen(T_ZBBG) = 500
462 unitLen(T_ZBBH) = 500
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463 unitLen(T_ZBBJ) = 500
464 unitLen(T_ZBBJ_L_BG_1008) = 250
465 unitLen(T_ZBBJ_R_BG_1008) = 250
466 unitLen(T_ZBBK) = 500
467 unitLen(T_ZBBK_L_BG_1010) = 250
468 unitLen(T_ZBBK_R_BG_1010) = 250
469 unitLen(T_ZBBL) = 500
470 unitLen(T_ZBBL_L_BG_1012) = 250
471 unitLen(T_ZBBL_R_BG_1012) = 250
472 unitLen(T_ZBBM) = 500
473 unitLen(T_ZBBM_L_BG_1014) = 250
474 unitLen(T_ZBBM_R_BG_1014) = 250
475 unitLen(T_0534) = 500
476 unitLen(T_0534_L_BG_1028) = 250
477 unitLen(T_0534_R_BG_1028) = 250
478 unitLen(T_0535) = 500
479 unitLen(T_0535_L_BG_1020) = 250
480 unitLen(T_0535_R_BG_1020) = 250
481 unitLen(T_0541) = 500
482 unitLen(T_0541_L_BG_1018) = 150
483 unitLen(T_0541_BG_1018_BG_1022) = 200
484 unitLen(T_0541_R_BG_1022) = 150
485 unitLen(T_0542) = 500
486 unitLen(T_0543) = 500
487 unitLen(T_0543_L_BG_1016) = 250
488 unitLen(T_0543_R_BG_1016) = 250
489 unitLen(T_0544) = 500
490 unitLen(T_0544_L_BG_1024) = 250
491 unitLen(T_0544_R_BG_1024) = 250
492 unitLen(T_null) = 0
493
494 uPreceding(C_BG_LU) = T_VTC001_L_BG_1000
495 uPreceding(C_BG_1000) = T_VTC001_R_BG_1000
496 uPreceding(C_VTC1_AA) = T_null
497 uPreceding(C_BG_1025) = T_ZAAA_L_BG_1025
498 uPreceding(C_BG_1001) = T_ZAAA_BG_1025_BG_1001
499 uPreceding(C_AA_AB) = T_ZAAA_R_BG_1001
500 uPreceding(C_BG_1023) = T_ZAAB_L_BG_1023
501 uPreceding(C_AB_AC) = T_ZAAB_R_BG_1023
502 uPreceding(C_BG_1027) = T_ZAAC_L_BG_1027
503 uPreceding(C_AC_AD) = T_ZAAC_R_BG_1027
504 uPreceding(C_BG_1031) = T_ZAAD_L_BG_1031
505 uPreceding(C_BG_1009) = T_ZAAD_BG_1031_BG_1009
506 uPreceding(C_AD_AE) = T_ZAAD_R_BG_1009
507 uPreceding(C_BG_1011) = T_ZAAE_L_BG_1011
508 uPreceding(C_AE_AF) = T_ZAAE_R_BG_1011
509 uPreceding(C_AF_AG) = T_ZAAF
510 uPreceding(C_BG_1017) = T_ZAAG_L_BG_1017
511 uPreceding(C_AG_AH) = T_ZAAG_R_BG_1017

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512 uPreceding(C_AH_AJ) = T_ZAAH
513 uPreceding(C_BG_1015) = T_ZAAJ_L_BG_1015
514 uPreceding(C_AJ_AK) = T_ZAAJ_R_BG_1015
515 uPreceding(C_BG_1013) = T_ZAAK_L_BG_1013
516 uPreceding(C_AK_AL) = T_ZAAK_R_BG_1013
517 uPreceding(C_BG_1019) = T_ZAAL_L_BG_1019
518 uPreceding(C_AL_0832) = T_ZAAL_R_BG_1019
519 uPreceding(C_0832_0833) = T_0832
520 uPreceding(C_BG_1033) = T_0833_L_BG_1033
521 uPreceding(C_0833_0834) = T_0833_R_BG_1033
522 uPreceding(C_0834_0835) = T_0834
523 uPreceding(C_BG_1021) = T_0835_L_BG_1021
524 uPreceding(C_BG_1029) = T_0835_BG_1021_BG_1029
525 uPreceding(C_0835_08411) = T_0835_R_BG_1029
526 uPreceding(C_08411_08412) = T_08411
527 uPreceding(C_BG_1003) = T_08412_L_BG_1003
528 uPreceding(C_08412_0842) = T_08412_R_BG_1003
529 uPreceding(C_0842_0843) = T_0842
530 uPreceding(C_BG_1005) = T_0843_L_BG_1005
531 uPreceding(C_BG_RU) = T_0843_R_BG_1005
532 uPreceding(C_BG_LD) = T_VTC002_L_BG_1030
533 uPreceding(C_BG_1030) = T_VTC002_BG_1030_BG_1032
534 uPreceding(C_BG_1032) = T_VTC002_R_BG_1032
535 uPreceding(C_VTC2_BA) = T_null
536 uPreceding(C_BG_998) = T_ZBBA_L_BG_998
537 uPreceding(C_BA_BB) = T_ZBBA_R_BG_998
538 uPreceding(C_BB_BC) = T_ZBBB
539 uPreceding(C_BG_1002) = T_ZBBC_L_BG_1002
540 uPreceding(C_BC_BD) = T_ZBBC_R_BG_1002
541 uPreceding(C_BG_1026) = T_ZBBD_L_BG_1004
542 uPreceding(C_BG_1004) = T_ZBBD_BG_1026_BG_1004
543 uPreceding(C_BD_BE) = T_ZBBD_R_BG_1004
544 uPreceding(C_BG_1006) = T_ZBBE_L_BG_1006
545 uPreceding(C_BE_BF) = T_ZBBE_R_BG_1006
546 uPreceding(C_BG_996) = T_ZBBF_L_BG_996
547 uPreceding(C_BF_BG) = T_ZBBF_R_BG_996
548 uPreceding(C_BG_BH) = T_ZBBG
549 uPreceding(C_BH_BJ) = T_ZBBH
550 uPreceding(C_BG_1008) = T_ZBBJ_L_BG_1008
551 uPreceding(C_BJ_BK) = T_ZBBJ_R_BG_1008
552 uPreceding(C_BG_1010) = T_ZBBK_L_BG_1010
553 uPreceding(C_BK_BL) = T_ZBBK_R_BG_1010
554 uPreceding(C_BG_1012) = T_ZBBL_L_BG_1012
555 uPreceding(C_BL_BM) = T_ZBBL_R_BG_1012
556 uPreceding(C_BG_1014) = T_ZBBM_L_BG_1014
557 uPreceding(C_BM_0534) = T_ZBBM_R_BG_1014
558 uPreceding(C_BG_1028) = T_0534_L_BG_1028
559 uPreceding(C_0534_0535) = T_0534_R_BG_1028
560 uPreceding(C_BG_1020) = T_0535_L_BG_1020

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561 uPreceding(C_0535_0541) = T_0535_R_BG_1020
562 uPreceding(C_BG_1018) = T_0541_L_BG_1018
563 uPreceding(C_BG_1022) = T_0541_BG_1018_BG_1022
564 uPreceding(C_0541_0542) = T_0541_R_BG_1022
565 uPreceding(C_0542_0543) = T_0542
566 uPreceding(C_BG_1016) = T_0543_L_BG_1016
567 uPreceding(C_0543_0544) = T_0543_R_BG_1016
568 uPreceding(C_BG_1024) = T_0544_L_BG_1024
569 uPreceding(C_BG_RD) = T_0544_R_BG_1024
570 uPreceding(C0) = T_null
571
572 uPreceding(C_AB_BC) = T_ZAAB_R_BG_1023
573 uPreceding(C_BB_AC) = T_ZBBB
574 uPreceding(C_0535_0834) = T_0535_R_BG_1020
575
576 cPreceding(C_BG_LU) = C_BG_1000
577 cPreceding(C_BG_1000) = C_VTC1_AA
578 cPreceding(C_VTC1_AA) = C_VTC1_AA
579 cPreceding(C_BG_1025) = C_VTC1_AA
580 cPreceding(C_BG_1001) = C_BG_1025
581 cPreceding(C_AA_AB) = C_BG_1001
582 cPreceding(C_BG_1023) = C_AA_AB
583 cPreceding(C_AB_AC) = C_BG_1023
584 cPreceding(C_BG_1027) = C_AB_AC
585 cPreceding(C_AC_AD) = C_BG_1027
586 cPreceding(C_BG_1031) = C_AC_AD
587 cPreceding(C_BG_1009) = C_BG_1031
588 cPreceding(C_AD_AE) = C_BG_1009
589 cPreceding(C_BG_1011) = C_AD_AE
590 cPreceding(C_AE_AF) = C_BG_1011
591 cPreceding(C_AF_AG) = C_AE_AF
592 cPreceding(C_BG_1017) = C_AF_AG
593 cPreceding(C_AG_AH) = C_BG_1017
594 cPreceding(C_AH_AJ) = C_AG_AH
595 cPreceding(C_BG_1015) = C_AH_AJ
596 cPreceding(C_AJ_AK) = C_BG_1015
597 cPreceding(C_BG_1013) = C_AJ_AK
598 cPreceding(C_AK_AL) = C_BG_1013
599 cPreceding(C_BG_1019) = C_AK_AL
600 cPreceding(C_AL_0832) = C_BG_1019
601 cPreceding(C_0832_0833) = C_AL_0832
602 cPreceding(C_BG_1033) = C_0832_0833
603 cPreceding(C_0833_0834) = C_BG_1033
604 cPreceding(C_0834_0835) = C_0833_0834
605 cPreceding(C_BG_1021) = C_0834_0835
606 cPreceding(C_BG_1029) = C_BG_1021
607 cPreceding(C_0835_08411) = C_BG_1029
608 cPreceding(C_08411_08412) = C_0835_08411
609 cPreceding(C_BG_1003) = C_08411_08412

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610 cPreceding(C_08412_0842) = C_BG_1003
611 cPreceding(C_0842_0843) = C_08412_0842
612 cPreceding(C_BG_1005) = C_0842_0843
613 cPreceding(C_BG_RU) = C_BG_1005
614 cPreceding(C_BG_LD) = C_BG_1030
615 cPreceding(C_BG_1030) = C_BG_1032
616 cPreceding(C_BG_1032) = C_VTC2_BA
617 cPreceding(C_VTC2_BA) = C_VTC2_BA
618 cPreceding(C_BG_998) = C_VTC2_BA
619 cPreceding(C_BA_BB) = C_BG_998
620 cPreceding(C_BB_BC) = C_BA_BB
621 cPreceding(C_BG_1002) = C_BB_BC
622 cPreceding(C_BC_BD) = C_BG_1002
623 cPreceding(C_BG_1026) = C_BC_BD
624 cPreceding(C_BG_1004) = C_BG_1026
625 cPreceding(C_BD_BE) = C_BG_1004
626 cPreceding(C_BG_1006) = C_BD_BE
627 cPreceding(C_BE_BF) = C_BG_1006
628 cPreceding(C_BG_996) = C_BE_BF
629 cPreceding(C_BF_BG) = C_BG_996
630 cPreceding(C_BG_BH) = C_BF_BG
631 cPreceding(C_BH_BJ) = C_BG_BH
632 cPreceding(C_BG_1008) = C_BH_BJ
633 cPreceding(C_BJ_BK) = C_BG_1008
634 cPreceding(C_BG_1010) = C_BJ_BK
635 cPreceding(C_BK_BL) = C_BG_1010
636 cPreceding(C_BG_1012) = C_BK_BL
637 cPreceding(C_BL_BM) = C_BG_1012
638 cPreceding(C_BG_1014) = C_BL_BM
639 cPreceding(C_BM_0534) = C_BG_1014
640 cPreceding(C_BG_1028) = C_BM_0534
641 cPreceding(C_0534_0535) = C_BG_1028
642 cPreceding(C_BG_1020) = C_0534_0535
643 cPreceding(C_0535_0541) = C_BG_1020
644 cPreceding(C_BG_1018) = C_0535_0541
645 cPreceding(C_BG_1022) = C_BG_1018
646 cPreceding(C_0541_0542) = C_BG_1022
647 cPreceding(C_0542_0543) = C_0541_0542
648 cPreceding(C_BG_1016) = C_0542_0543
649 cPreceding(C_0543_0544) = C_BG_1016
650 cPreceding(C_BG_1024) = C_0543_0544
651
652 cPreceding(C_BG_RD) = C_BG_1024
653 cPreceding(C0) = C0
654 cPreceding(C_AB_BC) = C_BG_1023
655 cPreceding(C_BB_AC) = C_BA_BB
656 cPreceding(C_0535_0834) = C_BG_1020
657
658 ConnectorsLeftOfOrigin = {C_BG_LU, C_BG_LD, C_BG_1000, C_BG_1030,

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    C_BG_1032}
659 ConnectorsRightOfOrigin = {C_AA_AB, C_AB_AC, C_AC_AD, C_AD_AE,
    C_AE_AF, C_AF_AG, C_AG_AH, C_AH_AJ, C_AJ_AK, C_AK_AL,
    C_AL_0832, C_0832_0833, C_0833_0834, C_0834_0835, C_0835_08411
    , C_08411_08412, C_08412_0842, C_0842_0843, C_BA_BB, C_BB_BC,
    C_BC_BD, C_BD_BE, C_BE_BF, C_BF_BG, C_BG_BH, C_BH_BJ, C_BJ_BK,
    C_BK_BL, C_BL_BM, C_BM_0534, C_0534_0535, C_0535_0541,
    C_0541_0542, C_0542_0543, C_0543_0544, C_BG_1001, C_BG_1002,
    C_BG_1003, C_BG_1004, C_BG_1005, C_BG_1006, C_BG_1008,
    C_BG_1009, C_BG_1010, C_BG_1011, C_BG_1012, C_BG_1013,
    C_BG_1014, C_BG_1015, C_BG_1016, C_BG_1017, C_BG_1018,
    C_BG_1019, C_BG_1020, C_BG_1021, C_BG_1022, C_BG_1023,
    C_BG_1024, C_BG_1025, C_BG_1026, C_BG_1027, C_BG_1028,
    C_BG_1029, C_BG_1031, C_BG_1033, C_BG_996, C_BG_998, C_BG_RU,
    C_BG_RD, C_AB_BC, C_BB_AC, C_0535_0834}

660
661 distance(C_VTC1_AA) = 0
662 distance(C_VTC2_BA) = 0
663 distance(connector) =
664     if member(connector, ConnectorsLeftOfOrigin)
665         then distance(cPreceding(connector)) - unitLen(uPreceding
            (connector))
666     else distance(cPreceding(connector)) + unitLen(uPreceding(
            connector))

667
668 unitsNextTo(C_BG_LU) = (T_null, T_VTC001_L_BG_1000)
669 unitsNextTo(C_BG_1000) = (T_VTC001_L_BG_1000, T_VTC001_R_BG_1000)
670 unitsNextTo(C_VTC1_AA) = (T_VTC001_R_BG_1000, T_ZAAA_L_BG_1025)
671 unitsNextTo(C_BG_1025) = (T_ZAAA_L_BG_1025,
    T_ZAAA_BG_1025_BG_1001)
672 unitsNextTo(C_BG_1001) = (T_ZAAA_BG_1025_BG_1001,
    T_ZAAA_R_BG_1001)
673 unitsNextTo(C_AA_AB) = (T_ZAAA_R_BG_1001, T_ZAAB_L_BG_1023)
674 unitsNextTo(C_BG_1023) = (T_ZAAB_L_BG_1023, T_ZAAB_R_BG_1023)
675 unitsNextTo(C_AB_AC) = (T_ZAAB_R_BG_1023, T_ZAAC_L_BG_1027)
676 unitsNextTo(C_BG_1027) = (T_ZAAC_L_BG_1027, T_ZAAC_R_BG_1027)
677 unitsNextTo(C_AC_AD) = (T_ZAAC_R_BG_1027, T_ZAAD_L_BG_1031)
678 unitsNextTo(C_BG_1031) = (T_ZAAD_L_BG_1031,
    T_ZAAD_BG_1031_BG_1009)
679 unitsNextTo(C_BG_1009) = (T_ZAAD_BG_1031_BG_1009,
    T_ZAAD_R_BG_1009)
680 unitsNextTo(C_AD_AE) = (T_ZAAD_R_BG_1009, T_ZAAE_L_BG_1011)
681 unitsNextTo(C_BG_1011) = (T_ZAAE_L_BG_1011, T_ZAAE_R_BG_1011)
682 unitsNextTo(C_AE_AF) = (T_ZAAE_R_BG_1011, T_ZAAF)
683 unitsNextTo(C_AF_AG) = (T_ZAAF, T_ZAAG_L_BG_1017)
684 unitsNextTo(C_BG_1017) = (T_ZAAG_L_BG_1017, T_ZAAG_R_BG_1017)
685 unitsNextTo(C_AG_AH) = (T_ZAAG_R_BG_1017, T_ZAAH)
686 unitsNextTo(C_AH_AJ) = (T_ZAAH, T_ZAAJ_L_BG_1015)
687 unitsNextTo(C_BG_1015) = (T_ZAAJ_L_BG_1015, T_ZAAJ_R_BG_1015)

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688 unitsNextTo(C_AJ_AK) = (T_ZAAJ_R_BG_1015, T_ZAAK_L_BG_1013)
689 unitsNextTo(C_BG_1013) = (T_ZAAK_L_BG_1013, T_ZAAK_R_BG_1013)
690 unitsNextTo(C_AK_AL) = (T_ZAAK_R_BG_1013, T_ZAAL_L_BG_1019)
691 unitsNextTo(C_BG_1019) = (T_ZAAL_L_BG_1019, T_ZAAL_R_BG_1019)
692 unitsNextTo(C_AL_0832) = (T_ZAAL_R_BG_1019, T_0832)
693 unitsNextTo(C_0832_0833) = (T_0832, T_0833_L_BG_1033)
694 unitsNextTo(C_BG_1033) = (T_0833_L_BG_1033, T_0833_R_BG_1033)
695 unitsNextTo(C_0833_0834) = (T_0833_R_BG_1033, T_0834)
696 unitsNextTo(C_0834_0835) = (T_0834, T_0835_L_BG_1021)
697 unitsNextTo(C_BG_1021) = (T_0835_L_BG_1021,
    T_0835_BG_1021_BG_1029)
698 unitsNextTo(C_BG_1029) = (T_0835_BG_1021_BG_1029,
    T_0835_R_BG_1029)
699 unitsNextTo(C_0835_08411) = (T_0835_R_BG_1029, T_08411)
700 unitsNextTo(C_08411_08412) = (T_08411, T_08412_L_BG_1003)
701 unitsNextTo(C_BG_1003) = (T_08412_L_BG_1003, T_08412_R_BG_1003)
702 unitsNextTo(C_08412_0842) = (T_08412_R_BG_1003, T_0842)
703 unitsNextTo(C_0842_0843) = (T_0842, T_0843_L_BG_1005)
704 unitsNextTo(C_BG_1005) = (T_0843_L_BG_1005, T_0843_R_BG_1005)
705 unitsNextTo(C_BG_RU) = (T_0843_R_BG_1005, T_null)
706 unitsNextTo(C_BG_LD) = (T_null, T_VTC002_L_BG_1030)
707 unitsNextTo(C_BG_1030) = (T_VTC002_L_BG_1030,
    T_VTC002_BG_1030_BG_1032)
708 unitsNextTo(C_BG_1032) = (T_VTC002_BG_1030_BG_1032,
    T_VTC002_R_BG_1032)
709 unitsNextTo(C_VTC2_BA) = (T_VTC002_R_BG_1032, T_ZBBA_L_BG_998)
710 unitsNextTo(C_BG_998) = (T_ZBBA_L_BG_998, T_ZBBA_R_BG_998)
711 unitsNextTo(C_BA_BB) = (T_ZBBA_R_BG_998, T_ZBBB)
712 unitsNextTo(C_BB_BC) = (T_ZBBB, T_ZBBC_L_BG_1002)
713 unitsNextTo(C_BG_1002) = (T_ZBBC_L_BG_1002, T_ZBBC_R_BG_1002)
714 unitsNextTo(C_BC_BD) = (T_ZBBC_R_BG_1002, T_ZBBD_L_BG_1004)
715 unitsNextTo(C_BG_1026) = (T_ZBBD_L_BG_1004,
    T_ZBBD_BG_1026_BG_1004)
716 unitsNextTo(C_BG_1004) = (T_ZBBD_BG_1026_BG_1004,
    T_ZBBD_R_BG_1004)
717 unitsNextTo(C_BD_BE) = (T_ZBBD_R_BG_1004, T_ZBBE_L_BG_1006)
718 unitsNextTo(C_BG_1006) = (T_ZBBE_L_BG_1006, T_ZBBE_R_BG_1006)
719 unitsNextTo(C_BE_BF) = (T_ZBBE_R_BG_1006, T_ZBBF_L_BG_996)
720 unitsNextTo(C_BG_996) = (T_ZBBF_L_BG_996, T_ZBBF_R_BG_996)
721 unitsNextTo(C_BF_BG) = (T_ZBBF_R_BG_996, T_ZBBG)
722 unitsNextTo(C_BG_BH) = (T_ZBBG, T_ZBBH)
723 unitsNextTo(C_BH_BJ) = (T_ZBBH, T_ZBBJ_L_BG_1008)
724 unitsNextTo(C_BG_1008) = (T_ZBBJ_L_BG_1008, T_ZBBJ_R_BG_1008)
725 unitsNextTo(C_BJ_BK) = (T_ZBBJ_R_BG_1008, T_ZBBK_L_BG_1010)
726 unitsNextTo(C_BG_1010) = (T_ZBBK_L_BG_1010, T_ZBBK_R_BG_1010)
727 unitsNextTo(C_BK_BL) = (T_ZBBK_R_BG_1010, T_ZBBL_L_BG_1012)
728 unitsNextTo(C_BG_1012) = (T_ZBBL_L_BG_1012, T_ZBBL_R_BG_1012)
729 unitsNextTo(C_BL_BM) = (T_ZBBL_R_BG_1012, T_ZBBM_L_BG_1014)
730 unitsNextTo(C_BG_1014) = (T_ZBBM_L_BG_1014, T_ZBBM_R_BG_1014)

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731 unitsNextTo(C_BM_0534) = (T_ZBBM_R_BG_1014, T_0534_L_BG_1028)
732 unitsNextTo(C_BG_1028) = (T_0534_L_BG_1028, T_0534_R_BG_1028)
733 unitsNextTo(C_0534_0535) = (T_0534_R_BG_1028, T_0535_L_BG_1020)
734 unitsNextTo(C_BG_1020) = (T_0535_L_BG_1020, T_0535_R_BG_1020)
735 unitsNextTo(C_0535_0541) = (T_0535_R_BG_1020, T_0541_L_BG_1018)
736 unitsNextTo(C_BG_1018) = (T_0541_L_BG_1018,
    T_0541_BG_1018_BG_1022)
737 unitsNextTo(C_BG_1022) = (T_0541_BG_1018_BG_1022,
    T_0541_R_BG_1022)
738 unitsNextTo(C_0541_0542) = (T_0541_R_BG_1022, T_0542)
739 unitsNextTo(C_0542_0543) = (T_0542, T_0543_L_BG_1016)
740 unitsNextTo(C_BG_1016) = (T_0543_L_BG_1016, T_0543_R_BG_1016)
741 unitsNextTo(C_0543_0544) = (T_0543_R_BG_1016, T_0544_L_BG_1024)
742 unitsNextTo(C_BG_1024) = (T_0544_L_BG_1024, T_0544_R_BG_1024)
743 unitsNextTo(C_BG_RD) = (T_0544_R_BG_1024, T_null)
744 unitsNextTo(C0) = (T_null, T_null)
745
746 unitsNextTo(C_AB_BC) = (T_ZAAB_R_BG_1023, T_ZBBC_L_BG_1002)
747 unitsNextTo(C_BB_AC) = (T_ZBBB, T_ZAAC_L_BG_1027)
748 unitsNextTo(C_0535_0834) = (T_0535_R_BG_1020, T_0834)
749
750 connectorsOnLine(upper) = upperConnectors
751 connectorsOnLine(lower) = lowerConnectors
752 connectorsOnLine(pointCon) = pointConnectors
753
754
755 lowerConnectors = {C_VTC2_BA, C_BA_BB, C_BB_BC, C_BC_BD, C_BD_BE,
    C_BE_BF, C_BF_BG, C_BG_BH, C_BH_BJ, C_BJ_BK, C_BK_BL, C_BL_BM,
    C_BM_0534, C_0534_0535, C_0535_0541, C_0541_0542,
    C_0542_0543, C_0543_0544, C_BG_1002, C_BG_1004, C_BG_1006,
    C_BG_1008, C_BG_1010, C_BG_1012, C_BG_1014, C_BG_1016,
    C_BG_1018, C_BG_1020, C_BG_1022, C_BG_1024, C_BG_1026,
    C_BG_1028, C_BG_1030, C_BG_1032, C_BG_996, C_BG_998, C_BG_LD,
    C_BG_RD}
756 pointConnectors = {C_AB_BC, C_BB_AC, C_0535_0834, C_AA_AB,
    C_BG_1023, C_BG_1027, C_AC_AD, C_BA_BB, C_BG_1002, C_BC_BD,
    C_0833_0834, C_0534_0535, C_BG_1020}
757 upperConnectors = {C_VTC1_AA, C_AA_AB, C_AB_AC, C_AC_AD, C_AD_AE,
    C_AE_AF, C_AF_AG, C_AG_AH, C_AH_AJ, C_AJ_AK, C_AK_AL,
    C_AL_0832, C_0832_0833, C_0833_0834, C_0834_0835, C_0835_08411,
    C_08411_08412, C_08412_0842, C_0842_0843, C_BG_1000,
    C_BG_1001, C_BG_1003, C_BG_1005, C_BG_1009, C_BG_1011,
    C_BG_1013, C_BG_1015, C_BG_1017, C_BG_1019, C_BG_1021,
    C_BG_1023, C_BG_1025, C_BG_1027, C_BG_1029, C_BG_1031,
    C_BG_1033, C_BG_LU, C_BG_RU}
758
759 offset(mb) =
760     if (member(mb, LeftwardMarker)) then 10
761     else -10

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762
763 mbConnector(MB_DBM001) = C_VTC1_AA
764 mbConnector(MB_DBM002) = C_BG_LU
765 mbConnector(MB_DBM003) = C_0842_0843
766 mbConnector(MB_DBM004) = C_VTC2_BA
767 mbConnector(MB_DBM005) = C_VTC2_BA
768 mbConnector(MB_5001) = C_AA_AB
769 mbConnector(MB_5002) = C_BC_BD
770 mbConnector(MB_5003) = C_BA_BB
771 mbConnector(MB_5004) = C_AC_AD
772 mbConnector(MB_5005) = C_AD_AE
773 mbConnector(MB_5006) = C_BD_BE
774 mbConnector(MB_5007) = C_BD_BE
775 mbConnector(MB_5008) = C_AD_AE
776 mbConnector(MB_5009) = C_AE_AF
777 mbConnector(MB_5010) = C_BG_BH
778 mbConnector(MB_5011) = C_BE_BF
779 mbConnector(MB_5012) = C_AG_AH
780 mbConnector(MB_5013) = C_AH_AJ
781 mbConnector(MB_5014) = C_BJ_BK
782 mbConnector(MB_5015) = C_BH_BJ
783 mbConnector(MB_5016) = C_AJ_AK
784 mbConnector(MB_5017) = C_AK_AL
785 mbConnector(MB_5018) = C_BK_BL
786 mbConnector(MB_5019) = C_BK_BL
787 mbConnector(MB_5020) = C_AK_AL
788 mbConnector(MB_5021) = C_BL_BM
789 mbConnector(MB_LU) = C_BG_LU
790 mbConnector(MB_LD) = C_BG_LD
791 mbConnector(MB_RU) = C_BG_RU
792 mbConnector(MB_RD) = C_BG_RD
793
794 mbLocation(mb) = distance(mbConnector(mb)) + offset(mb)
795
796 BALISE_OFFSET = 250
797 baliseLoc(BG_LU) = distance(C_BG_LU)
798 baliseLoc(BG_LD) = distance(C_BG_LD)
799 baliseLoc(BG_RU) = distance(C_BG_RU)
800 baliseLoc(BG_RD) = distance(C_BG_RD)
801 baliseLoc(BG_1000) = distance(C_VTC1_AA) - BALISE_OFFSET
802 baliseLoc(BG_1025) = distance(C_AA_AB) - 350
803 baliseLoc(BG_1001) = baliseLoc(BG_1025) + 200
804 baliseLoc(BG_1023) = distance(C_AB_AC) - BALISE_OFFSET
805 baliseLoc(BG_1027) = distance(C_AC_AD) - BALISE_OFFSET
806 baliseLoc(BG_1031) = distance(C_AD_AE) - 350
807 baliseLoc(BG_1009) = baliseLoc(BG_1031) + 200
808 baliseLoc(BG_1011) = distance(C_AE_AF) - BALISE_OFFSET
809 baliseLoc(BG_1017) = distance(C_AG_AH) - BALISE_OFFSET
810 baliseLoc(BG_1015) = distance(C_AJ_AK)

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811 baliseLoc(BG_1013) = distance(C_AK_AL) - BALISE_OFFSET
812 baliseLoc(BG_1019) = distance(C_AL_0832) - BALISE_OFFSET
813 baliseLoc(BG_1033) = distance(C_0833_0834) - BALISE_OFFSET
814 baliseLoc(BG_1021) = distance(C_0835_08411) -350
815 baliseLoc(BG_1029) = baliseLoc(BG_1021) + 200
816 baliseLoc(BG_1003) = distance(C_08412_0842) - BALISE_OFFSET
817 baliseLoc(BG_1005) = distance(C_BG_RU) - BALISE_OFFSET
818 baliseLoc(BG_1030) = distance(C_VTC2_BA) - 350
819 baliseLoc(BG_1032) = baliseLoc(BG_1030) + 200
820 baliseLoc(BG_998) = distance(C_BA_BB) - BALISE_OFFSET
821 baliseLoc(BG_1002) = distance(C_BC_BD) - BALISE_OFFSET
822 baliseLoc(BG_1026) = distance(C_BD_BE) - 350
823 baliseLoc(BG_1004) = baliseLoc(BG_1026) + 200
824 baliseLoc(BG_1006) = distance(C_BE_BF) - BALISE_OFFSET
825 baliseLoc(BG_996) = distance(C_BF_BG) - BALISE_OFFSET
826 baliseLoc(BG_1008) = distance(C_BJ_BK) - BALISE_OFFSET
827 baliseLoc(BG_1010) = distance(C_BK_BL) - BALISE_OFFSET
828 baliseLoc(BG_1012) = distance(C_BL_BM) - BALISE_OFFSET
829 baliseLoc(BG_1014) = distance(C_BM_0534) - BALISE_OFFSET
830 baliseLoc(BG_1028) = distance(C_0534_0535) - BALISE_OFFSET
831 baliseLoc(BG_1020) = distance(C_0535_0541) - BALISE_OFFSET
832 baliseLoc(BG_1018) = distance(C_0541_0542) - 350
833 baliseLoc(BG_1022) = baliseLoc(BG_1018) + 200
834 baliseLoc(BG_1016) = distance(C_0543_0544) - BALISE_OFFSET
835 baliseLoc(BG_1024) = distance(C_BG_RD) - BALISE_OFFSET
836
837 baliseConnector(BG_LU) = C_BG_LU
838 baliseConnector(BG_LD) = C_BG_LD
839 baliseConnector(BG_RU) = C_BG_RU
840 baliseConnector(BG_RD) = C_BG_RD
841 baliseConnector(BG_1000) = C_BG_1000
842 baliseConnector(BG_1025) = C_BG_1025
843 baliseConnector(BG_1001) = C_BG_1001
844 baliseConnector(BG_1023) = C_BG_1023
845 baliseConnector(BG_1027) = C_BG_1027
846 baliseConnector(BG_1031) = C_BG_1031
847 baliseConnector(BG_1009) = C_BG_1009
848 baliseConnector(BG_1011) = C_BG_1011
849 baliseConnector(BG_1017) = C_BG_1017
850 baliseConnector(BG_1015) = C_BG_1015
851 baliseConnector(BG_1013) = C_BG_1013
852 baliseConnector(BG_1019) = C_BG_1019
853 baliseConnector(BG_1033) = C_BG_1033
854 baliseConnector(BG_1021) = C_BG_1021
855 baliseConnector(BG_1029) = C_BG_1029
856 baliseConnector(BG_1003) = C_BG_1003
857 baliseConnector(BG_1005) = C_BG_1005
858 baliseConnector(BG_1030) = C_BG_1030
859 baliseConnector(BG_1032) = C_BG_1032

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860 baliseConnector(BG_998) = C_BG_998
861 baliseConnector(BG_1002) = C_BG_1002
862 baliseConnector(BG_1026) = C_BG_1026
863 baliseConnector(BG_1004) = C_BG_1004
864 baliseConnector(BG_1006) = C_BG_1006
865 baliseConnector(BG_996) = C_BG_996
866 baliseConnector(BG_1008) = C_BG_1008
867 baliseConnector(BG_1010) = C_BG_1010
868 baliseConnector(BG_1012) = C_BG_1012
869 baliseConnector(BG_1014) = C_BG_1014
870 baliseConnector(BG_1028) = C_BG_1028
871 baliseConnector(BG_1020) = C_BG_1020
872 baliseConnector(BG_1018) = C_BG_1018
873 baliseConnector(BG_1022) = C_BG_1022
874 baliseConnector(BG_1016) = C_BG_1016
875 baliseConnector(BG_1024) = C_BG_1024
876
877 connectorBalise(C_BG_LU) = BG_LU
878 connectorBalise(C_BG_LD) = BG_LD
879 connectorBalise(C_BG_RU) = BG_RU
880 connectorBalise(C_BG_RD) = BG_RD
881 connectorBalise(C_BG_1000) = BG_1000
882 connectorBalise(C_BG_1025) = BG_1025
883 connectorBalise(C_BG_1001) = BG_1001
884 connectorBalise(C_BG_1023) = BG_1023
885 connectorBalise(C_BG_1027) = BG_1027
886 connectorBalise(C_BG_1031) = BG_1031
887 connectorBalise(C_BG_1009) = BG_1009
888 connectorBalise(C_BG_1011) = BG_1011
889 connectorBalise(C_BG_1017) = BG_1017
890 connectorBalise(C_BG_1015) = BG_1015
891 connectorBalise(C_BG_1013) = BG_1013
892 connectorBalise(C_BG_1019) = BG_1019
893 connectorBalise(C_BG_1033) = BG_1033
894 connectorBalise(C_BG_1021) = BG_1021
895 connectorBalise(C_BG_1029) = BG_1029
896 connectorBalise(C_BG_1003) = BG_1003
897 connectorBalise(C_BG_1005) = BG_1005
898 connectorBalise(C_BG_1030) = BG_1030
899 connectorBalise(C_BG_1032) = BG_1032
900 connectorBalise(C_BG_998) = BG_998
901 connectorBalise(C_BG_1002) = BG_1002
902 connectorBalise(C_BG_1026) = BG_1026
903 connectorBalise(C_BG_1004) = BG_1004
904 connectorBalise(C_BG_1006) = BG_1006
905 connectorBalise(C_BG_996) = BG_996
906 connectorBalise(C_BG_1008) = BG_1008
907 connectorBalise(C_BG_1010) = BG_1010
908 connectorBalise(C_BG_1012) = BG_1012
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909 connectorBalise(C_BG_1014) = BG_1014
910 connectorBalise(C_BG_1028) = BG_1028
911 connectorBalise(C_BG_1020) = BG_1020
912 connectorBalise(C_BG_1018) = BG_1018
913 connectorBalise(C_BG_1022) = BG_1022
914 connectorBalise(C_BG_1016) = BG_1016
915 connectorBalise(C_BG_1024) = BG_1024
916
917 baliseMb(BG_1000) = MB_DBM001
918 baliseMb(BG_1025) = MB_DBM002
919 baliseMb(BG_1003) = MB_DBM003
920 baliseMb(BG_1032) = MB_DBM004
921 baliseMb(BG_998) = MB_DBM005
922 baliseMb(BG_1001) = MB_5001
923 baliseMb(BG_1026) = MB_5002
924 baliseMb(BG_998) = MB_5003
925 baliseMb(BG_1031) = MB_5004
926 baliseMb(BG_1009) = MB_5005
927 baliseMb(BG_1006) = MB_5006
928 baliseMb(BG_1004) = MB_5007
929 baliseMb(BG_1011) = MB_5008
930 baliseMb(BG_1011) = MB_5009
931 baliseMb(BG_1008) = MB_5010
932 baliseMb(BG_1006) = MB_5011
933 baliseMb(BG_1015) = MB_5012
934 baliseMb(BG_1017) = MB_5013
935 baliseMb(BG_1010) = MB_5014
936 baliseMb(BG_996) = MB_5015
937 baliseMb(BG_1013) = MB_5016
938 baliseMb(BG_1013) = MB_5017
939 baliseMb(BG_1012) = MB_5018
940 baliseMb(BG_1010) = MB_5019
941 baliseMb(BG_1019) = MB_5020
942 baliseMb(BG_1012) = MB_5021
943 baliseMb(BG_LU) = MB_LU
944 baliseMb(BG_LD) = MB_LD
945 baliseMb(BG_RU) = MB_RU
946 baliseMb(BG_RD) = MB_RD
947
948 nextBalise(BG_LU) = BG_1000
949 nextBalise(BG_1000) = BG_1025
950 nextBalise(BG_1025) = BG_1001
951 nextBalise(BG_1001) = BG_1023
952 nextBalise(BG_1023) = BG_1027
953 nextBalise(BG_1027) = BG_1031
954 nextBalise(BG_1031) = BG_1009
955 nextBalise(BG_1009) = BG_1011
956 nextBalise(BG_1011) = BG_1017
957 nextBalise(BG_1017) = BG_1015
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958 nextBalise(BG_1015) = BG_1013
959 nextBalise(BG_1013) = BG_1019
960 nextBalise(BG_1019) = BG_1033
961 nextBalise(BG_1033) = BG_1021
962 nextBalise(BG_1021) = BG_1029
963 nextBalise(BG_1029) = BG_1003
964 nextBalise(BG_1003) = BG_1005
965 nextBalise(BG_1005) = BG_RU
966 nextBalise(BG_RU) = BG_RU
967 nextBalise(BG_LD) = BG_1030
968 nextBalise(BG_1030) = BG_1032
969 nextBalise(BG_1032) = BG_998
970 nextBalise(BG_998) = BG_1002
971 nextBalise(BG_1002) = BG_1026
972 nextBalise(BG_1026) = BG_1004
973 nextBalise(BG_1004) = BG_1006
974 nextBalise(BG_1006) = BG_996
975 nextBalise(BG_996) = BG_1008
976 nextBalise(BG_1008) = BG_1010
977 nextBalise(BG_1010) = BG_1012
978 nextBalise(BG_1012) = BG_1014
979 nextBalise(BG_1014) = BG_1028
980 nextBalise(BG_1028) = BG_1020
981 nextBalise(BG_1020) = BG_1018
982 nextBalise(BG_1018) = BG_1022
983 nextBalise(BG_1022) = BG_1016
984 nextBalise(BG_1016) = BG_1024
985 nextBalise(BG_1024) = BG_RD
986 nextBalise(BG_RD) = BG_RD
987
988 endOfRoute(ROUTE_DBM001) = MB_5001
989 endOfRoute(ROUTE_DBM002) = MB_LU
990 endOfRoute(ROUTE_DBM003) = MB_RU
991 endOfRoute(ROUTE_DBM004) = MB_5003
992 endOfRoute(ROUTE_DBM005) = MB_LD
993 endOfRoute(ROUTE_5001_U) = MB_5005
994 endOfRoute(ROUTE_5001_D) = MB_5007
995 endOfRoute(ROUTE_5002_U) = MB_DBM002
996 endOfRoute(ROUTE_5002_D) = MB_DBM005
997 endOfRoute(ROUTE_5003_U) = MB_5005
998 endOfRoute(ROUTE_5003_D) = MB_5007
999 endOfRoute(ROUTE_5004_U) = MB_DBM002
1000 endOfRoute(ROUTE_5004_D) = MB_DBM005
1001 endOfRoute(ROUTE_5005) = MB_5009
1002 endOfRoute(ROUTE_5006) = MB_5002
1003 endOfRoute(ROUTE_5007) = MB_5011
1004 endOfRoute(ROUTE_5008) = MB_5004
1005 endOfRoute(ROUTE_5009) = MB_5013
1006 endOfRoute(ROUTE_5010) = MB_5006

```

```

1007 endOfRoute(ROUTE_5011) = MB_5015
1008 endOfRoute(ROUTE_5012) = MB_5008
1009 endOfRoute(ROUTE_5013) = MB_5017
1010 endOfRoute(ROUTE_5014) = MB_5010
1011 endOfRoute(ROUTE_5015) = MB_5019
1012 endOfRoute(ROUTE_5016) = MB_5012
1013 endOfRoute(ROUTE_5017) = MB_DBM003
1014 endOfRoute(ROUTE_5018) = MB_5014
1015 endOfRoute(ROUTE_5019) = MB_5021
1016 endOfRoute(ROUTE_5020) = MB_5016
1017 endOfRoute(ROUTE_5021_U) = MB_DBM003
1018 endOfRoute(ROUTE_5021_D) = MB_RD
1019 endOfRoute(ROUTE_EntryLU) = MB_DBM001
1020 endOfRoute(ROUTE_EntryLD) = MB_DBM004
1021 endOfRoute(ROUTE_EntryRU_U) = MB_5020
1022 endOfRoute(ROUTE_EntryRU_D) = MB_5018
1023 endOfRoute(ROUTE_EntryRD) = MB_5018
1024
1025 nextRoute(ROUTE_DBM001) = {ROUTE_5001_U,ROUTE_5001_D}
1026 nextRoute(ROUTE_DBM002) = {ROUTE_null}
1027 nextRoute(ROUTE_DBM003) = {ROUTE_null}
1028 nextRoute(ROUTE_DBM004) = {ROUTE_5003_U,ROUTE_5003_D}
1029 nextRoute(ROUTE_DBM005) = {ROUTE_null}
1030 nextRoute(ROUTE_5001_U) = {ROUTE_5005}
1031 nextRoute(ROUTE_5001_D) = {ROUTE_5007}
1032 nextRoute(ROUTE_5002_U) = {ROUTE_DBM002}
1033 nextRoute(ROUTE_5002_D) = {ROUTE_DBM005}
1034 nextRoute(ROUTE_5003_U) = {ROUTE_5005}
1035 nextRoute(ROUTE_5003_D) = {ROUTE_5007}
1036 nextRoute(ROUTE_5004_U) = {ROUTE_DBM002}
1037 nextRoute(ROUTE_5004_D) = {ROUTE_DBM005}
1038 nextRoute(ROUTE_5005) = {ROUTE_5009}
1039 nextRoute(ROUTE_5006) = {ROUTE_5002_U,ROUTE_5002_D}
1040 nextRoute(ROUTE_5007) = {ROUTE_5011}
1041 nextRoute(ROUTE_5008) = {ROUTE_5004_U,ROUTE_5004_D}
1042 nextRoute(ROUTE_5009) = {ROUTE_5013}
1043 nextRoute(ROUTE_5010) = {ROUTE_5006}
1044 nextRoute(ROUTE_5011) = {ROUTE_5015}
1045 nextRoute(ROUTE_5012) = {ROUTE_5008}
1046 nextRoute(ROUTE_5013) = {ROUTE_5017}
1047 nextRoute(ROUTE_5014) = {ROUTE_5010}
1048 nextRoute(ROUTE_5015) = {ROUTE_5019}
1049 nextRoute(ROUTE_5016) = {ROUTE_5012}
1050 nextRoute(ROUTE_5017) = {ROUTE_DBM003}
1051 nextRoute(ROUTE_5018) = {ROUTE_5014}
1052 nextRoute(ROUTE_5019) = {ROUTE_5021_U,ROUTE_5021_D}
1053 nextRoute(ROUTE_5020) = {ROUTE_5016}
1054 nextRoute(ROUTE_5021_U) = {ROUTE_DBM003}
1055 nextRoute(ROUTE_5021_D) = {ROUTE_null}

```



```

1056 nextRoute(ROUTE_EntryLU) = {ROUTE_DBM001}
1057 nextRoute(ROUTE_EntryLD) = {ROUTE_DBM004}
1058 nextRoute(ROUTE_EntryRU_U) = {ROUTE_5020}
1059 nextRoute(ROUTE_EntryRU_D) = {ROUTE_5018}
1060 nextRoute(ROUTE_EntryRD) = {ROUTE_5018}
1061 nextRoute(ROUTE_null) = {ROUTE_null}
1062
1063 lastRoute(ROUTE_DBM001) = {ROUTE_EntryLU}
1064 lastRoute(ROUTE_DBM002) = {ROUTE_5002_U,ROUTE_5004_U}
1065 lastRoute(ROUTE_DBM003) = {ROUTE_5017,ROUTE_5021_U}
1066 lastRoute(ROUTE_DBM004) = {ROUTE_EntryLD}
1067 lastRoute(ROUTE_DBM005) = {ROUTE_5002_D,ROUTE_5004_D}
1068 lastRoute(ROUTE_5001_U) = {ROUTE_DBM001}
1069 lastRoute(ROUTE_5001_D) = {ROUTE_DBM001}
1070 lastRoute(ROUTE_5002_U) = {ROUTE_5006}
1071 lastRoute(ROUTE_5002_D) = {ROUTE_5006}
1072 lastRoute(ROUTE_5003_U) = {ROUTE_DBM004}
1073 lastRoute(ROUTE_5003_D) = {ROUTE_DBM004}
1074 lastRoute(ROUTE_5004_U) = {ROUTE_5008}
1075 lastRoute(ROUTE_5004_D) = {ROUTE_5008}
1076 lastRoute(ROUTE_5005) = {ROUTE_5001_U,ROUTE_5003_U}
1077 lastRoute(ROUTE_5006) = {ROUTE_5010}
1078 lastRoute(ROUTE_5007) = {ROUTE_5001_D,ROUTE_5003_D}
1079 lastRoute(ROUTE_5008) = {ROUTE_5012}
1080 lastRoute(ROUTE_5009) = {ROUTE_5005}
1081 lastRoute(ROUTE_5010) = {ROUTE_5014}
1082 lastRoute(ROUTE_5011) = {ROUTE_5007}
1083 lastRoute(ROUTE_5012) = {ROUTE_5016}
1084 lastRoute(ROUTE_5013) = {ROUTE_5009}
1085 lastRoute(ROUTE_5014) = {ROUTE_5018}
1086 lastRoute(ROUTE_5015) = {ROUTE_5011}
1087 lastRoute(ROUTE_5016) = {ROUTE_5020}
1088 lastRoute(ROUTE_5017) = {ROUTE_5013}
1089 lastRoute(ROUTE_5018) = {ROUTE_EntryRU_D,ROUTE_EntryRD}
1090 lastRoute(ROUTE_5019) = {ROUTE_5015}
1091 lastRoute(ROUTE_5020) = {ROUTE_EntryRU_U}
1092 lastRoute(ROUTE_5021_U) = {ROUTE_5019}
1093 lastRoute(ROUTE_5021_D) = {ROUTE_5019}
1094 lastRoute(ROUTE_EntryLU) = {ROUTE_null}
1095 lastRoute(ROUTE_EntryLD) = {ROUTE_null}
1096 lastRoute(ROUTE_EntryRU_U) = {ROUTE_null}
1097 lastRoute(ROUTE_EntryRU_D) = {ROUTE_null}
1098 lastRoute(ROUTE_EntryRD) = {ROUTE_null}
1099 lastRoute(ROUTE_null) = {ROUTE_null}
1100
1101 RoutesWithSuccessors = {ROUTE_DBM001, ROUTE_DBM004, ROUTE_5001_U,
    ROUTE_5001_D, ROUTE_5002_U, ROUTE_5002_D, ROUTE_5003_U,
    ROUTE_5003_D, ROUTE_5004_U, ROUTE_5004_D, ROUTE_5005,
    ROUTE_5006, ROUTE_5007, ROUTE_5008, ROUTE_5009, ROUTE_5010,

```

```
ROUTE_5011, ROUTE_5012, ROUTE_5013, ROUTE_5014, ROUTE_5015,
ROUTE_5016, ROUTE_5017, ROUTE_5018, ROUTE_5019, ROUTE_5020,
ROUTE_5021_U, ROUTE_EntryLU, ROUTE_EntryLD, ROUTE_EntryRU_U,
ROUTE_EntryRU_D, ROUTE_EntryRD}
1102
1103 BottomRoutes = {ROUTE_DBM004, ROUTE_DBM005, ROUTE_5001_D,
ROUTE_5002_D, ROUTE_5003_D, ROUTE_5004_D, ROUTE_5006,
ROUTE_5007, ROUTE_5010, ROUTE_5011, ROUTE_5014, ROUTE_5015,
ROUTE_5018, ROUTE_5019, ROUTE_5021_D, ROUTE_EntryLD,
ROUTE_EntryRU_D, ROUTE_EntryRD}
1104 TopRoutes = {ROUTE_DBM001, ROUTE_DBM002, ROUTE_DBM003,
ROUTE_5001_U, ROUTE_5002_U, ROUTE_5003_U, ROUTE_5004_U,
ROUTE_5005, ROUTE_5008, ROUTE_5009, ROUTE_5012, ROUTE_5013,
ROUTE_5016, ROUTE_5017, ROUTE_5020, ROUTE_5021_U,
ROUTE_EntryLU, ROUTE_EntryRU_U}
1105
1106 BottomTracks = {T_VTC002, T_ZBBA, T_ZBBB, T_ZBBC, T_ZBBD, T_ZBBE,
T_ZBBF, T_ZBBG, T_ZBBH, T_ZBBJ, T_ZBBK, T_ZBBL, T_ZBBM,
T_0534, T_0535, T_0541, T_0542, T_0543, T_0544}
1107 TopTracks = {T_VTC001, T_ZAAA, T_ZAAB, T_ZAAC, T_ZAAD, T_ZAAE,
T_ZAAF, T_ZAAG, T_ZAAH, T_ZAAJ, T_ZAAK, T_ZAAL, T_0832, T_0833,
T_0834, T_0835, T_08411, T_08412, T_0842, T_0843}
1108
1109 directionPosMin(dRight) = 1
1110 directionPosMin(dLeft) = -1
1111
1112
1113 baliseType(BG_LU,RIGHT) = true
1114 baliseType(BG_1000,RIGHT) = true
1115 baliseType(BG_1001,RIGHT) = true
1116 baliseType(BG_1009,RIGHT) = true
1117 baliseType(BG_1011,RIGHT) = true
1118 baliseType(BG_1017,RIGHT) = true
1119 baliseType(BG_1013,RIGHT) = true
1120 baliseType(BG_1003,RIGHT) = true
1121 baliseType(BG_RU,LEFT) = true
1122 baliseType(BG_1033,LEFT) = true
1123 baliseType(BG_1013,LEFT) = true
1124 baliseType(BG_1015,LEFT) = true
1125 baliseType(BG_1011,LEFT) = true
1126 baliseType(BG_1009,LEFT) = true
1127 baliseType(BG_1023,LEFT) = true
1128
1129 baliseType(BG_LD,RIGHT) = true
1130 baliseType(BG_1032,RIGHT) = true
1131 baliseType(BG_998,RIGHT) = true
1132 baliseType(BG_1004,RIGHT) = true
1133 baliseType(BG_1006,RIGHT) = true
1134 baliseType(BG_996,RIGHT) = true
```

```

1135 baliseType(BG_1010,RIGHT) = true
1136 baliseType(BG_1012,RIGHT) = true
1137 baliseType(BG_RD,LEFT) = true
1138 baliseType(BG_1018,LEFT) = true
1139 baliseType(BG_1012,LEFT) = true
1140 baliseType(BG_1010,LEFT) = true
1141 baliseType(BG_1008,LEFT) = true
1142 baliseType(BG_1006,LEFT) = true
1143 baliseType(BG_1026,LEFT) = true
1144 baliseType(BG_998,LEFT) = true
1145
1146 baliseType(,_) = false
1147
1148 connectorRoutePoints(C_AB_BC) = REVERSE
1149 connectorRoutePoints(C_BB_AC) = REVERSE
1150 connectorRoutePoints(C_0535_0834) = REVERSE
1151 connectorRoutePoints(_) = NORMAL
1152
1153 balConDis(line) =
1154     if (line == lower)
1155         then lowerBaliseConnectorDistances
1156     else upperBaliseConnectorDistances

```

The CSP Operations file

```

1 include "Topology.csp"
2
3 nametype Direction = (Connector, Connector)
4 nametype Move = (Unit, Direction)
5 datatype TrainLevel = NTC | L2
6 datatype Orientation = LEFT | RIGHT
7
8 setHead(x) =
9     if empty(x)
10        then {}
11     else
12        {head(seq(x))}
13
14 unwrap({x}) =
15     if card({x}) > 1
16        then unwrap(setHead({x}))
17     else x
18
19 first((x,y)) = x
20 second((x,y)) = y
21
22 isPath((u1, d1), (u2, d2)) =
23     (second(d1) == first(d2))
24     and (u1 != u2)

```

```

25         and member(d1, directions(u1))
26         and member(d2, directions(u2))
27
28 successor(move) = {move' | move' <- Move, isPath(move, move')}
29 predecessor(move) = {move' | move' <- Move, isPath(move', move)}
30
31 getDirFromMove(u, (c1,c2)) = (c1,c2)
32
33 isValidMove((unit, dir)) = member(dir, directions(unit))
34
35 next(move) = unwrap(successor(move))
36 prev(move) = unwrap(predecessor(move))
37
38 unit(direction) = unwrap({ unit | unit <- Unit, isValidMove( (
    unit, direction) ) })
39 succOfDir(dir) = successor( (unit(dir), dir) )
40
41 EntryMoves = { move | move <- Move, isValidMove(move), empty(
    predecessor(move)) }
42 ExitMoves = { move | move <- Move, isValidMove(move), empty(
    successor(move)) }
43
44 abs(x) = if (x < 0) then -x else x
45
46 baliseDiff(x, y) = abs(baliseLoc(x) - baliseLoc(y))
47
48 distConvert(dist, oldBalise, newBalise) = dist - baliseDiff(
    oldBalise, newBalise)
49
50 baliseToNext(balise) = baliseDiff(balise, nextBalise(balise))
51
52 baliseToMb(balise, mb) = abs(mbLocation(mb) - baliseLoc(balise))
53
54 locToNextBalise(curBalise, locDist) = baliseToNext(curBalise) -
    locDist
55
56 isBeyondNextbalise(curBalise, locDist) = locDist >= baliseToNext(
    curBalise)
57
58 connectorDiff(c1, c2) = abs(distance(c1) - distance(c2))
59
60 unitLeftOf(connector) = first(unitsNextTo(connector))
61
62 unitRightOf(connector) = second(unitsNextTo(connector))
63
64 connectorsAt(dist,line) = {x | x <- connectorsOnLine(line),
    distance(x) == dist}
65
66 connectorAt(dist, line, curTrack) =

```

```

67     if (line == upper)
68         then unwrap({x | x <- upperConnectors, distance(x) ==
           dist})
69     else if (line == lower)
70         then unwrap({x | x <- lowerConnectors, distance(x) ==
           dist})
71     else
72         if member(curTrack, UpperTracks)
73             then unwrap(setHead({x | x <- pointConnectors,
              distance(x) == dist}))
74         else if (card({x | x <- pointConnectors, distance(x) ==
              dist}) > 1)
75             then unwrap(diff(({x | x <- pointConnectors,
              distance(x) == dist}), setHead({x | x <-
              pointConnectors, distance(x) == dist})))
76         else unwrap({x | x <- pointConnectors, distance(x)
              == dist})
77
78 unitsLeftOf(dist, line) = {unitLeftOf(con) | con <- connectorsAt(
           dist, line)}
79
80 unitsRightOf(dist, line) = {unitRightOf(con) | con <- connectorsAt
           (dist, line)}
81
82 connectorsRightOf(dist, line) =
83     let curUnits = unitsRightOf(dist, line)
84         newDistances = { dist + unitLen(u) | u <- curUnits }
85     within Union({ connectorsAt(newDist, line) | newDist <-
           newDistances })
86
87 connectorsLeftOf(dist, line) =
88     let curUnits = unitsLeftOf(dist, line)
89         newDistances = { dist - unitLen(u) | u <- curUnits}
90     within Union({ connectorsAt(newDist, line) | newDist <-
           newDistances })
91
92
93 posDirectionCheck(dir, pos) =
94     if (dir == RIGHT)
95         then pos+1
96     else pos-1
97
98 connectorDirectionCheck(dir, pos, line) =
99     if (dir == RIGHT)
100         then connectorPointsCheck(connectorsRightOf(pos-1, line),
           line)
101     else connectorPointsCheck(connectorsLeftOf(pos+1, line), line)
102
103 connectorPointsCheck(conns, line) =

```

```

104     if (line == upper)
105         then {x | x <- inter(conns, upperConnectors)}
106     else if (line == lower)
107         then {x | x <- inter(conns, lowerConnectors)}
108     else {x | x <- inter(conns, pointConnectors)}
109
110
111
112 oldDirectionCheck(dir, pos, line, curTrack) =
113     if (dir == RIGHT)
114         then unitLeftOf(connectorAt(pos, line, curTrack))
115     else unitRightOf(connectorAt(pos, line, curTrack))
116
117 newDirectionCheck(dir, pos, line, curTrack) =
118     if (dir == RIGHT)
119         then unitRightOf(connectorAt(pos, line, curTrack))
120     else unitLeftOf(connectorAt(pos, line, curTrack))
121
122 directionConvert(dir) =
123     if (dir == RIGHT)
124         then dRight
125     else dLeft
126
127 connectorDecision(dir, pos, line, con, curTrack) =
128     if (card(connectorDirectionCheck(dir, pos, line)) > 0)
129         then connectorAt(distance(unwrap(setHead(
130             connectorDirectionCheck(dir, pos, line))), line,
131             curTrack))
132     else con
133
134 baliseDirectionValid(balDir, dir) =
135     if ((balDir == bidirectional) or ((balDir == rightwards) and
136         (dir == dRight)) or ((balDir == leftwards) and (dir ==
137         dLeft)))
138         then true
139     else false
140
141 LineCheck(trackPos, con) =
142     if member(trackPos, PointTrack)
143         then if (connectorRoutePoints(con) == REVERSE)
144             then pointCon
145             else LineCheck2(trackPos)
146     else LineCheck2(trackPos)
147
148 LineCheck2(trackPos) =
149     if member(trackPos, TopTracks)
150         then upper
151     else lower

```

The CSP Control file

```
1
2 include "Operations.csp"
3
4 channel train_NextAction: TRAIN.Connector.Int
5 channel train_to_ixl_TrackChange: TRAIN.WholeTrack.WholeTrack.
  trackConnectors
6 channel train_PassedBalise: TRAIN.Balise
7 channel train_AtEoA: TRAIN
8 channel train_to_ixl_Enter: TRAIN.ENTRY.ANSWERS
9 channel train_to_ixl_Exit: TRAIN.EXIT
10 channel train_to_rbc_MAResult : TRAIN.Balise.DIRECTION
11 channel rbc_to_train_MAGrant : routeMaDistances
12 channel rbc_to_ixl_RequestToProceed : Route.ANSWERS
13 channel rbc_to_ixl_Request : Route.ANSWERS
14 channel rbc_to_ixl_Release : Route.ANSWERS
15 channel ixl_to_rbc_GrantRoute : Route.ANSWERS
16 channel rbc_to_ixl_ClearRoute : Route
17 channel rbc_to_train_RequestAccepted : ANSWERS
18 channel collision
19 channel exceededEOA : TRAIN
20 channel TrainEntryDetails : TRAIN.Unit
21
22 ERR = collision -> ERR
23
24 RBC(aRoutes) =
25     (train_to_rbc_MAResult?TrainID?lrbg?direction
26     -> RBC1(aRoutes,nextRoutes(distance(baliseConnector(
27         lrbg)),lrbg,direction)))
28     []
29     ([[] rt : Route @ rbc_to_ixl_Request!rt?ans
30     -> if (ans == yes)
31         then (RBC(union(aRoutes, {rt})))
32         else RBC(aRoutes))
33     []
34     ([[] rt : aRoutes @ rbc_to_ixl_Release!rt?ans
35     -> if (ans == yes)
36         then (RBC(diff(aRoutes, {rt})))
37         else RBC(aRoutes))
38 RBC1(aRoutes, nRoutes) =
39     (if (empty(inter(aRoutes, nRoutes)) == false)
40     then (rbc_to_ixl_RequestToProceed!unwrap(setHead(
41         inter(aRoutes, nRoutes))))?ans
42     -> if (ans == yes)
43         then (rbc_to_train_RequestAccepted!ans
44             -> RBC2(diff(aRoutes, setHead(inter(
45                 aRoutes, nRoutes))),unwrap(setHead(
```

```

44         inter(aRoutes,nRoutes))))))
45         else RBC1(aRoutes,nRoutes))
46     else (rbc_to_train_RequestAccepted!no -> RBC(aRoutes)))
47 []
48     ([[] rt : Route @ rbc_to_ixl_Request!rt?ans
49      -> if (ans == yes)
50         then (RBC1(union(aRoutes, {rt}),nRoutes))
51         else RBC1(aRoutes,nRoutes))
52 []
53     ([[] rt : aRoutes @ rbc_to_ixl_Release!rt?ans
54      -> if (ans == yes)
55         then (RBC1(diff(aRoutes, {rt}),nRoutes))
56         else RBC1(aRoutes,nRoutes))
57 RBC2(aRoutes,new_route) =
58     (ixl_to_rbc_GrantRoute.new_route?ans
59      -> rbc_to_ixl_ClearRoute!unwrap(setHead(lastRoute(
60         new_route)))
61      -> rbc_to_train_MAGrant.RouteMA(new_route)
62      -> RBC(diff(aRoutes,{new_route})))
63 []
64     ([[] rt : Route @ rbc_to_ixl_Request!rt?ans
65      -> if (ans == yes)
66         then (RBC2(union(aRoutes, {rt}),new_route))
67         else RBC2(aRoutes,new_route))
68 []
69     ([[] rt : aRoutes @ rbc_to_ixl_Release!rt?ans
70      -> if (ans == yes)
71         then (RBC2(diff(aRoutes, {rt}),new_route))
72         else RBC2(aRoutes,new_route))
73 UnifiedTrain(train, orientation, pos, eoaDist, lrbg, curTrack,
74 targetConnector) =
75     (let currentLine = LineCheck(curTrack, targetConnector)
76      within (
77         if (pos == eoaDist)
78             then (train_AtEoA.train
79                  -> train_to_ixl_Exit!train!baliseTrack(
80                     uPreceding(targetConnector))
81                  -> STOP)
82             else (if ((orientation == RIGHT ) and (pos > eoaDist)
83                    ) or ((orientation == LEFT ) and (pos < eoaDist))
84                    then exceededEOA.train
85                    -> STOP
86                 else (
87                     if (member(pos, balConDis(currentLine)))
88                         then (let conBal = connectorBalise(

```



```

connectorAt(pos, currentLine, curTrack)
)
88   within (
89       train_PassedBalise.train.conBal
90       -> if ((baliseType(conBal,
                orientation)) and
                baliseDirectionValid(
                baliseDirectionCheck(conBal),
                directionConvert(orientation))
                )
91       then (train_to_rbc_MARequest!
                train!conBal!
                directionConvert(orientation
                )
92       -> rbc_to_train_RequestAccepted
                ?ans
93       -> if(ans == yes)
94           then (
                rbc_to_train_MAGrant?
                new_MA
95           -> UnifiedTrain(train
                , orientation,
                posDirectionCheck(
                orientation, pos),
                new_MA, conBal,
                curTrack,
                targetConnector))
96           else (UnifiedTrain(train,
                orientation, pos,
                eoaDist, lrbg,
                curTrack,
                targetConnector))
97       else UnifiedTrain(train,
                orientation,
                posDirectionCheck(
                orientation, pos), eoaDist,
                conBal, curTrack,
                targetConnector)
98   )
99   ) else if (member(pos, ConnectorDistances
100   ))
101   then (
102       let oldUnit = oldDirectionCheck(
                orientation, pos, currentLine,
                curTrack)
102       newUnit = newDirectionCheck(
                orientation, pos,
                currentLine, curTrack)
103       within (

```

```

104         if (newUnit == T_null)
105             then STOP
106         else
107             train_to_ixl_TrackChange
108                 !train!baliseTrack(
109                     oldUnit)?newpos?con
110                 -> UnifiedTrain(train,
111                     orientation,
112                     posDirectionCheck(
113                         orientation, pos),
114                     eoaDist, lrbg,
115                     newpos, con)
116             )
117         else(
118             let con = connectorDecision(
119                 orientation, pos, currentLine,
120                 targetConnector, curTrack)
121             within (train_NextAction.train.
122                 con.distance(con)
123                 -> UnifiedTrain(train,
124                     orientation, distance(con)
125                     , eoaDist, lrbg, curTrack,
126                     targetConnector))
127             )
128         )
129     )
130 )
131
132 EntryRequest(t_id, entry_track) =
133     TrainEntryDetails.t_id.entry_track ->
134     if (entry_track == T_VTC001)
135         then rbc_to_ixl_Request!ROUTE_EntryLU?ans
136             -> TrainEntry(t_id, entry_track)
137     else if (entry_track == T_VTC002)
138         then rbc_to_ixl_Request!ROUTE_EntryLD?ans
139             -> TrainEntry(t_id, entry_track)
140     else if (entry_track == T_0843)
141         then rbc_to_ixl_Request!ROUTE_EntryRU_U?ans
142             -> rbc_to_ixl_Request!ROUTE_EntryRU_D?ans
143             -> TrainEntry(t_id, entry_track)
144     else if (entry_track == T_0544)
145         then rbc_to_ixl_Request!ROUTE_EntryRD?ans
146             -> TrainEntry(t_id, entry_track)
147     else STOP
148
149 TrainEntry(t_id, entry_track) =
150     train_to_ixl_Enter!t_id!entry_track?ans -> (

```

```

140     if (ans == yes)
141         then (
142             if (entry_track == T_VTC001)
143                 then (UnifiedTrain(t_id,RIGHT,distance(C_BG_LU),
144                     distance(C_BG_LU)+1,BG_LU, T_VTC001, C_VTC1_AA
145                     ))
146             else if (entry_track == T_VTC002)
147                 then (UnifiedTrain(t_id,RIGHT,distance(C_BG_LD),
148                     distance(C_BG_LD)+1,BG_LD, T_VTC002, C_VTC2_BA
149                     ))
150             else if (entry_track == T_0843)
151                 then (UnifiedTrain(t_id,LEFT,distance(C_BG_RU),
152                     distance(C_BG_RU)-1,BG_RU, T_0843, C_0842_0843
153                     ))
154             else if (entry_track == T_0544)
155                 then (UnifiedTrain(t_id,LEFT,distance(C_BG_RD),
156                     distance(C_BG_RD)-1,BG_RD, T_0544, C_0543_0544
157                     ))
158             else STOP
159         )
160     else (
161         ([] et:ENTRY @ TrainEntry(t_id,et))
162     )
163 )
164
165 MAIN = ((ERR ||| RBC({ROUTE_EntryLU, ROUTE_EntryLD,
166     ROUTE_EntryRU_U, ROUTE_EntryRU_D, ROUTE_EntryRD}))
167     [|{|train_to_rbc_MARrequest, rbc_to_train_MAGrant,
168     rbc_to_train_RequestAccepted|}|]
169     (([] et:ENTRY @ EntryRequest(Train_1,et)) ||| ([] et:ENTRY @
170     EntryRequest(Train_2,et))))

```


Appendix B

RETS Scripts

In the following, the initialisation files for simulations on the RETS test rig are given.

The complete files can be viewed at: <https://rb.gy/hjvwh9>

Simple Single Train Movement

Simple.rss

```
1 00:00:01 StartJourney (6062544, "C:\RETS\SCRIPTS\Aled Test
   Scripts\1 - Single Train Run (Timed and Force Stop)\1 - Simple
   \Test1 (Upper).rjs", "RETS2", "Desiro City FLU", "Aggressive",
   "None", 0, true)
2
3
4 00:20:00 EndScenario
```

Simple.rjs

```
1 InitTrain ("S9003", 10, "NC", "Apply Brake")
2
3 OperateTrain
4
5 ChangeCommsStatus ("C","Valid")
```

Lower Train Runs Until Obstruction

LowerStop.rss

```
1 00:00:01 StartJourney (6062544, "C:\Users\Hylia\OneDrive\
   Documents\Uni\Siemens\Siemens July 2022\Test Scripts\1 -
   Single Train Run (Timed and Force Stop)\Simple\Test1 (Lower
   Stop)", "RETS2", "Desiro City FLU", "Aggressive", "None", 0,
   true)
```

B. RETS Scripts

```
2  
3  
4 00:20:00 EndScenario
```

LowerStop.rjs

```
1 InitTrain ("S9001", 10, "NC", "Apply Brake")  
2  
3 OperateTrain  
4  
5 ChangeCommsStatus ("C","Valid")  
6  
7 FailTC ("T0544", "Occupied")
```

Two Trains on a Single Track To simulate a fast train moving behind a slower train, track occupation has been simulated at specified locations where the leading train would be required to extend its movement authority. These tracks are only released when the trailing train reaches the point of its next movement authority request. This gives both trains a reason to slow to a potential stop.

TwoTrains.rss

```
1 00:00:01 StartJourney (6062544, "C:\RETS\SCRIPTS\Aled Test  
Scripts\3 - Two Trains Single Track\2 - MA\Test3 (Train1 MA).  
rjs", "RETS2", "Tiny Train", "Aggressive", "None", 0, true)  
2  
3 00:01:01 StartJourney (6062545, "C:\RETS\SCRIPTS\Aled Test  
Scripts\3 - Two Trains Single Track\2 - MA\Test3 (Train2 MA).  
rjs", "RETS2", "Tiny Train", "Aggressive", "None", 0, true)  
4  
5  
6 00:20:00 EndScenario
```

TwoTrains1.rjs

```
1 InitTrain ("S9003", 10, "NC", "Apply Brake")  
2  
3 OperateTrain  
4  
5 ChangeCommsStatus ("C","Valid")  
6  
7 FailTC ("TZBBC2", "Occupied")  
8 FailTC ("TZAAB", "Occupied")  
9  
10 SetTrackCctTrigger ("TZAAA", "Occupied", 0)  
11 FailTC ("TZAAB", "None")  
12 FailTC ("TZAAE", "Occupied")  
13  
14 SetTrackCctTrigger ("TZAAC", "Occupied", 0)  
15 FailTC ("TZBBC2", "None")
```

```

16
17 SetTrackCctTrigger ("TZAAD", "Occupied", 0)
18 FailTC ("TZAAE", "None")
19 FailTC ("TZAAF", "Occupied")
20
21 SetPoints("P2057A","Reverse")
22 SetPoints("P2057B","Reverse")
23 SetPoints("P2058A","Reverse")
24 SetPoints("P2058B","Reverse")
25
26
27 SetTrackCctTrigger ("TZAAE", "Occupied", 0)
28 FailTC ("TZAAF", "None")
29 FailTC ("TZAAJ", "Occupied")
30
31 SetTrackCctTrigger ("TZA AH", "Occupied", 0)
32 FailTC ("TZAAJ", "None")
33 FailTC ("TZAAL", "Occupied")
34
35 SetTrackCctTrigger ("TZA AK", "Occupied", 0)
36 FailTC ("TZAAL", "None")
37 FailTC ("T0843", "Occupied")

```

TwoTrains2.rjs

```

1 InitTrain ("S9003", 10, "NC", "Apply Brake")
2
3 OperateTrain
4
5 ChangeCommsStatus ("C","Valid")
6
7 FailTC ("TZBBC2", "Occupied")
8 FailTC ("TZAAB", "Occupied")
9
10 SetTrackCctTrigger ("TZAAA", "Occupied", 0)
11 FailTC ("TZAAB", "None")
12 FailTC ("TZAAE", "Occupied")
13
14 SetTrackCctTrigger ("TZAAC", "Occupied", 0)
15 FailTC ("TZBBC2", "None")
16
17 SetTrackCctTrigger ("TZAAD", "Occupied", 0)
18 FailTC ("TZAAE", "None")
19 FailTC ("TZAAF", "Occupied")
20
21 SetTrackCctTrigger ("TZAAE", "Occupied", 0)
22 Wait(Duration, 60)
23
24 FailTC ("TZAAF", "None")

```

B. RETS Scripts

```
25 FailTC ("TZAAJ", "Occupied")
26
27 SetTrackCctTrigger ("TZAAH", "Occupied", 0)
28 FailTC ("TZAAJ", "None")
29 FailTC ("TZAAL", "Occupied")
30
31 SetTrackCctTrigger ("TZAAK", "Occupied", 0)
32 FailTC ("TZAAL", "None")
33 FailTC ("T0843", "Occupied")
```


Appendix C

Simulation Traces

In the following, the full simulation traces from ProB are included.

The complete trace files can be viewed at: <https://rb.gy/r477qy>

ProB

Train Across Top Track (Initial Model)

```
1 start_cspm_MAIN
2 tau($setup_constants)
3 tau($initialise_machine)
4 rbc_to_ixl_Request(Route_EntryL)-->yes
5 train_to_ixl_Enter(Train_1,LL)-->yes
6 CSP:train_PassedBalise.Train_1.b_1
7 CSP:train_to_rbc_MARequest.Train_1.b_1.dRight
8 rbc_to_ixl_RequestToProceed(Route_EntryL)-->yes
9 CSP:rbc_to_train_RequestAccepted.yes
10 ixl_to_rbc_GrantRoute(Route_EntryL)-->yes
11 rbc_to_ixl_ClearRoute(Route_null)
12 CSP:rbc_to_train_MAGrant.-4600
13 CSP:train_NextAction.Train_1.bal_b1.-4950
14 CSP:train_PassedBalise.Train_1.b1
15 CSP:train_to_rbc_MARequest.Train_1.b1.dRight
16 rbc_to_ixl_Request(Route_1B)-->yes
17 rbc_to_ixl_RequestToProceed(Route_1B)-->yes
18 CSP:rbc_to_train_RequestAccepted.yes
19 ixl_to_rbc_GrantRoute(Route_1B)-->yes
20 rbc_to_ixl_ClearRoute(Route_EntryL)
21 CSP:rbc_to_train_MAGrant.-1550
22 CSP:train_NextAction.Train_1.a.-4550
23 train_to_ixl_TrackChange(Train_1,LL)-->AA,b
24 CSP:train_NextAction.Train_1.b.-3250
25 train_to_ixl_TrackChange(Train_1,AA)-->AB,h
```

```
26 CSP:train_NextAction.Train_1.h.-3000
27 train_to_ixl_TrackChange(Train_1,AB)-->BC,i
28 CSP:train_NextAction.Train_1.bal_b2.-2900
29 CSP:train_PassedBalise.Train_1.b2
30 CSP:train_to_rbc_MAResquest.Train_1.b2.dRight
31 rbc_to_ixl_Request(Route_2)-->yes
32 rbc_to_ixl_RequestToProceed(Route_2)-->yes
33 CSP:rbc_to_train_RequestAccepted.yes
34 ixl_to_rbc_GrantRoute(Route_2)-->yes
35 rbc_to_ixl_ClearRoute(Route_1B)
36 CSP:rbc_to_train_MAGrant.2200
37 CSP:train_NextAction.Train_1.i.-1500
38 train_to_ixl_TrackChange(Train_1,BC)-->BD,j
39 CSP:train_NextAction.Train_1.j.0
40 train_to_ixl_TrackChange(Train_1,BD)-->AE,f
41 CSP:train_NextAction.Train_1.f.250
42 train_to_ixl_TrackChange(Train_1,AE)-->AF,g
43 CSP:train_NextAction.Train_1.bal_b6.350
44 CSP:train_PassedBalise.Train_1.b6
45 CSP:train_to_rbc_MAResquest.Train_1.b6.dRight
46 rbc_to_ixl_Request(Route_ExitR2)-->yes
47 rbc_to_ixl_RequestToProceed(Route_ExitR2)-->yes
48 CSP:rbc_to_train_RequestAccepted.yes
49 ixl_to_rbc_GrantRoute(Route_ExitR2)-->yes
50 rbc_to_ixl_ClearRoute(Route_2)
51 CSP:rbc_to_train_MAGrant.2250
52 CSP:train_NextAction.Train_1.g.1750
53 train_to_ixl_TrackChange(Train_1,AF)-->RR,r
54 CSP:train_NextAction.Train_1.bal_b4.2150
55 CSP:train_PassedBalise.Train_1.b4
56 CSP:train_NextAction.Train_1.r.2250
57 CSP:train_AtEoA.Train_1
58 train_to_ixl_Exit(Train_1,RR)
```

Simple Single Train Movement

```
1 start_cspm_MAIN
2 tau($setup_constants)
3 tau($initialise_machine)
4 CSP:TrainEntryDetails.Train_1.T_VTC001
5 rbc_to_ixl_Request(ROUTE_EntryLU)-->yes
6 train_to_ixl_Enter(Train_1,T_VTC001)-->yes
7 CSP:train_PassedBalise.Train_1.BG_LU
8 CSP:train_to_rbc_MAResquest.Train_1.BG_LU.dRight
9 rbc_to_ixl_RequestToProceed(ROUTE_EntryLU)-->yes
10 CSP:rbc_to_train_RequestAccepted.yes
11 ixl_to_rbc_GrantRoute(ROUTE_EntryLU)-->yes
12 rbc_to_ixl_ClearRoute(ROUTE_null)
13 CSP:rbc_to_train_MAGrant.-50
```

```

14 CSP:train_NextAction.Train_1.C_BG_1000.-250
15 CSP:train_PassedBalise.Train_1.BG_1000
16 CSP:train_to_rbc_MAResult.Train_1.BG_1000.dRight
17 rbc_to_ixl_Request(ROUTE_DBM001)-->yes
18 rbc_to_ixl_RequestToProceed(ROUTE_DBM001)-->yes
19 CSP:rbc_to_train_RequestAccepted.yes
20 ixl_to_rbc_GrantRoute(ROUTE_DBM001)-->yes
21 rbc_to_ixl_ClearRoute(ROUTE_EntryLU)
22 CSP:rbc_to_train_MAGrant.450
23 CSP:train_NextAction.Train_1.C_VTC1_AA.0
24 train_to_ixl_TrackChange(Train_1,T_VTC001)-->T_ZAAA,C_AA_AB
25 CSP:train_NextAction.Train_1.C_BG_1025.150
26 CSP:train_PassedBalise.Train_1.BG_1025
27 CSP:train_NextAction.Train_1.C_BG_1001.350
28 CSP:train_PassedBalise.Train_1.BG_1001
29 CSP:train_to_rbc_MAResult.Train_1.BG_1001.dRight
30 rbc_to_ixl_Request(ROUTE_5001_U)-->yes
31 rbc_to_ixl_RequestToProceed(ROUTE_5001_U)-->yes
32 CSP:rbc_to_train_RequestAccepted.yes
33 ixl_to_rbc_GrantRoute(ROUTE_5001_U)-->yes
34 rbc_to_ixl_ClearRoute(ROUTE_DBM001)
35 CSP:rbc_to_train_MAGrant.1950
36 CSP:train_NextAction.Train_1.C_AA_AB.500
37 train_to_ixl_TrackChange(Train_1,T_ZAAA)-->T_ZAAB,C_AB_AC
38 CSP:train_NextAction.Train_1.C_BG_1023.750
39 CSP:train_PassedBalise.Train_1.BG_1023
40 CSP:train_NextAction.Train_1.C_AB_AC.1000
41 train_to_ixl_TrackChange(Train_1,T_ZAAB)-->T_ZAAC,C_AC_AD
42 CSP:train_NextAction.Train_1.C_BG_1027.1250
43 CSP:train_PassedBalise.Train_1.BG_1027
44 CSP:train_NextAction.Train_1.C_AC_AD.1500
45 train_to_ixl_TrackChange(Train_1,T_ZAAC)-->T_ZAAD,C_AD_AE
46 CSP:train_NextAction.Train_1.C_BG_1031.1650
47 CSP:train_PassedBalise.Train_1.BG_1031
48 CSP:train_NextAction.Train_1.C_BG_1009.1850
49 CSP:train_PassedBalise.Train_1.BG_1009
50 CSP:train_to_rbc_MAResult.Train_1.BG_1009.dRight
51 rbc_to_ixl_Request(ROUTE_5005)-->yes
52 rbc_to_ixl_RequestToProceed(ROUTE_5005)-->yes
53 CSP:rbc_to_train_RequestAccepted.yes
54 ixl_to_rbc_GrantRoute(ROUTE_5005)-->yes
55 rbc_to_ixl_ClearRoute(ROUTE_5001_U)
56 CSP:rbc_to_train_MAGrant.2450
57 CSP:train_NextAction.Train_1.C_AD_AE.2000
58 train_to_ixl_TrackChange(Train_1,T_ZAAD)-->T_ZAAE,C_AE_AF
59 CSP:train_NextAction.Train_1.C_BG_1011.2250
60 CSP:train_PassedBalise.Train_1.BG_1011
61 CSP:train_to_rbc_MAResult.Train_1.BG_1011.dRight
62 rbc_to_ixl_Request(ROUTE_5009)-->yes

```

C. Simulation Traces

```
63 rbc_to_ixl_RequestToProceed(ROUTE_5009)-->yes
64 CSP:rbc_to_train_RequestAccepted.yes
65 ixl_to_rbc_GrantRoute(ROUTE_5009)-->yes
66 rbc_to_ixl_ClearRoute(ROUTE_5005)
67 CSP:rbc_to_train_MAGrant.3950
68 CSP:train_NextAction.Train_1.C_AE_AF.2500
69 train_to_ixl_TrackChange(Train_1,T_ZAAE)-->T_ZAAF,C_AF_AG
70 CSP:train_NextAction.Train_1.C_AF_AG.3000
71 train_to_ixl_TrackChange(Train_1,T_ZAAF)-->T_ZAAG,C_AG_AH
72 CSP:train_NextAction.Train_1.C_BG_1017.3250
73 CSP:train_PassedBalise.Train_1.BG_1017
74 CSP:train_to_rbc_MAResult.Train_1.BG_1017.dRight
75 rbc_to_ixl_Request(ROUTE_5013)-->yes
76 rbc_to_ixl_RequestToProceed(ROUTE_5013)-->yes
77 CSP:rbc_to_train_RequestAccepted.yes
78 ixl_to_rbc_GrantRoute(ROUTE_5013)-->yes
79 rbc_to_ixl_ClearRoute(ROUTE_5009)
80 CSP:rbc_to_train_MAGrant.4950
81 CSP:train_NextAction.Train_1.C_AG_AH.3500
82 train_to_ixl_TrackChange(Train_1,T_ZAAG)-->T_ZAAH,C_AH_AJ
83 CSP:train_NextAction.Train_1.C_AH_AJ.4000
84 train_to_ixl_TrackChange(Train_1,T_ZAAH)-->T_ZAAJ,C_AJ_AK
85 CSP:train_NextAction.Train_1.C_BG_1015.4250
86 CSP:train_PassedBalise.Train_1.BG_1015
87 CSP:train_NextAction.Train_1.C_AJ_AK.4500
88 train_to_ixl_TrackChange(Train_1,T_ZAAJ)-->T_ZAAK,C_AK_AL
89 CSP:train_NextAction.Train_1.C_BG_1013.4750
90 CSP:train_PassedBalise.Train_1.BG_1013
91 CSP:train_to_rbc_MAResult.Train_1.BG_1013.dRight
92 rbc_to_ixl_Request(ROUTE_5017)-->yes
93 rbc_to_ixl_RequestToProceed(ROUTE_5017)-->yes
94 CSP:rbc_to_train_RequestAccepted.yes
95 ixl_to_rbc_GrantRoute(ROUTE_5017)-->yes
96 rbc_to_ixl_ClearRoute(ROUTE_5013)
97 CSP:rbc_to_train_MAGrant.8950
98 CSP:train_NextAction.Train_1.C_AK_AL.5000
99 train_to_ixl_TrackChange(Train_1,T_ZAAK)-->T_ZAAL,C_AL_0832
100 CSP:train_NextAction.Train_1.C_BG_1019.5250
101 CSP:train_PassedBalise.Train_1.BG_1019
102 CSP:train_NextAction.Train_1.C_AL_0832.5500
103 train_to_ixl_TrackChange(Train_1,T_ZAAL)-->T_0832,C_0832_0833
104 CSP:train_NextAction.Train_1.C_0832_0833.6000
105 train_to_ixl_TrackChange(Train_1,T_0832)-->T_0833,C_0833_0834
106 CSP:train_NextAction.Train_1.C_BG_1033.6250
107 CSP:train_PassedBalise.Train_1.BG_1033
108 CSP:train_NextAction.Train_1.C_0833_0834.6500
109 train_to_ixl_TrackChange(Train_1,T_0833)-->T_0834,C_0834_0835
110 CSP:train_NextAction.Train_1.C_0834_0835.7000
111 train_to_ixl_TrackChange(Train_1,T_0834)-->T_0835,C_0835_08411
```

```

112 CSP:train_NextAction.Train_1.C_BG_1021.7150
113 CSP:train_PassedBalise.Train_1.BG_1021
114 CSP:train_NextAction.Train_1.C_BG_1029.7350
115 CSP:train_PassedBalise.Train_1.BG_1029
116 CSP:train_NextAction.Train_1.C_0835_08411.7500
117 train_to_ixl_TrackChange(Train_1,T_0835)-->T_08411,C_08411_08412
118 CSP:train_NextAction.Train_1.C_08411_08412.8000
119 train_to_ixl_TrackChange(Train_1,T_08411)-->T_08412,C_08412_0842
120 CSP:train_NextAction.Train_1.C_BG_1003.8250
121 CSP:train_PassedBalise.Train_1.BG_1003
122 CSP:train_to_rbc_MAResult.Train_1.BG_1003.dRight
123 rbc_to_ixl_Request(ROUTE_DBM003)-->yes
124 rbc_to_ixl_RequestToProceed(ROUTE_DBM003)-->yes
125 CSP:rbc_to_train_RequestAccepted.yes
126 ixl_to_rbc_GrantRoute(ROUTE_DBM003)-->yes
127 rbc_to_ixl_ClearRoute(ROUTE_5017)
128 CSP:rbc_to_train_MAGrant.9500
129 CSP:train_NextAction.Train_1.C_08412_0842.8500
130 train_to_ixl_TrackChange(Train_1,T_08412)-->T_0842,C_0842_0843
131 CSP:train_NextAction.Train_1.C_0842_0843.9000

```

Lower Train Runs Until Obstruction

```

1 start_cspm_MAIN
2 tau($setup_constants)
3 tau($initialise_machine)
4 CSP:TrainEntryDetails.Train_1.T_VTC002
5 rbc_to_ixl_Request(ROUTE_EntryLD)-->yes
6 train_to_ixl_Enter(Train_1,T_VTC002)-->yes
7 CSP:train_PassedBalise.Train_1.BG_LD
8 CSP:train_to_rbc_MAResult.Train_1.BG_LD.dRight
9 rbc_to_ixl_RequestToProceed(ROUTE_EntryLD)-->yes
10 CSP:rbc_to_train_RequestAccepted.yes
11 ixl_to_rbc_GrantRoute(ROUTE_EntryLD)-->yes
12 rbc_to_ixl_ClearRoute(ROUTE_null)
13 CSP:rbc_to_train_MAGrant.-50
14 CSP:train_NextAction.Train_1.C_BG_1030.-350
15 CSP:train_PassedBalise.Train_1.BG_1030
16 CSP:train_NextAction.Train_1.C_BG_1032.-150
17 CSP:train_PassedBalise.Train_1.BG_1032
18 CSP:train_to_rbc_MAResult.Train_1.BG_1032.dRight
19 rbc_to_ixl_Request(ROUTE_DBM004)-->yes
20 rbc_to_ixl_RequestToProceed(ROUTE_DBM004)-->yes
21 CSP:rbc_to_train_RequestAccepted.yes
22 ixl_to_rbc_GrantRoute(ROUTE_DBM004)-->yes
23 rbc_to_ixl_ClearRoute(ROUTE_EntryLD)
24 CSP:rbc_to_train_MAGrant.450
25 CSP:train_NextAction.Train_1.C_VTC2_BA.0
26 train_to_ixl_TrackChange(Train_1,T_VTC002)-->T_ZBBA,C_BA_BB

```

C. Simulation Traces

```
27 CSP:train_NextAction.Train_1.C_BG_998.250
28 CSP:train_PassedBalise.Train_1.BG_998
29 CSP:train_to_rbc_MAResponse.Train_1.BG_998.dRight
30 rbc_to_ixl_Request(ROUTE_5003_D)-->yes
31 rbc_to_ixl_RequestToProceed(ROUTE_5003_D)-->yes
32 CSP:rbc_to_train_RequestAccepted.yes
33 ixl_to_rbc_GrantRoute(ROUTE_5003_D)-->yes
34 rbc_to_ixl_ClearRoute(ROUTE_DBM004)
35 CSP:rbc_to_train_MAGrant.1950
36 CSP:train_NextAction.Train_1.C_BA_BB.500
37 train_to_ixl_TrackChange(Train_1,T_ZBBA)-->T_ZBBB,C_BB_BC
38 CSP:train_NextAction.Train_1.C_BB_BC.1000
39 train_to_ixl_TrackChange(Train_1,T_ZBBB)-->T_ZBBC,C_BC_BD
40 CSP:train_NextAction.Train_1.C_BG_1002.1250
41 CSP:train_PassedBalise.Train_1.BG_1002
42 CSP:train_NextAction.Train_1.C_BC_BD.1500
43 train_to_ixl_TrackChange(Train_1,T_ZBBC)-->T_ZBBD,C_BD_BE
44 CSP:train_NextAction.Train_1.C_BG_1026.1650
45 CSP:train_PassedBalise.Train_1.BG_1026
46 CSP:train_NextAction.Train_1.C_BG_1004.1850
47 CSP:train_PassedBalise.Train_1.BG_1004
48 CSP:train_to_rbc_MAResponse.Train_1.BG_1004.dRight
49 rbc_to_ixl_Request(ROUTE_5007)-->yes
50 rbc_to_ixl_RequestToProceed(ROUTE_5007)-->yes
51 CSP:rbc_to_train_RequestAccepted.yes
52 ixl_to_rbc_GrantRoute(ROUTE_5007)-->yes
53 rbc_to_ixl_ClearRoute(ROUTE_5001_D)
54 CSP:rbc_to_train_MAGrant.2450
55 CSP:train_NextAction.Train_1.C_BD_BE.2000
56 train_to_ixl_TrackChange(Train_1,T_ZBBD)-->T_ZBBE,C_BE_BF
57 CSP:train_NextAction.Train_1.C_BG_1006.2250
58 CSP:train_PassedBalise.Train_1.BG_1006
59 CSP:train_to_rbc_MAResponse.Train_1.BG_1006.dRight
60 rbc_to_ixl_Request(ROUTE_5011)-->yes
61 rbc_to_ixl_RequestToProceed(ROUTE_5011)-->yes
62 CSP:rbc_to_train_RequestAccepted.yes
63 ixl_to_rbc_GrantRoute(ROUTE_5011)-->yes
64 rbc_to_ixl_ClearRoute(ROUTE_5007)
65 CSP:rbc_to_train_MAGrant.3950
66 CSP:train_NextAction.Train_1.C_BE_BF.2500
67 train_to_ixl_TrackChange(Train_1,T_ZBBE)-->T_ZBBF,C_BF_BG
68 CSP:train_NextAction.Train_1.C_BG_996.2750
69 CSP:train_PassedBalise.Train_1.BG_996
70 CSP:train_to_rbc_MAResponse.Train_1.BG_996.dRight
71 rbc_to_ixl_Request(ROUTE_5015)-->yes
72 rbc_to_ixl_RequestToProceed(ROUTE_5015)-->yes
73 CSP:rbc_to_train_RequestAccepted.yes
74 ixl_to_rbc_GrantRoute(ROUTE_5015)-->yes
75 rbc_to_ixl_ClearRoute(ROUTE_5011)
```

```

76 CSP:rbc_to_train_MAGrant.4950
77 CSP:train_NextAction.Train_1.C_BF_BG.3000
78 train_to_ixl_TrackChange(Train_1,T_ZBBF)-->T_ZBBG,C_BG_BH
79 CSP:train_NextAction.Train_1.C_BG_BH.3500
80 train_to_ixl_TrackChange(Train_1,T_ZBBG)-->T_ZBBH,C_BH_BJ
81 CSP:train_NextAction.Train_1.C_BH_BJ.4000
82 train_to_ixl_TrackChange(Train_1,T_ZBBH)-->T_ZBBJ,C_BJ_BK
83 CSP:train_NextAction.Train_1.C_BG_1008.4250
84 CSP:train_PassedBalise.Train_1.BG_1008
85 CSP:train_NextAction.Train_1.C_BJ_BK.4500
86 train_to_ixl_TrackChange(Train_1,T_ZBBJ)-->T_ZBBK,C_BK_BL
87 CSP:train_NextAction.Train_1.C_BG_1010.4750
88 CSP:train_PassedBalise.Train_1.BG_1010
89 CSP:train_to_rbc_MAResult.Train_1.BG_1010.dRight
90 rbc_to_ixl_Request(ROUTE_5019)-->yes
91 rbc_to_ixl_RequestToProceed(ROUTE_5019)-->yes
92 CSP:rbc_to_train_RequestAccepted.yes
93 ixl_to_rbc_GrantRoute(ROUTE_5019)-->yes
94 rbc_to_ixl_ClearRoute(ROUTE_5015)
95 CSP:rbc_to_train_MAGrant.5450
96 CSP:train_NextAction.Train_1.C_BK_BL.5000
97 train_to_ixl_TrackChange(Train_1,T_ZBBK)-->T_ZBBL,C_BL_BM
98 CSP:train_NextAction.Train_1.C_BG_1012.5250
99 CSP:train_PassedBalise.Train_1.BG_1012
100 CSP:train_to_rbc_MAResult.Train_1.BG_1012.dRight
101 CSP:rbc_to_train_RequestAccepted.no
102 CSP:train_PassedBalise.Train_1.BG_1012
103 CSP:train_to_rbc_MAResult.Train_1.BG_1012.dRight
104 CSP:rbc_to_train_RequestAccepted.no

```

Two Trains on a Single Track

```

1 start_cspm_MAIN
2 tau($setup_constants)
3 tau($initialise_machine)
4 CSP:TrainEntryDetails.Train_1.T_VTC001
5 rbc_to_ixl_Request(ROUTE_EntryLU)-->yes
6 train_to_ixl_Enter(Train_1,T_VTC001)-->yes
7 CSP:train_PassedBalise.Train_1.BG_LU
8 CSP:train_to_rbc_MAResult.Train_1.BG_LU.dRight
9 rbc_to_ixl_Request(ROUTE_DBM001)-->yes
10 rbc_to_ixl_RequestToProceed(ROUTE_EntryLU)-->yes
11 CSP:rbc_to_train_RequestAccepted.yes
12 ixl_to_rbc_GrantRoute(ROUTE_EntryLU)-->yes
13 rbc_to_ixl_ClearRoute(ROUTE_null)
14 CSP:rbc_to_train_MAGrant.-50
15 CSP:train_NextAction.Train_1.C_BG_1000.-250
16 CSP:train_PassedBalise.Train_1.BG_1000
17 CSP:train_to_rbc_MAResult.Train_1.BG_1000.dRight

```

C. Simulation Traces

```
18 rbc_to_ixl_Request(ROUTE_5001_U)-->yes
19 rbc_to_ixl_RequestToProceed(ROUTE_DBM001)-->yes
20 CSP:rbc_to_train_RequestAccepted.yes
21 ixl_to_rbc_GrantRoute(ROUTE_DBM001)-->yes
22 rbc_to_ixl_ClearRoute(ROUTE_EntryLU)
23 CSP:rbc_to_train_MAGrant.450
24 CSP:TrainEntryDetails.Train_2.T_VTC001
25 rbc_to_ixl_Request(ROUTE_EntryLU)-->no
26 CSP:train_NextAction.Train_1.C_VTC1_AA.0
27 train_to_ixl_TrackChange(Train_1,T_VTC001)-->T_ZAAA,C_AA_AB
28 train_to_ixl_Enter(Train_2,T_VTC001)-->yes
29 CSP:train_PassedBalise.Train_2.BG_LU
30 CSP:train_to_rbc_MAResult.Train_2.BG_LU.dRight
31 rbc_to_ixl_Request(ROUTE_DBM001)-->no
32 CSP:rbc_to_train_RequestAccepted.no
33 CSP:train_NextAction.Train_1.C_BG_1025.150
34 CSP:train_PassedBalise.Train_1.BG_1025
35 CSP:train_NextAction.Train_1.C_BG_1001.350
36 CSP:train_PassedBalise.Train_1.BG_1001
37 CSP:train_to_rbc_MAResult.Train_1.BG_1001.dRight
38 rbc_to_ixl_Request(ROUTE_5005)-->yes
39 rbc_to_ixl_RequestToProceed(ROUTE_5001_U)-->yes
40 CSP:rbc_to_train_RequestAccepted.yes
41 ixl_to_rbc_GrantRoute(ROUTE_5001_U)-->yes
42 rbc_to_ixl_ClearRoute(ROUTE_DBM001)
43 CSP:rbc_to_train_MAGrant.1950
44 CSP:train_NextAction.Train_1.C_AA_AB.500
45 train_to_ixl_TrackChange(Train_1,T_ZAAA)-->T_ZAAB,C_AB_AC
46 CSP:train_PassedBalise.Train_2.BG_LU
47 rbc_to_ixl_Request(ROUTE_DBM001)-->yes
```

Siemens DataLogger The following files are the filtered DataLogger logs.

The complete log files can be viewed at: <https://rb.gy/jx64tz>

Simple Single Train Movement (Filtered)

```
1 09:43:00.521410 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
  :192.168.0.132
2      10000100 00000110 10000010 11010001 10110110 11001000
      00010111 00100000 01110100 00000010 00000000 00001000
      00010000 00000010 00011111 10000100 01101100
      11000000 00000000 00110010 00000000 01100100 10000000
      11111000 00000001 00110011
3      NID_MESSAGE = 132 (84h) (10000100)
4      L_MESSAGE = 26 (1Ah) (0000011010)
```



```

5      T_TRAIN = 189192992 (B46DB20h)
        (00001011010001101101101100100000)
6      NID_ENGINE = 6062544 (5C81D0h)
        (010111001000000111010000)
7      Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
        driver"
8      Packet 0 - TrainToTrack - Pos Report
9          NID_PACKET = 0 (0h) (00000000)
10         L_PACKET = 129 (81h) (0000010000001)
11         Q_SCALE = 0 (0h) (00) "10 cm scale"
12     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
13         NID_C = 2 (2h) (0000000010)
14         NID_BG = 2017 (7E1h) (0001111100001)
15         D_LRBG = 3480 (D98h) (000110110011000) "348.0m"
16         Q_DIRLRBG = 0 (0h) (00) "Reverse"
17         Q_DLRBG = 0 (0h) (00) "Reverse"
18         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
19         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
        "
20     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
        integrity monitoring device"
21         L_TRAININT = 248 (F8h) (000000011111000)
22         V_TRAIN = 0 (0h) (0000000) "0 km/h"
23         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
24         M_MODE = 6 (6h) (0110) "Stand By"
25     M_LEVEL = 3 (3h) (011) "Level 2"
26 09:43:01.499769 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
        (PK21) - Train 6062544 - Dest:192.168.0.134
27     00000011 00010010 11000010 11010001 10110110 11100001
        00000000 00010000 11111100 00100001 11100000 00010110
        00010000 00000000 00000000 00000000 11110100
        10010000 00000000 00011111 10000111 00100000 00001100
        01000110 01111111 11110000 10100011 10100000
        00001001 00001000 01010111 11111111 11110010 00010000
        00110000 00110000 01010000 00010010 01101000
        00010111 01110000 01111101 00010000 00010001 00000000
        00110110 00001000 00000011 00000001 00000000
        01010000 00001111 10100110 00000010 00110110 00000001
        01011001 00000000 00000000 00101010 00000000
        10000001 11101001 11111110 00000000 10101000 00000100
        11100100 00000000 00000100 00000000 00100000
        01111010 01011111 11100000
28     NID_MESSAGE = 3 (3h) (00000011)
29     L_MESSAGE = 75 (4Bh) (0001001011)
30     T_TRAIN = 189193092 (B46DB84h)
        (0000101101000110110110110000100)
31     M_ACK = 0 (0h) (0) "No acknowledgement required"
32     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
33         NID_C = 2 (2h) (0000000010)

```

C. Simulation Traces

```
34         NID_BG = 2017 (7E1h) (00011111100001)
35 Packet 15 - TrackToTrain - Level 2/3 MA
36         NID_PACKET = 15 (Fh) (00001111)
37         Q_DIR = 0 (0h) (00) "Reverse"
38         L_PACKET = 88 (58h) (0000001011000)
39         Q_SCALE = 1 (1h) (01) "1 m scale"
40         V_EMA = 0 (0h) (0000000) "0 km/h"
41         T_EMA = 0 (0h) (0000000000)
42 N_ITER = 0 (0h) (00000)
43         L_ENDSECTION = 489 (1E9h) (000000111101001)
44         "489m"
45 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
46         information"
47 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
48         information"
49 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
50         follow"
51         D_DP = 0 (0h) (000000000000000) "0m"
52         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
53         calculated release speed"
54 Q_OVERLAP = 0 (0h) (0) "No overlap information"
55 Packet 57 - TrackToTrain - MA Request Params
56         NID_PACKET = 57 (39h) (00111001)
57         Q_DIR = 0 (0h) (00) "Reverse"
58         L_PACKET = 49 (31h) (0000000110001)
59         T_MAR = 25 (19h) (00011001)
60         T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
61         request triggering with regards to this
62         function"
63         T_CYCRQST = 10 (Ah) (00001010)
64 Packet 58 - TrackToTrain - Pos Report Params
65         NID_PACKET = 58 (3Ah) (00111010)
66         Q_DIR = 0 (0h) (00) "Reverse"
67         L_PACKET = 72 (48h) (0000001001000)
68         Q_SCALE = 1 (1h) (01) "1 m scale"
69         T_CYCLOC = 10 (Ah) (00001010)
70         D_CYCLOC = 32767 (7FFFh) (1111111111111) "The
71         train has not to report cyclically its
72         position"
73         M_LOC = 1 (1h) (001) "Every LRBG compliant
74         balise group"
75 N_ITER = 1 (1h) (00001)
76         [0] D_LOC = 385 (181h) (000000110000001) "385m"
77         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
78 Packet 5 - TrackToTrain - Linking
79         NID_PACKET = 5 (5h) (00000101)
80         Q_DIR = 0 (0h) (00) "Reverse"
81         L_PACKET = 147 (93h) (0000010010011)
82         Q_SCALE = 1 (1h) (01) "1 m scale"
```

```

73         D_LINK = 375 (177h) (000000101110111) "375m"
74 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
75         NID_BG = 1000 (3E8h) (00001111101000)
76         Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
77         Q_LINKREACTION = 0 (0h) (00) "Train trip"
78         Q_LOCACCC = 1 (1h) (000001)
79 N_ITER = 2 (2h) (00010)
80         [0] D_LINK = 54 (36h) (000000000110110) "54m"
81 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
82         [0] NID_BG = 1025 (401h) (00010000000001)
83         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
84         [0] Q_LINKREACTION = 0 (0h) (00) "Train trip"
85         [0] Q_LOCACCC = 1 (1h) (000001)
86         [1] D_LINK = 40 (28h) (000000000101000) "40m"
87 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
88         [1] NID_BG = 1001 (3E9h) (00001111101001)
89         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
90         [1] Q_LINKREACTION = 0 (0h) (00) "Train trip"
91         [1] Q_LOCACCC = 1 (1h) (000001)
92 Packet 27 - TrackToTrain - International SSP
93         NID_PACKET = 27 (1Bh) (00011011)
94         Q_DIR = 0 (0h) (00) "Reverse"
95         L_PACKET = 86 (56h) (0000001010110)
96         Q_SCALE = 1 (1h) (01) "1 m scale"
97         D_STATIC = 0 (0h) (000000000000000) "0m"
98         V_STATIC = 10 (Ah) (0001010) "50 km/h"
99         Q_FRONT = 1 (1h) (1) "No train length delay on
      validity end point of profile element"
100 N_ITER = 0 (0h) (00000)
101 N_ITER = 1 (1h) (00001)
102         [0] D_STATIC = 489 (1E9h) (000000111101001)
      "489m"
103         [0] V_STATIC = 127 (7Fh) (1111111) "Non
      numerical value telling that the static
      speed profile description ends at D_STATIC(n
      )"
104         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
105 [0] N_ITER = 0 (0h) (00000)
106 Packet 21 - TrackToTrain - Gradient Profile

```

C. Simulation Traces

```

107         NID_PACKET = 21 (15h) (00010101)
108         Q_DIR = 0 (0h) (00) "Reverse"
109         L_PACKET = 78 (4Eh) (0000001001110)
110         Q_SCALE = 1 (1h) (01) "1 m scale"
111         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
112         Q_GDIR = 1 (1h) (1) "Uphill"
113         G_A = 0 (0h) (00000000) "0 o/oo"
114     N_ITER = 1 (1h) (00001)
115         [0] D_GRADIENT = 489 (1E9h) (000000111101001)
           "489m"
116         [0] Q_GDIR = 0 (0h) (0) "Downhill"
117         [0] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
118 09:43:02.015821 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
           (PK21) - Train 6062544 - Dest:192.168.0.134
119     00000011 00011000 11000010 11010001 10110110 11101011
           00000000 00010000 11111100 00100001 11100000 00010110
           00010000 00000000 00000000 00000010 00111100
           00010000 00000000 00011111 10000111 00100000 00001100
           01000110 01111111 11110000 10100011 10100000
           00001011 00001000 01010111 11111111 11110010 00100000
           00110000 00110000 00010000 01110000 01010000
           00100101 11101000 00010111 01110000 01111101 00010000
           00010011 00000000 00110110 00001000 00000011
           00000001 00000000 01010000 00001111 10100110 00000010
           00000000 10010000 00011111 11111100 00000100
           00000001 10100000 01000000 00110000 00001000 00001001
           01000000 10000000 11110000 00010000 00110100
           01100000 11111100 01100000 00100011 01100000 00010101
           10010000 00000000 00000010 10100000 00001000
           01000111 10001111 11100000 00001010 10000000 01100110
           01000000 00000000 01000000 00000100 00001000
           10100110 00001010 00001001 00111101 11111110
120     NID_MESSAGE = 3 (3h) (00000011)
121     L_MESSAGE = 99 (63h) (0001100011)
122     T_TRAIN = 189193132 (B46DBACh)
           (00001011010001101101101110101100)
123     M_ACK = 0 (0h) (0) "No acknowledgement required"
124     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
125         NID_C = 2 (2h) (0000000010)
126         NID_BG = 2017 (7E1h) (00011111100001)
127     Packet 15 - TrackToTrain - Level 2/3 MA
128         NID_PACKET = 15 (Fh) (00001111)
129         Q_DIR = 0 (0h) (00) "Reverse"
130         L_PACKET = 88 (58h) (0000001011000)
131         Q_SCALE = 1 (1h) (01) "1 m scale"
132         V_EMA = 0 (0h) (00000000) "0 km/h"
133         T_EMA = 0 (0h) (0000000000)

```

```

134     N_ITER = 0 (0h) (00000)
135         L_ENDSECTION = 1144 (478h) (000010001111000)
           "1144m"
136     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
137     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
138     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
139         D_DP = 0 (0h) (0000000000000000) "0m"
140         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
141     Q_OVERLAP = 0 (0h) (0) "No overlap information"
142     Packet 57 - TrackToTrain - MA Request Params
143         NID_PACKET = 57 (39h) (00111001)
144         Q_DIR = 0 (0h) (00) "Reverse"
145         L_PACKET = 49 (31h) (0000000110001)
146         T_MAR = 25 (19h) (00011001)
147         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
148         T_CYCRQST = 10 (Ah) (00001010)
149     Packet 58 - TrackToTrain - Pos Report Params
150         NID_PACKET = 58 (3Ah) (00111010)
151         Q_DIR = 0 (0h) (00) "Reverse"
152         L_PACKET = 88 (58h) (0000001011000)
153         Q_SCALE = 1 (1h) (01) "1 m scale"
154         T_CYCLOC = 10 (Ah) (00001010)
155         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
156         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
157     N_ITER = 2 (2h) (00010)
158         [0] D_LOC = 385 (181h) (000000110000001) "385m"
159         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
160         [1] D_LOC = 131 (83h) (000000010000011) "131m"
161         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
162     Packet 5 - TrackToTrain - Linking
163         NID_PACKET = 5 (5h) (00000101)
164         Q_DIR = 0 (0h) (00) "Reverse"
165         L_PACKET = 303 (12Fh) (0000100101111)
166         Q_SCALE = 1 (1h) (01) "1 m scale"
167         D_LINK = 375 (177h) (000000101110111) "375m"
168     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
169         NID_BG = 1000 (3E8h) (00001111101000)
170         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal

```

```

                direction"
171         Q_LINKREACTION = 0 (0h) (00) "Train trip"
172         Q_LOCACC = 1 (1h) (000001)
173     N_ITER = 6 (6h) (00110)
174         [0] D_LINK = 54 (36h) (000000000110110) "54m"
175     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
176         [0] NID_BG = 1025 (401h) (00010000000001)
177         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
178         [0] Q_LINKREACTION = 0 (0h) (00) "Train trip"
179         [0] Q_LOCACC = 1 (1h) (000001)
180         [1] D_LINK = 40 (28h) (000000000101000) "40m"
181     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
182         [1] NID_BG = 1001 (3E9h) (00001111101001)
183         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
184         [1] Q_LINKREACTION = 0 (0h) (00) "Train trip"
185         [1] Q_LOCACC = 1 (1h) (000001)
186         [2] D_LINK = 36 (24h) (000000000100100) "36m"
187     [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
188         [2] NID_BG = 1023 (3FFh) (00001111111111)
189         [2] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
190         [2] Q_LINKREACTION = 0 (0h) (00) "Train trip"
191         [2] Q_LOCACC = 1 (1h) (000001)
192         [3] D_LINK = 52 (34h) (000000000110100) "52m"
193     [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
194         [3] NID_BG = 1027 (403h) (00010000000011)
195         [3] Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
196         [3] Q_LINKREACTION = 0 (0h) (00) "Train trip"
197         [3] Q_LOCACC = 1 (1h) (000001)
198         [4] D_LINK = 148 (94h) (000000010010100) "148m"
199     [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
200         [4] NID_BG = 1031 (407h) (00010000000111)
201         [4] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
202         [4] Q_LINKREACTION = 0 (0h) (00) "Train trip"
203         [4] Q_LOCACC = 1 (1h) (000001)

```

```

204             [5] D_LINK = 419 (1A3h) (000000110100011) "419m
                "
205     [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
206             [5] NID_BG = 1009 (3F1h) (00001111110001)
207             [5] Q_LINKORIENTATION = 1 (1h) (1) "The balise
                group is seen by the train in nominal
                direction"
208             [5] Q_LINKREACTION = 0 (0h) (00) "Train trip"
209             [5] Q_LOCACCC = 1 (1h) (000001)
210     Packet 27 - TrackToTrain - International SSP
211             NID_PACKET = 27 (1Bh) (00011011)
212             Q_DIR = 0 (0h) (00) "Reverse"
213             L_PACKET = 86 (56h) (0000001010110)
214             Q_SCALE = 1 (1h) (01) "1 m scale"
215             D_STATIC = 0 (0h) (0000000000000000) "0m"
216             V_STATIC = 10 (Ah) (0001010) "50 km/h"
217             Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
218     N_ITER = 0 (0h) (00000)
219     N_ITER = 1 (1h) (00001)
220             [0] D_STATIC = 1144 (478h) (000010001111000)
                "1144m"
221             [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
222             [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
223     [0] N_ITER = 0 (0h) (00000)
224     Packet 21 - TrackToTrain - Gradient Profile
225             NID_PACKET = 21 (15h) (00010101)
226             Q_DIR = 0 (0h) (00) "Reverse"
227             L_PACKET = 102 (66h) (0000001100110)
228             Q_SCALE = 1 (1h) (01) "1 m scale"
229             D_GRADIENT = 0 (0h) (0000000000000000) "0m"
230             Q_GDIR = 1 (1h) (1) "Uphill"
231             G_A = 0 (0h) (00000000) "0 o/oo"
232     N_ITER = 2 (2h) (00010)
233             [0] D_GRADIENT = 553 (229h) (000001000101001)
                "553m"
234             [0] Q_GDIR = 1 (1h) (1) "Uphill"
235             [0] G_A = 5 (5h) (00000101) "5 o/oo"
236             [1] D_GRADIENT = 591 (24Fh) (000001001001111)
                "591m"
237             [1] Q_GDIR = 0 (0h) (0) "Downhill"
238             [1] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"

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C. Simulation Traces

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239 09:43:02.336887 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
240      10000100 00000110 10000010 11010001 10110110 11111010
      00010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00011111 10000100 01101100
      11000000 00000000 00110010 00000000 01100100 10000000
      11111000 00000001 00000011
241      NID_MESSAGE = 132 (84h) (10000100)
242      L_MESSAGE = 26 (1Ah) (0000011010)
243      T_TRAIN = 189193192 (B46DBE8h)
      (00001011010001101101101111101000)
244      NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
245      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
246      Packet 0 - TrainToTrack - Pos Report
247      NID_PACKET = 0 (0h) (00000000)
248      L_PACKET = 129 (81h) (00000100000001)
249      Q_SCALE = 0 (0h) (00) "10 cm scale"
250      NID_LRBG = 34785 (87E1h) (000000001000011111100001)
251      NID_C = 2 (2h) (0000000010)
252      NID_BG = 2017 (7E1h) (00011111100001)
253      D_LRBG = 3480 (D98h) (000110110011000) "348.0m"
254      Q_DIRLRBG = 0 (0h) (00) "Reverse"
255      Q_DLRBG = 0 (0h) (00) "Reverse"
256      L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
257      L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
258      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
259      L_TRAININT = 248 (F8h) (000000011111000)
260      V_TRAIN = 0 (0h) (00000000) "0 km/h"
261      Q_DIRTRAIN = 2 (2h) (10) "Unknown"
262      M_MODE = 0 (0h) (0000) "Full Supervision"
263      M_LEVEL = 3 (3h) (011) "Level 2"
264 09:43:03.039472 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062544 - Dest:192.168.0.134
265      00000011 00011011 01000010 11010001 10110111 00001110
      00000000 00010000 11111100 00100001 11100000 00010110
      00010000 00000000 00000000 00000010 10000111
      10010000 00000000 00011111 10000111 00100000 00001100
      01000110 01111111 11110000 10100011 10100000
      00001101 00001000 01010111 11111111 11110010 00110000
      00110000 00110000 00010000 01110000 01010001
      11110000 01010000 00101010 11001000 00010111 01110000
      01111101 00010000 00010011 10000000 00110110
      00001000 00000011 00000001 00000000 01010000 00001111
      10100110 00000010 00000000 10010000 00011111
      11111100 00000100 00000001 10100000 01000000 00110000

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00001000 00001001 01000000 10000000 11110000
00010000 00110100 01100000 11111100 01100000 00100000
00100100 00000001 11111001 11000000 01000110
11000000 00101011 00100000 00000000 00000101 01000000
00010000 10100001 11111111 11000000 00010101
00000000 11111100 10000000 00000000 10000000 00001100
00010001 01001100 00010100 00010010 10101100
00000000 00000100 10001011 11111100
266 NID_MESSAGE = 3 (3h) (00000011)
267 L_MESSAGE = 109 (6Dh) (0001101101)
268 T_TRAIN = 189193272 (B46DC38h)
(00001011010001101101110000111000)
269 M_ACK = 0 (0h) (0) "No acknowledgement required"
270 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
271 NID_C = 2 (2h) (0000000010)
272 NID_BG = 2017 (7E1h) (00011111100001)
273 Packet 15 - TrackToTrain - Level 2/3 MA
274 NID_PACKET = 15 (Fh) (00001111)
275 Q_DIR = 0 (0h) (00) "Reverse"
276 L_PACKET = 88 (58h) (0000001011000)
277 Q_SCALE = 1 (1h) (01) "1 m scale"
278 V_EMA = 0 (0h) (00000000) "0 km/h"
279 T_EMA = 0 (0h) (0000000000)
280 N_ITER = 0 (0h) (000000)
281 L_ENDSECTION = 1295 (50Fh) (0000101000011111)
"1295m"
282 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
283 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
284 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
285 D_DP = 0 (0h) (0000000000000000) "0m"
286 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
287 Q_OVERLAP = 0 (0h) (0) "No overlap information"
288 Packet 57 - TrackToTrain - MA Request Params
289 NID_PACKET = 57 (39h) (00111001)
290 Q_DIR = 0 (0h) (00) "Reverse"
291 L_PACKET = 49 (31h) (0000000110001)
292 T_MAR = 25 (19h) (00011001)
293 T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
request triggering with regards to this
function"
294 T_CYCRQST = 10 (Ah) (00001010)
295 Packet 58 - TrackToTrain - Pos Report Params
296 NID_PACKET = 58 (3Ah) (00111010)
297 Q_DIR = 0 (0h) (00) "Reverse"
298 L_PACKET = 104 (68h) (0000001101000)

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299         Q_SCALE = 1 (1h) (01) "1 m scale"
300         T_CYCLOC = 10 (Ah) (00001010)
301         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
302         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
303     N_ITER = 3 (3h) (00011)
304         [0] D_LOC = 385 (181h) (000000110000001) "385m"
305         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
306         [1] D_LOC = 131 (83h) (000000010000011) "131m"
307         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
308         [2] D_LOC = 655 (28Fh) (000001010001111) "655m"
309         [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
310     Packet 5 - TrackToTrain - Linking
311         NID_PACKET = 5 (5h) (00000101)
312         Q_DIR = 0 (0h) (00) "Reverse"
313         L_PACKET = 342 (156h) (0000101010110)
314         Q_SCALE = 1 (1h) (01) "1 m scale"
315         D_LINK = 375 (177h) (000000101110111) "375m"
316     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
317         NID_BG = 1000 (3E8h) (00001111101000)
318         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
319         Q_LINKREACTION = 0 (0h) (00) "Train trip"
320         Q_LOCACC = 1 (1h) (000001)
321     N_ITER = 7 (7h) (00111)
322         [0] D_LINK = 54 (36h) (000000000110110) "54m"
323     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
324         [0] NID_BG = 1025 (401h) (00010000000001)
325         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
326         [0] Q_LINKREACTION = 0 (0h) (00) "Train trip"
327         [0] Q_LOCACC = 1 (1h) (000001)
328         [1] D_LINK = 40 (28h) (000000000101000) "40m"
329     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
330         [1] NID_BG = 1001 (3E9h) (00001111101001)
331         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
332         [1] Q_LINKREACTION = 0 (0h) (00) "Train trip"
333         [1] Q_LOCACC = 1 (1h) (000001)
334         [2] D_LINK = 36 (24h) (000000000100100) "36m"
335     [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway

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administration, no NID_C follows"
336 [2] NID_BG = 1023 (3FFh) (000011111111111)
337 [2] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
338 [2] Q_LINKREACTION = 0 (0h) (00) "Train trip"
339 [2] Q_LOCACC = 1 (1h) (000001)
340 [3] D_LINK = 52 (34h) (000000000110100) "52m"
341 [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
342 [3] NID_BG = 1027 (403h) (00010000000011)
343 [3] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
344 [3] Q_LINKREACTION = 0 (0h) (00) "Train trip"
345 [3] Q_LOCACC = 1 (1h) (000001)
346 [4] D_LINK = 148 (94h) (000000010010100) "148m"
347 [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
348 [4] NID_BG = 1031 (407h) (00010000000111)
349 [4] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
350 [4] Q_LINKREACTION = 0 (0h) (00) "Train trip"
351 [4] Q_LOCACC = 1 (1h) (000001)
352 [5] D_LINK = 419 (1A3h) (000000110100011) "419m
"
353 [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
354 [5] NID_BG = 1009 (3F1h) (00001111110001)
355 [5] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
356 [5] Q_LINKREACTION = 0 (0h) (00) "Train trip"
357 [5] Q_LOCACC = 1 (1h) (000001)
358 [6] D_LINK = 144 (90h) (000000010010000) "144m"
359 [6] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
360 [6] NID_BG = 1011 (3F3h) (00001111110011)
361 [6] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
362 [6] Q_LINKREACTION = 0 (0h) (00) "Train trip"
363 [6] Q_LOCACC = 1 (1h) (000001)
364 Packet 27 - TrackToTrain - International SSP
365 NID_PACKET = 27 (1Bh) (00011011)
366 Q_DIR = 0 (0h) (00) "Reverse"
367 L_PACKET = 86 (56h) (0000001010110)
368 Q_SCALE = 1 (1h) (01) "1 m scale"

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369         D_STATIC = 0 (0h) (0000000000000000) "0m"
370         V_STATIC = 10 (Ah) (0001010) "50 km/h"
371         Q_FRONT = 1 (1h) (1) "No train length delay on
          validity end point of profile element"
372     N_ITER = 0 (0h) (00000)
373     N_ITER = 1 (1h) (00001)
374     [0] D_STATIC = 1295 (50Fh) (000010100001111)
          "1295m"
375     [0] V_STATIC = 127 (7Fh) (1111111) "Non
          numerical value telling that the static
          speed profile description ends at D_STATIC(n
          )"
376     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
          validity end point of profile element"
377     [0] N_ITER = 0 (0h) (00000)
378     Packet 21 - TrackToTrain - Gradient Profile
379     NID_PACKET = 21 (15h) (00010101)
380     Q_DIR = 0 (0h) (00) "Reverse"
381     L_PACKET = 126 (7Eh) (0000001111110)
382     Q_SCALE = 1 (1h) (01) "1 m scale"
383     D_GRADIENT = 0 (0h) (0000000000000000) "0m"
384     Q_GDIR = 1 (1h) (1) "Uphill"
385     G_A = 0 (0h) (00000000) "0 o/oo"
386     N_ITER = 3 (3h) (00011)
387     [0] D_GRADIENT = 553 (229h) (000001000101001)
          "553m"
388     [0] Q_GDIR = 1 (1h) (1) "Uphill"
389     [0] G_A = 5 (5h) (00000101) "5 o/oo"
390     [1] D_GRADIENT = 597 (255h) (000001001010101)
          "597m"
391     [1] Q_GDIR = 1 (1h) (1) "Uphill"
392     [1] G_A = 0 (0h) (00000000) "0 o/oo"
393     [2] D_GRADIENT = 145 (91h) (000000010010001)
          "145m"
394     [2] Q_GDIR = 0 (0h) (0) "Downhill"
395     [2] G_A = 255 (FFh) (11111111) "Non numerical
          value telling that the current gradient
          description ends at D_GRADIENT(n)"
396 09:43:04.061584 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
          (PK21) - Train 6062544 - Dest:192.168.0.134
397 00000011 00011100 10000010 11010001 10110111 00100111
          00000000 00010000 11111100 00100001 11100000 00010000
          10010000 00000000 00000000 00000100 00111000
          10000001 11001000 00000011 00010001 10011111 11111100
          00101000 11101000 00000011 11000010 00010101
          11111111 11111100 10010000 00001100 00001100 00000100
          00011100 00010100 01111100 00000100 10111100
          00010100 00001010 10110010 00000101 11011100 00011111
          01000100 00000100 11100000 00001101 10000010

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00000000 11000000 01000000 00010100 00000011 11101001
10000000 10000000 00100100 00000111 11111111
00000001 00000000 01101000 00010000 00001100 00000010
00000010 01010000 00100000 00111100 00000100
00001101 00011000 00111111 00011000 00001000 00001001
00000000 01111110 01110000 00010001 10110000
00001010 11001000 00000000 00000001 01010000 00000100
01000011 10001111 11110000 00000101 01000000
01010111 00100000 00000000 00100000 00000101 00000100
01010011 00000101 00000100 10101011 00000000
00000100 00100100 00000010 00000010 00000101 00000000
00000001 10111110 11111111
398 NID_MESSAGE = 3 (3h) (00000011)
399 L_MESSAGE = 114 (72h) (0001110010)
400 T_TRAIN = 189193372 (B46DC9Ch)
      (00001011010001101101110010011100)
401 M_ACK = 0 (0h) (0) "No acknowledgement required"
402 NID_LRBG = 34785 (87E1h) (0000000010000111111100001)
403     NID_C = 2 (2h) (0000000010)
404     NID_BG = 2017 (7E1h) (00011111100001)
405 Packet 15 - TrackToTrain - Level 2/3 MA
406     NID_PACKET = 15 (Fh) (00001111)
407     Q_DIR = 0 (0h) (00) "Reverse"
408     L_PACKET = 66 (42h) (0000001000010)
409     Q_SCALE = 1 (1h) (01) "1 m scale"
410     V_EMA = 0 (0h) (00000000) "0 km/h"
411     T_EMA = 0 (0h) (0000000000)
412 N_ITER = 0 (0h) (000000)
413     L_ENDSECTION = 2161 (871h) (000100001110001)
      "2161m"
414 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
415 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
416 Q_DANGERPOINT = 0 (0h) (0) "No danger point information"
417 Q_OVERLAP = 0 (0h) (0) "No overlap information"
418 Packet 57 - TrackToTrain - MA Request Params
419     NID_PACKET = 57 (39h) (00111001)
420     Q_DIR = 0 (0h) (00) "Reverse"
421     L_PACKET = 49 (31h) (0000000110001)
422     T_MAR = 25 (19h) (00011001)
423     T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
      request triggering with regards to this
      function"
424     T_CYCRQST = 10 (Ah) (00001010)
425 Packet 58 - TrackToTrain - Pos Report Params
426     NID_PACKET = 58 (3Ah) (00111010)
427     Q_DIR = 0 (0h) (00) "Reverse"
428     L_PACKET = 120 (78h) (0000001111000)

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429         Q_SCALE = 1 (1h) (01) "1 m scale"
430         T_CYCLOC = 10 (Ah) (00001010)
431         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
432         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
433     N_ITER = 4 (4h) (00100)
434         [0] D_LOC = 385 (181h) (000000110000001) "385m"
435         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
436         [1] D_LOC = 131 (83h) (000000010000011) "131m"
437         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
438         [2] D_LOC = 655 (28Fh) (000001010001111) "655m"
439         [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
440         [3] D_LOC = 151 (97h) (000000010010111) "151m"
441         [3] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
442     Packet 5 - TrackToTrain - Linking
443         NID_PACKET = 5 (5h) (00000101)
444         Q_DIR = 0 (0h) (00) "Reverse"
445         L_PACKET = 342 (156h) (0000101010110)
446         Q_SCALE = 1 (1h) (01) "1 m scale"
447         D_LINK = 375 (177h) (000000101110111) "375m"
448     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
449         NID_BG = 1000 (3E8h) (00001111101000)
450         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
451         Q_LINKREACTION = 0 (0h) (00) "Train trip"
452         Q_LOCACC = 1 (1h) (000001)
453     N_ITER = 7 (7h) (00111)
454         [0] D_LINK = 54 (36h) (000000000110110) "54m"
455     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
456         [0] NID_BG = 1025 (401h) (00010000000001)
457         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
458         [0] Q_LINKREACTION = 0 (0h) (00) "Train trip"
459         [0] Q_LOCACC = 1 (1h) (000001)
460         [1] D_LINK = 40 (28h) (000000000101000) "40m"
461     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
462         [1] NID_BG = 1001 (3E9h) (00001111101001)
463         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
464         [1] Q_LINKREACTION = 0 (0h) (00) "Train trip"
465         [1] Q_LOCACC = 1 (1h) (000001)

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466         [2] D_LINK = 36 (24h) (000000000100100) "36m"
467 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
         administration, no NID_C follows"
468         [2] NID_BG = 1023 (3FFh) (000011111111111)
469         [2] Q_LINKORIENTATION = 1 (1h) (1) "The balise
         group is seen by the train in nominal
         direction"
470         [2] Q_LINKREACTION = 0 (0h) (00) "Train trip"
471         [2] Q_LOCACC = 1 (1h) (000001)
472         [3] D_LINK = 52 (34h) (000000000110100) "52m"
473 [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
         administration, no NID_C follows"
474         [3] NID_BG = 1027 (403h) (00010000000011)
475         [3] Q_LINKORIENTATION = 0 (0h) (0) "The balise
         group is seen by the train in reverse
         direction"
476         [3] Q_LINKREACTION = 0 (0h) (00) "Train trip"
477         [3] Q_LOCACC = 1 (1h) (000001)
478         [4] D_LINK = 148 (94h) (000000010010100) "148m"
479 [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
         administration, no NID_C follows"
480         [4] NID_BG = 1031 (407h) (00010000000111)
481         [4] Q_LINKORIENTATION = 1 (1h) (1) "The balise
         group is seen by the train in nominal
         direction"
482         [4] Q_LINKREACTION = 0 (0h) (00) "Train trip"
483         [4] Q_LOCACC = 1 (1h) (000001)
484         [5] D_LINK = 419 (1A3h) (000000110100011) "419m
         "
485 [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
         administration, no NID_C follows"
486         [5] NID_BG = 1009 (3F1h) (00001111110001)
487         [5] Q_LINKORIENTATION = 1 (1h) (1) "The balise
         group is seen by the train in nominal
         direction"
488         [5] Q_LINKREACTION = 0 (0h) (00) "Train trip"
489         [5] Q_LOCACC = 1 (1h) (000001)
490         [6] D_LINK = 144 (90h) (000000010010000) "144m"
491 [6] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
         administration, no NID_C follows"
492         [6] NID_BG = 1011 (3F3h) (00001111110011)
493         [6] Q_LINKORIENTATION = 1 (1h) (1) "The balise
         group is seen by the train in nominal
         direction"
494         [6] Q_LINKREACTION = 0 (0h) (00) "Train trip"
495         [6] Q_LOCACC = 1 (1h) (000001)
496 Packet 27 - TrackToTrain - International SSP
497         NID_PACKET = 27 (1Bh) (00011011)
498         Q_DIR = 0 (0h) (00) "Reverse"

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499         L_PACKET = 86 (56h) (0000001010110)
500         Q_SCALE = 1 (1h) (01) "1 m scale"
501         D_STATIC = 0 (0h) (0000000000000000) "0m"
502         V_STATIC = 10 (Ah) (0001010) "50 km/h"
503         Q_FRONT = 1 (1h) (1) "No train length delay on
                    validity end point of profile element"
504     N_ITER = 0 (0h) (00000)
505     N_ITER = 1 (1h) (00001)
506         [0] D_STATIC = 2161 (871h) (000100001110001)
                    "2161m"
507         [0] V_STATIC = 127 (7Fh) (1111111) "Non
                    numerical value telling that the static
                    speed profile description ends at D_STATIC(n
                    )"
508         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                    validity end point of profile element"
509     [0] N_ITER = 0 (0h) (00000)
510     Packet 21 - TrackToTrain - Gradient Profile
511         NID_PACKET = 21 (15h) (00010101)
512         Q_DIR = 0 (0h) (00) "Reverse"
513         L_PACKET = 174 (AEh) (0000010101110)
514         Q_SCALE = 1 (1h) (01) "1 m scale"
515         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
516         Q_GDIR = 1 (1h) (1) "Uphill"
517         G_A = 0 (0h) (00000000) "0 o/oo"
518     N_ITER = 5 (5h) (00101)
519         [0] D_GRADIENT = 553 (229h) (000001000101001)
                    "553m"
520         [0] Q_GDIR = 1 (1h) (1) "Uphill"
521         [0] G_A = 5 (5h) (00000101) "5 o/oo"
522         [1] D_GRADIENT = 597 (255h) (000001001010101)
                    "597m"
523         [1] Q_GDIR = 1 (1h) (1) "Uphill"
524         [1] G_A = 0 (0h) (00000000) "0 o/oo"
525         [2] D_GRADIENT = 530 (212h) (000001000010010)
                    "530m"
526         [2] Q_GDIR = 0 (0h) (0) "Downhill"
527         [2] G_A = 2 (2h) (00000010) "2 o/oo"
528         [3] D_GRADIENT = 258 (102h) (000000100000010)
                    "258m"
529         [3] Q_GDIR = 1 (1h) (1) "Uphill"
530         [3] G_A = 0 (0h) (00000000) "0 o/oo"
531         [4] D_GRADIENT = 223 (DFh) (000000011011111)
                    "223m"
532         [4] Q_GDIR = 0 (0h) (0) "Downhill"
533         [4] G_A = 255 (FFh) (11111111) "Non numerical
                    value telling that the current gradient
                    description ends at D_GRADIENT(n)"
534 09:43:10.518443 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)

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(PK21) - Train 6062544 - Dest:192.168.0.134
535 00000011 00011111 10000010 11010001 10110111 11001010
    10000000 00010000 01111101 00000001 11101000 00010110
    00010000 00000000 00000000 00000101 01110011
    10010000 00000000 00011111 10000111 00101000 00001100
    01000110 01111111 11110000 10100011 10100100
    00001111 00001000 01010111 11111111 11110010 01000000
    00000001 01010000 00010000 01110000 01010001
    11110000 00010010 11110000 01010100 00101010 11001000
    00000011 01100000 10000000 00111000 00010011
    10000000 00101000 00000111 11010011 10000001 00000000
    01001000 00001111 11111111 00000010 00000000
    11010000 00100000 00011010 00000100 00000100 10100000
    01000000 01111100 00001000 00011010 00110000
    01111110 00111000 00010000 00010010 00000000 11111100
    11110000 00100001 10010110 11000001 11111100
    10100000 01000110 11010000 00101011 00100000 00000000
    00000101 01000000 00010001 01011100 11111111
    11000000 00010101 01000001 11101100 10000000 00000000
    10000000 00100000 00000101 10010100 00010100
    00010010 10101100 00000000 00010000 10010000 00001000
    00001000 00010100 00000000 00001100 10010100
    00011000 00001001 10010100 00010000 00001111 10011100
    00111100 00000000 10101011 11111100
536 NID_MESSAGE = 3 (3h) (00000011)
537 L_MESSAGE = 126 (7Eh) (0001111110)
538 T_TRAIN = 189194026 (B46DF2Ah)
    (00001011010001101101111100101010)
539 M_ACK = 0 (0h) (0) "No acknowledgement required"
540 NID_LRBG = 33768 (83E8h) (000000001000001111101000)
541     NID_C = 2 (2h) (0000000010)
542     NID_BG = 1000 (3E8h) (00001111101000)
543 Packet 15 - TrackToTrain - Level 2/3 MA
544     NID_PACKET = 15 (Fh) (00001111)
545     Q_DIR = 1 (1h) (01) "Nominal"
546     L_PACKET = 88 (58h) (0000001011000)
547     Q_SCALE = 1 (1h) (01) "1 m scale"
548     V_EMA = 0 (0h) (00000000) "0 km/h"
549     T_EMA = 0 (0h) (0000000000)
550 N_ITER = 0 (0h) (000000)
551     L_ENDSECTION = 2791 (AE7h) (000101011100111)
    "2791m"
552 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
    information"
553 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
    information"
554 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
    follow"
555     D_DP = 0 (0h) (0000000000000000) "0m"

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C. Simulation Traces

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556         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
          calculated release speed"
557     Q_OVERLAP = 0 (0h) (0) "No overlap information"
558     Packet 57 - TrackToTrain - MA Request Params
559         NID_PACKET = 57 (39h) (00111001)
560         Q_DIR = 1 (1h) (01) "Nominal"
561         L_PACKET = 49 (31h) (0000000110001)
562         T_MAR = 25 (19h) (00011001)
563         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
          request triggering with regards to this
          function"
564         T_CYCRQST = 10 (Ah) (00001010)
565     Packet 58 - TrackToTrain - Pos Report Params
566         NID_PACKET = 58 (3Ah) (00111010)
567         Q_DIR = 1 (1h) (01) "Nominal"
568         L_PACKET = 120 (78h) (0000001111000)
569         Q_SCALE = 1 (1h) (01) "1 m scale"
570         T_CYCLOC = 10 (Ah) (00001010)
571         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
          train has not to report cyclically its
          position"
572         M_LOC = 1 (1h) (001) "Every LRBG compliant
          balise group"
573     N_ITER = 4 (4h) (00100)
574         [0] D_LOC = 10 (Ah) (000000000001010) "10m"
575         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
576         [1] D_LOC = 131 (83h) (000000010000011) "131m"
577         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
578         [2] D_LOC = 655 (28Fh) (000001010001111) "655m"
579         [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
580         [3] D_LOC = 151 (97h) (000000010010111) "151m"
581         [3] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
582     Packet 5 - TrackToTrain - Linking
583         NID_PACKET = 5 (5h) (00000101)
584         Q_DIR = 1 (1h) (01) "Nominal"
585         L_PACKET = 342 (156h) (0000101010110)
586         Q_SCALE = 1 (1h) (01) "1 m scale"
587         D_LINK = 54 (36h) (000000000110110) "54m"
588     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
          administration, no NID_C follows"
589         NID_BG = 1025 (401h) (00010000000001)
590         Q_LINKORIENTATION = 1 (1h) (1) "The balise
          group is seen by the train in nominal
          direction"
591         Q_LINKREACTION = 2 (2h) (10) "No reaction"
592         Q_LOCAC = 1 (1h) (000001)
593     N_ITER = 7 (7h) (00111)
594         [0] D_LINK = 40 (28h) (000000000101000) "40m"
595     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
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administration, no NID_C follows"
596         [0] NID_BG = 1001 (3E9h) (00001111101001)
597         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
598         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
599         [0] Q_LOCACCC = 1 (1h) (000001)
600         [1] D_LINK = 36 (24h) (000000000100100) "36m"
601 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
602         [1] NID_BG = 1023 (3FFh) (000011111111111)
603         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
604         [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
605         [1] Q_LOCACCC = 1 (1h) (000001)
606         [2] D_LINK = 52 (34h) (000000000110100) "52m"
607 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
608         [2] NID_BG = 1027 (403h) (00010000000011)
609         [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
610         [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
611         [2] Q_LOCACCC = 1 (1h) (000001)
612         [3] D_LINK = 148 (94h) (000000010010100) "148m"
613 [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
614         [3] NID_BG = 1031 (407h) (00010000000111)
615         [3] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
616         [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
617         [3] Q_LOCACCC = 1 (1h) (000001)
618         [4] D_LINK = 419 (1A3h) (000000110100011) "419m
           "
619 [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
620         [4] NID_BG = 1009 (3F1h) (00001111110001)
621         [4] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
622         [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
623         [4] Q_LOCACCC = 1 (1h) (000001)
624         [5] D_LINK = 144 (90h) (000000010010000) "144m"
625 [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
626         [5] NID_BG = 1011 (3F3h) (00001111110011)
627         [5] Q_LINKORIENTATION = 1 (1h) (1) "The balise

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        group is seen by the train in nominal
        direction"
628     [5] Q_LINKREACTION = 2 (2h) (10) "No reaction"
629     [5] Q_LOCACC = 1 (1h) (000001)
630     [6] D_LINK = 1627 (65Bh) (000011001011011)
        "1627m"
631     [6] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
632     [6] NID_BG = 1017 (3F9h) (00001111111001)
633     [6] Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
634     [6] Q_LINKREACTION = 2 (2h) (10) "No reaction"
635     [6] Q_LOCACC = 1 (1h) (000001)
636     Packet 27 - TrackToTrain - International SSP
637     NID_PACKET = 27 (1Bh) (00011011)
638     Q_DIR = 1 (1h) (01) "Nominal"
639     L_PACKET = 86 (56h) (0000001010110)
640     Q_SCALE = 1 (1h) (01) "1 m scale"
641     D_STATIC = 0 (0h) (0000000000000000) "0m"
642     V_STATIC = 10 (Ah) (0001010) "50 km/h"
643     Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
644     N_ITER = 0 (0h) (00000)
645     N_ITER = 1 (1h) (00001)
646     [0] D_STATIC = 2791 (AE7h) (000101011100111)
        "2791m"
647     [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
648     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
649     [0] N_ITER = 0 (0h) (00000)
650     Packet 21 - TrackToTrain - Gradient Profile
651     NID_PACKET = 21 (15h) (00010101)
652     Q_DIR = 1 (1h) (01) "Nominal"
653     L_PACKET = 246 (F6h) (0000011110110)
654     Q_SCALE = 1 (1h) (01) "1 m scale"
655     D_GRADIENT = 0 (0h) (0000000000000000) "0m"
656     Q_GDIR = 1 (1h) (1) "Uphill"
657     G_A = 0 (0h) (00000000) "0 o/oo"
658     N_ITER = 8 (8h) (01000)
659     [0] D_GRADIENT = 178 (B2h) (000000010110010)
        "178m"
660     [0] Q_GDIR = 1 (1h) (1) "Uphill"
661     [0] G_A = 5 (5h) (00000101) "5 o/oo"
662     [1] D_GRADIENT = 597 (255h) (000001001010101)
        "597m"

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663 [1] Q_GDIR = 1 (1h) (1) "Uphill"
664 [1] G_A = 0 (0h) (00000000) "0 o/oo"
665 [2] D_GRADIENT = 530 (212h) (000001000010010)
    "530m"
666 [2] Q_GDIR = 0 (0h) (0) "Downhill"
667 [2] G_A = 2 (2h) (00000010) "2 o/oo"
668 [3] D_GRADIENT = 258 (102h) (000000100000010)
    "258m"
669 [3] Q_GDIR = 1 (1h) (1) "Uphill"
670 [3] G_A = 0 (0h) (00000000) "0 o/oo"
671 [4] D_GRADIENT = 402 (192h) (000000110010010)
    "402m"
672 [4] Q_GDIR = 1 (1h) (1) "Uphill"
673 [4] G_A = 6 (6h) (00000110) "6 o/oo"
674 [5] D_GRADIENT = 306 (132h) (000000100110010)
    "306m"
675 [5] Q_GDIR = 1 (1h) (1) "Uphill"
676 [5] G_A = 4 (4h) (00000100) "4 o/oo"
677 [6] D_GRADIENT = 499 (1F3h) (000000111110011)
    "499m"
678 [6] Q_GDIR = 1 (1h) (1) "Uphill"
679 [6] G_A = 15 (Fh) (00001111) "15 o/oo"
680 [7] D_GRADIENT = 21 (15h) (000000000010101) "21
    m"
681 [7] Q_GDIR = 0 (0h) (0) "Downhill"
682 [7] G_A = 255 (FFh) (11111111) "Non numerical
    value telling that the current gradient
    description ends at D_GRADIENT(n)"
683 09:44:08.594739 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
    (PK21) - Train 6062544 - Dest:192.168.0.134
684 00000011 00011010 01000010 11010001 10111101 01110110
    01000000 00010000 01111110 00100001 11101000 00010110
    00010000 00000000 00000000 00000101 10101111
    10010000 00000000 00011111 10000111 00101000 00001100
    01000110 01111111 11110000 10100011 10100100
    00001101 00001000 01010111 11111111 11110010 00110000
    00000101 11110000 00010010 11110000 11101001
    11110000 01010100 00010111 01001000 00001001 00000000
    01111110 01111000 00010001 10000110 01011011
    00000111 11110010 10000001 00000011 01001100 00001111
    11011101 00000010 00001001 11101000 00011111
    10101010 00000100 01101101 00000010 10110010 00000000
    00000000 01010100 00000001 00010110 10111111
    11111100 00000001 01010100 00011110 11001000 00000000
    00001000 00101010 00000000 00001101 01000000
    00000001 00001001 00000000 10000000 10000001 01000000
    00000000 11001001 01000001 10000000 10011001
    01000001 00000000 11111001 11000011 11000001 10000010
    11000001 01000000 00111010 10111111 11000000

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C. Simulation Traces

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685     NID_MESSAGE = 3 (3h) (00000011)
686     L_MESSAGE = 105 (69h) (0001101001)
687     T_TRAIN = 189199833 (B46F5D9h)
        (00001011010001101111010111011001)
688     M_ACK = 0 (0h) (0) "No acknowledgement required"
689     NID_LRBG = 33777 (83F1h) (000000001000001111110001)
690         NID_C = 2 (2h) (0000000010)
691         NID_BG = 1009 (3F1h) (00001111110001)
692     Packet 15 - TrackToTrain - Level 2/3 MA
693         NID_PACKET = 15 (Fh) (00001111)
694         Q_DIR = 1 (1h) (01) "Nominal"
695         L_PACKET = 88 (58h) (0000001011000)
696         Q_SCALE = 1 (1h) (01) "1 m scale"
697         V_EMA = 0 (0h) (00000000) "0 km/h"
698         T_EMA = 0 (0h) (0000000000)
699     N_ITER = 0 (0h) (00000)
700         L_ENDSECTION = 2911 (B5Fh) (000101101011111)
        "2911m"
701     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
        information"
702     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
        information"
703     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
        follow"
704         D_DP = 0 (0h) (0000000000000000) "0m"
705         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
        calculated release speed"
706     Q_OVERLAP = 0 (0h) (0) "No overlap information"
707     Packet 57 - TrackToTrain - MA Request Params
708         NID_PACKET = 57 (39h) (00111001)
709         Q_DIR = 1 (1h) (01) "Nominal"
710         L_PACKET = 49 (31h) (0000000110001)
711         T_MAR = 25 (19h) (00011001)
712         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
        request triggering with regards to this
        function"
713         T_CYCRQST = 10 (Ah) (00001010)
714     Packet 58 - TrackToTrain - Pos Report Params
715         NID_PACKET = 58 (3Ah) (00111010)
716         Q_DIR = 1 (1h) (01) "Nominal"
717         L_PACKET = 104 (68h) (0000001101000)
718         Q_SCALE = 1 (1h) (01) "1 m scale"
719         T_CYCLOC = 10 (Ah) (00001010)
720         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
        train has not to report cyclically its
        position"
721         M_LOC = 1 (1h) (001) "Every LRBG compliant
        balise group"
722     N_ITER = 3 (3h) (00011)
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723 [0] D_LOC = 47 (2Fh) (000000000101111) "47m"
724 [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
725 [1] D_LOC = 151 (97h) (000000010010111) "151m"
726 [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
727 [2] D_LOC = 1871 (74Fh) (000011101001111) "1871
    m"
728 [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
729 Packet 5 - TrackToTrain - Linking
730 NID_PACKET = 5 (5h) (00000101)
731 Q_DIR = 1 (1h) (01) "Nominal"
732 L_PACKET = 186 (BAh) (0000010111010)
733 Q_SCALE = 1 (1h) (01) "1 m scale"
734 D_LINK = 144 (90h) (000000010010000) "144m"
735 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
    administration, no NID_C follows"
736 NID_BG = 1011 (3F3h) (00001111110011)
737 Q_LINKORIENTATION = 1 (1h) (1) "The balise
    group is seen by the train in nominal
    direction"
738 Q_LINKREACTION = 2 (2h) (10) "No reaction"
739 Q_LOCACC = 1 (1h) (000001)
740 N_ITER = 3 (3h) (00011)
741 [0] D_LINK = 1627 (65Bh) (000011001011011)
    "1627m"
742 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
    administration, no NID_C follows"
743 [0] NID_BG = 1017 (3F9h) (00001111111001)
744 [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
    group is seen by the train in reverse
    direction"
745 [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
746 [0] Q_LOCACC = 1 (1h) (000001)
747 [1] D_LINK = 422 (1A6h) (000000110100110) "422m
    "
748 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
    administration, no NID_C follows"
749 [1] NID_BG = 1015 (3F7h) (00001111110111)
750 [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
    group is seen by the train in reverse
    direction"
751 [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
752 [1] Q_LOCACC = 1 (1h) (000001)
753 [2] D_LINK = 634 (27Ah) (000001001111010) "634m
    "
754 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
    administration, no NID_C follows"
755 [2] NID_BG = 1013 (3F5h) (00001111110101)
756 [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
    group is seen by the train in reverse

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C. Simulation Traces

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              direction"
757         [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
758         [2] Q_LOCACC = 1 (1h) (000001)
759     Packet 27 - TrackToTrain - International SSP
760         NID_PACKET = 27 (1Bh) (00011011)
761         Q_DIR = 1 (1h) (01) "Nominal"
762         L_PACKET = 86 (56h) (0000001010110)
763         Q_SCALE = 1 (1h) (01) "1 m scale"
764         D_STATIC = 0 (0h) (0000000000000000) "0m"
765         V_STATIC = 10 (Ah) (0001010) "50 km/h"
766         Q_FRONT = 1 (1h) (1) "No train length delay on
              validity end point of profile element"
767     N_ITER = 0 (0h) (00000)
768     N_ITER = 1 (1h) (00001)
769         [0] D_STATIC = 2911 (B5Fh) (000101101011111)
              "2911m"
770         [0] V_STATIC = 127 (7Fh) (1111111) "Non
              numerical value telling that the static
              speed profile description ends at D_STATIC(n
              )"
771         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
              validity end point of profile element"
772     [0] N_ITER = 0 (0h) (00000)
773     Packet 21 - TrackToTrain - Gradient Profile
774         NID_PACKET = 21 (15h) (00010101)
775         Q_DIR = 1 (1h) (01) "Nominal"
776         L_PACKET = 246 (F6h) (0000011110110)
777         Q_SCALE = 1 (1h) (01) "1 m scale"
778         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
779         Q_GDIR = 1 (1h) (1) "Uphill"
780         G_A = 5 (5h) (00000101) "5 o/oo"
781     N_ITER = 8 (8h) (01000)
782         [0] D_GRADIENT = 26 (1Ah) (000000000011010) "26
              m"
783         [0] Q_GDIR = 1 (1h) (1) "Uphill"
784         [0] G_A = 0 (0h) (00000000) "0 o/oo"
785         [1] D_GRADIENT = 530 (212h) (000001000010010)
              "530m"
786         [1] Q_GDIR = 0 (0h) (0) "Downhill"
787         [1] G_A = 2 (2h) (00000010) "2 o/oo"
788         [2] D_GRADIENT = 258 (102h) (000000100000010)
              "258m"
789         [2] Q_GDIR = 1 (1h) (1) "Uphill"
790         [2] G_A = 0 (0h) (00000000) "0 o/oo"
791         [3] D_GRADIENT = 402 (192h) (000000110010010)
              "402m"
792         [3] Q_GDIR = 1 (1h) (1) "Uphill"
793         [3] G_A = 6 (6h) (00000110) "6 o/oo"
794         [4] D_GRADIENT = 306 (132h) (000000100110010)

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"306m"
795 [4] Q_GDIR = 1 (1h) (1) "Uphill"
796 [4] G_A = 4 (4h) (00000100) "4 o/oo"
797 [5] D_GRADIENT = 499 (1F3h) (000000111110011)
"499m"
798 [5] Q_GDIR = 1 (1h) (1) "Uphill"
799 [5] G_A = 15 (Fh) (00001111) "15 o/oo"
800 [6] D_GRADIENT = 773 (305h) (000001100000101)
"773m"
801 [6] Q_GDIR = 1 (1h) (1) "Uphill"
802 [6] G_A = 5 (5h) (00000101) "5 o/oo"
803 [7] D_GRADIENT = 117 (75h) (000000001110101)
"117m"
804 [7] Q_GDIR = 0 (0h) (0) "Downhill"
805 [7] G_A = 255 (FFh) (11111111) "Non numerical
value telling that the current gradient
description ends at D_GRADIENT(n)"
806 09:46:16.084645 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
(PK21) - Train 6062544 - Dest:192.168.0.134
807 00000011 00010101 10000010 11010001 11001001 11101001
11000000 00010000 01111111 00100001 11100000 00010110
00010000 00000000 00000000 00000010 11001000
00010000 00000000 00011111 10000111 00100000 00001100
01000110 01111111 11110000 10100011 10100000
00001011 00001000 01010111 11111111 11110010 00100000
00100101 01010000 01101100 10110000 01010000
00010010 01101000 00011010 01100000 01111110 11101000
00010001 00000010 01111010 00000111 11101010
10000001 00000001 10000110 00001111 11101111 00000010
00110110 00000001 01011001 00000000 00000000
00101010 00000000 10000101 10010000 11111110 00000000
10101000 00001001 01100100 00000000 00000100
00010000 10000000 00111110 10100001 11100000 11000001
01100000 10100000 00100000 00100001 11100000
01000100 01011111 11100000
808 NID_MESSAGE = 3 (3h) (00000011)
809 L_MESSAGE = 86 (56h) (0001010110)
810 T_TRAIN = 189212583 (B4727A7h)
(00001011010001110010011110100111)
811 M_ACK = 0 (0h) (0) "No acknowledgement required"
812 NID_LRBG = 33785 (83F9h) (000000001000001111111001)
813 NID_C = 2 (2h) (0000000010)
814 NID_BG = 1017 (3F9h) (00001111111001)
815 Packet 15 - TrackToTrain - Level 2/3 MA
816 NID_PACKET = 15 (Fh) (00001111)
817 Q_DIR = 0 (0h) (00) "Reverse"
818 L_PACKET = 88 (58h) (0000001011000)
819 Q_SCALE = 1 (1h) (01) "1 m scale"
820 V_EMA = 0 (0h) (0000000) "0 km/h"

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821         T_EMA = 0 (0h) (0000000000)
822     N_ITER = 0 (0h) (00000)
823         L_ENDSECTION = 1424 (590h) (000010110010000)
            "1424m"
824     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
            information"
825     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
            information"
826     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
            follow"
827         D_DP = 0 (0h) (0000000000000000) "0m"
828         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
            calculated release speed"
829     Q_OVERLAP = 0 (0h) (0) "No overlap information"
830     Packet 57 - TrackToTrain - MA Request Params
831         NID_PACKET = 57 (39h) (00111001)
832         Q_DIR = 0 (0h) (00) "Reverse"
833         L_PACKET = 49 (31h) (0000000110001)
834         T_MAR = 25 (19h) (00011001)
835         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
            request triggering with regards to this
            function"
836         T_CYCRQST = 10 (Ah) (00001010)
837     Packet 58 - TrackToTrain - Pos Report Params
838         NID_PACKET = 58 (3Ah) (00111010)
839         Q_DIR = 0 (0h) (00) "Reverse"
840         L_PACKET = 88 (58h) (0000001011000)
841         Q_SCALE = 1 (1h) (01) "1 m scale"
842         T_CYCLOC = 10 (Ah) (00001010)
843         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
            train has not to report cyclically its
            position"
844         M_LOC = 1 (1h) (001) "Every LRBG compliant
            balise group"
845     N_ITER = 2 (2h) (00010)
846         [0] D_LOC = 298 (12Ah) (000000100101010) "298m"
847         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
848         [1] D_LOC = 869 (365h) (000001101100101) "869m"
849         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
850     Packet 5 - TrackToTrain - Linking
851         NID_PACKET = 5 (5h) (00000101)
852         Q_DIR = 0 (0h) (00) "Reverse"
853         L_PACKET = 147 (93h) (0000010010011)
854         Q_SCALE = 1 (1h) (01) "1 m scale"
855         D_LINK = 422 (1A6h) (000000110100110) "422m"
856     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
            administration, no NID_C follows"
857         NID_BG = 1015 (3F7h) (00001111110111)
858         Q_LINKORIENTATION = 0 (0h) (0) "The balise

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      group is seen by the train in reverse
      direction"
859     Q_LINKREACTION = 2 (2h) (10) "No reaction"
860     Q_LOCACC = 1 (1h) (000001)
861     N_ITER = 2 (2h) (00010)
862     [0] D_LINK = 634 (27Ah) (000001001111010) "634m
      "
863     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
864     [0] NID_BG = 1013 (3F5h) (00001111110101)
865     [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
866     [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
867     [0] Q_LOCACC = 1 (1h) (000001)
868     [1] D_LINK = 195 (C3h) (000000011000011) "195m"
869     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
870     [1] NID_BG = 1019 (3FBh) (0000111111011)
871     [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
872     [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
873     [1] Q_LOCACC = 1 (1h) (000001)
874     Packet 27 - TrackToTrain - International SSP
875     NID_PACKET = 27 (1Bh) (00011011)
876     Q_DIR = 0 (0h) (00) "Reverse"
877     L_PACKET = 86 (56h) (0000001010110)
878     Q_SCALE = 1 (1h) (01) "1 m scale"
879     D_STATIC = 0 (0h) (000000000000000) "0m"
880     V_STATIC = 10 (Ah) (0001010) "50 km/h"
881     Q_FRONT = 1 (1h) (1) "No train length delay on
      validity end point of profile element"
882     N_ITER = 0 (0h) (00000)
883     N_ITER = 1 (1h) (00001)
884     [0] D_STATIC = 1424 (590h) (000010110010000)
      "1424m"
885     [0] V_STATIC = 127 (7Fh) (1111111) "Non
      numerical value telling that the static
      speed profile description ends at D_STATIC(n
      )"
886     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
887     [0] N_ITER = 0 (0h) (00000)
888     Packet 21 - TrackToTrain - Gradient Profile
889     NID_PACKET = 21 (15h) (00010101)
890     Q_DIR = 0 (0h) (00) "Reverse"
891     L_PACKET = 150 (96h) (0000010010110)
892     Q_SCALE = 1 (1h) (01) "1 m scale"

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893         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
894         Q_GDIR = 1 (1h) (1) "Uphill"
895         G_A = 4 (4h) (00000100) "4 o/oo"
896     N_ITER = 4 (4h) (00100)
897         [0] D_GRADIENT = 250 (FAh) (000000011111010)
            "250m"
898         [0] Q_GDIR = 1 (1h) (1) "Uphill"
899         [0] G_A = 15 (Fh) (00001111) "15 o/oo"
900         [1] D_GRADIENT = 773 (305h) (000001100000101)
            "773m"
901         [1] Q_GDIR = 1 (1h) (1) "Uphill"
902         [1] G_A = 5 (5h) (00000101) "5 o/oo"
903         [2] D_GRADIENT = 128 (80h) (000000010000000)
            "128m"
904         [2] Q_GDIR = 1 (1h) (1) "Uphill"
905         [2] G_A = 15 (Fh) (00001111) "15 o/oo"
906         [3] D_GRADIENT = 273 (111h) (000000100010001)
            "273m"
907         [3] Q_GDIR = 0 (0h) (0) "Downhill"
908         [3] G_A = 255 (FFh) (11111111) "Non numerical
            value telling that the current gradient
            description ends at D_GRADIENT(n)"
909 09:47:20.638948 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
            :192.168.0.132
910     10000100 00000110 10000010 11010001 11010000 00111000
            01010111 00100000 01110100 00000100 00000000 00001000
            00010000 00000010 00001111 11011100 10010101
            11100000 00000000 00110010 00000000 01100100 10000000
            11111000 00010100 00000011
911     NID_MESSAGE = 132 (84h) (10000100)
912     L_MESSAGE = 26 (1Ah) (0000011010)
913     T_TRAIN = 189219041 (B4740E1h)
            (00001011010001110100000011100001)
914     NID_ENGINE = 6062544 (5C81D0h)
            (010111001000000111010000)
915     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
            the perturbation location reached"
916     Packet 0 - TrainToTrack - Pos Report
917         NID_PACKET = 0 (0h) (00000000)
918         L_PACKET = 129 (81h) (00000100000001)
919         Q_SCALE = 0 (0h) (00) "10 cm scale"
920     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
921         NID_C = 2 (2h) (0000000010)
922         NID_BG = 1015 (3F7h) (00001111110111)
923         D_LRBG = 4796 (12BCh) (001001010111100) "479.6m
            "
924         Q_DIRLRBG = 0 (0h) (00) "Reverse"
925         Q_DLRBG = 0 (0h) (00) "Reverse"
926         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"

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927         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
          "
928     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
929         L_TRAININT = 248 (F8h) (000000011111000)
930         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
931         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
932         M_MODE = 0 (0h) (0000) "Full Supervision"
933     M_LEVEL = 3 (3h) (011) "Level 2"
934 09:47:20.663578 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
          (PK21) - Train 6062544 - Dest:192.168.0.134
935     00000011 00010011 00000010 11010001 11010000 00111000
          01000000 00010000 01111110 11100001 11100000 00010110
          00010000 00000000 00000000 00000001 11110101
          00010000 00000000 00011111 10000111 00100000 00001100
          01000110 01111111 11110000 10100011 10100000
          00001001 00001000 01010111 11111111 11110010 00010000
          01011101 00110000 01010000 00001101 10001000
          00100111 10100000 01111110 10101000 00010000 10000000
          11000011 00000111 11110111 10000001 00011011
          00000000 10101100 10000000 00000000 00010101 00000000
          01000001 11110101 01111111 00000000 01010100
          00000011 11110010 00000000 00000010 00011110 00110000
          01001011 00110000 01010000 00010000 00010000
          11110000 00100010 00101111 11110000
936     NID_MESSAGE = 3 (3h) (00000011)
937     L_MESSAGE = 76 (4Ch) (0001001100)
938     T_TRAIN = 189219041 (B4740E1h)
          (00001011010001110100000011100001)
939     M_ACK = 0 (0h) (0) "No acknowledgement required"
940     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
941         NID_C = 2 (2h) (0000000010)
942         NID_BG = 1015 (3F7h) (00001111110111)
943     Packet 15 - TrackToTrain - Level 2/3 MA
944         NID_PACKET = 15 (Fh) (00001111)
945         Q_DIR = 0 (0h) (00) "Reverse"
946         L_PACKET = 88 (58h) (0000001011000)
947         Q_SCALE = 1 (1h) (01) "1 m scale"
948         V_EMA = 0 (0h) (0000000) "0 km/h"
949         T_EMA = 0 (0h) (0000000000)
950     N_ITER = 0 (0h) (00000)
951         L_ENDSECTION = 1002 (3EAh) (000001111101010)
          "1002m"
952     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
          information"
953     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
          information"
954     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
          follow"

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955         D_DP = 0 (0h) (0000000000000000) "0m"
956         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
          calculated release speed"
957     Q_OVERLAP = 0 (0h) (0) "No overlap information"
958     Packet 57 - TrackToTrain - MA Request Params
959         NID_PACKET = 57 (39h) (00111001)
960         Q_DIR = 0 (0h) (00) "Reverse"
961         L_PACKET = 49 (31h) (0000000110001)
962         T_MAR = 25 (19h) (00011001)
963         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
          request triggering with regards to this
          function"
964         T_CYCRQST = 10 (Ah) (00001010)
965     Packet 58 - TrackToTrain - Pos Report Params
966         NID_PACKET = 58 (3Ah) (00111010)
967         Q_DIR = 0 (0h) (00) "Reverse"
968         L_PACKET = 72 (48h) (0000001001000)
969         Q_SCALE = 1 (1h) (01) "1 m scale"
970         T_CYCLOC = 10 (Ah) (00001010)
971         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
          train has not to report cyclically its
          position"
972         M_LOC = 1 (1h) (001) "Every LRBG compliant
          balise group"
973     N_ITER = 1 (1h) (00001)
974         [0] D_LOC = 745 (2E9h) (000001011101001) "745m"
975         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
976     Packet 5 - TrackToTrain - Linking
977         NID_PACKET = 5 (5h) (00000101)
978         Q_DIR = 0 (0h) (00) "Reverse"
979         L_PACKET = 108 (6Ch) (0000001101100)
980         Q_SCALE = 1 (1h) (01) "1 m scale"
981         D_LINK = 634 (27Ah) (000001001111010) "634m"
982     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
          administration, no NID_C follows"
983         NID_BG = 1013 (3F5h) (00001111110101)
984         Q_LINKORIENTATION = 0 (0h) (0) "The balise
          group is seen by the train in reverse
          direction"
985         Q_LINKREACTION = 2 (2h) (10) "No reaction"
986         Q_LOCACCC = 1 (1h) (000001)
987     N_ITER = 1 (1h) (00001)
988         [0] D_LINK = 195 (C3h) (000000011000011) "195m"
989     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
          administration, no NID_C follows"
990         [0] NID_BG = 1019 (3FBh) (00001111111011)
991         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
          group is seen by the train in nominal
          direction"
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992             [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
993             [0] Q_LOCACCC = 1 (1h) (000001)
994     Packet 27 - TrackToTrain - International SSP
995             NID_PACKET = 27 (1Bh) (00011011)
996             Q_DIR = 0 (0h) (00) "Reverse"
997             L_PACKET = 86 (56h) (0000001010110)
998             Q_SCALE = 1 (1h) (01) "1 m scale"
999             D_STATIC = 0 (0h) (0000000000000000) "0m"
1000            V_STATIC = 10 (Ah) (0001010) "50 km/h"
1001            Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
1002     N_ITER = 0 (0h) (00000)
1003     N_ITER = 1 (1h) (00001)
1004            [0] D_STATIC = 1002 (3EAh) (000001111101010)
                "1002m"
1005            [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
1006            [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
1007     [0] N_ITER = 0 (0h) (00000)
1008     Packet 21 - TrackToTrain - Gradient Profile
1009             NID_PACKET = 21 (15h) (00010101)
1010             Q_DIR = 0 (0h) (00) "Reverse"
1011             L_PACKET = 126 (7Eh) (00000011111110)
1012             Q_SCALE = 1 (1h) (01) "1 m scale"
1013             D_GRADIENT = 0 (0h) (0000000000000000) "0m"
1014             Q_GDIR = 1 (1h) (1) "Uphill"
1015             G_A = 15 (Fh) (00001111) "15 o/oo"
1016     N_ITER = 3 (3h) (00011)
1017            [0] D_GRADIENT = 601 (259h) (000001001011001)
                "601m"
1018            [0] Q_GDIR = 1 (1h) (1) "Uphill"
1019            [0] G_A = 5 (5h) (00000101) "5 o/oo"
1020            [1] D_GRADIENT = 128 (80h) (000000010000000)
                "128m"
1021            [1] Q_GDIR = 1 (1h) (1) "Uphill"
1022            [1] G_A = 15 (Fh) (00001111) "15 o/oo"
1023            [2] D_GRADIENT = 273 (111h) (000000100010001)
                "273m"
1024            [2] Q_GDIR = 0 (0h) (0) "Downhill"
1025            [2] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
1026 09:47:21.488497 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
                :192.168.0.132
1027            10000100 00000110 10000010 11010001 11010000 01000100
                11010111 00100000 01110100 00000100 00000000 00001000

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00010000 00000010 00001111 11011100 10011000
00001000 00000000 00110010 00000000 01100100 10000000
11111000 00010100 00000011
1028 NID_MESSAGE = 132 (84h) (10000100)
1029 L_MESSAGE = 26 (1Ah) (0000011010)
1030 T_TRAIN = 189219091 (B474113h)
(00001011010001110100000100010011)
1031 NID_ENGINE = 6062544 (5C81D0h)
(010111001000000111010000)
1032 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
the perturbation location reached"
1033 Packet 0 - TrainToTrack - Pos Report
1034 NID_PACKET = 0 (0h) (00000000)
1035 L_PACKET = 129 (81h) (0000010000001)
1036 Q_SCALE = 0 (0h) (00) "10 cm scale"
1037 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
1038 NID_C = 2 (2h) (0000000010)
1039 NID_BG = 1015 (3F7h) (00001111110111)
1040 D_LRBG = 4865 (1301h) (001001100000001) "486.5m
"
1041 Q_DIRLRBG = 0 (0h) (00) "Reverse"
1042 Q_DLRBG = 0 (0h) (00) "Reverse"
1043 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1044 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
"
1045 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
1046 L_TRAININT = 248 (F8h) (000000011111000)
1047 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1048 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
1049 M_MODE = 0 (0h) (0000) "Full Supervision"
1050 M_LEVEL = 3 (3h) (011) "Level 2"
1051 09:47:31.269932 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
:192.168.0.132
1052 10000100 00000110 10000010 11010001 11010001 00111111
00010111 00100000 01110100 00000100 00000000 00001000
00010000 00000010 00001111 11011100 11000011
01110000 00000000 00110010 00000000 01100100 10000000
11111000 00010100 00000011
1053 NID_MESSAGE = 132 (84h) (10000100)
1054 L_MESSAGE = 26 (1Ah) (0000011010)
1055 T_TRAIN = 189220092 (B4744FCh)
(00001011010001110100010011111100)
1056 NID_ENGINE = 6062544 (5C81D0h)
(010111001000000111010000)
1057 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
the perturbation location reached"
1058 Packet 0 - TrainToTrack - Pos Report
1059 NID_PACKET = 0 (0h) (00000000)

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1060         L_PACKET = 129 (81h) (00000100000001)
1061         Q_SCALE = 0 (0h) (00) "10 cm scale"
1062     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
1063         NID_C = 2 (2h) (0000000010)
1064         NID_BG = 1015 (3F7h) (00001111110111)
1065         D_LRBG = 6254 (186Eh) (001100001101110) "625.4m
        "
1066         Q_DIRLRBG = 0 (0h) (00) "Reverse"
1067         Q_DLRBG = 0 (0h) (00) "Reverse"
1068         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1069         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
        "
1070     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
        integrity monitoring device"
1071         L_TRAININT = 248 (F8h) (000000011111000)
1072         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1073         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
1074         M_MODE = 0 (0h) (0000) "Full Supervision"
1075     M_LEVEL = 3 (3h) (011) "Level 2"
1076 09:47:31.299336 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
        (PK21) - Train 6062544 - Dest:192.168.0.134
1077     00000011 00010011 00000010 11010001 11010001 00111111
        00000000 00010000 01111110 11100001 11100000 00010110
        00010000 00000000 00000000 00000001 11110101
        00010000 00000000 00011111 10000111 00100000 00001100
        01000110 01111111 11110000 10100011 10100000
        00001001 00001000 01010111 11111111 11110010 00010000
        01011101 00110000 01010000 00001101 10001000
        00100111 10100000 01111110 10101000 00010000 10000000
        11000011 00000111 11110111 10000001 00011011
        00000000 10101100 10000000 00000000 00010101 00000000
        01000001 11110101 01111111 00000000 01010100
        00000011 11110010 00000000 00000010 00011110 00110000
        01001011 00110000 01010000 00010000 00010000
        11110000 00100010 00101111 11110000
1078     NID_MESSAGE = 3 (3h) (00000011)
1079     L_MESSAGE = 76 (4Ch) (0001001100)
1080     T_TRAIN = 189220092 (B4744FCh)
        (00001011010001110100010011111100)
1081     M_ACK = 0 (0h) (0) "No acknowledgement required"
1082     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
1083         NID_C = 2 (2h) (0000000010)
1084         NID_BG = 1015 (3F7h) (00001111110111)
1085     Packet 15 - TrackToTrain - Level 2/3 MA
1086         NID_PACKET = 15 (Fh) (00001111)
1087         Q_DIR = 0 (0h) (00) "Reverse"
1088         L_PACKET = 88 (58h) (0000001011000)
1089         Q_SCALE = 1 (1h) (01) "1 m scale"
1090         V_EMA = 0 (0h) (0000000) "0 km/h"

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C. Simulation Traces

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1091         T_EMA = 0 (0h) (0000000000)
1092     N_ITER = 0 (0h) (00000)
1093         L_ENDSECTION = 1002 (3EAh) (000001111101010)
           "1002m"
1094     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
1095     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
1096     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
1097         D_DP = 0 (0h) (0000000000000000) "0m"
1098         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
1099     Q_OVERLAP = 0 (0h) (0) "No overlap information"
1100     Packet 57 - TrackToTrain - MA Request Params
1101         NID_PACKET = 57 (39h) (00111001)
1102         Q_DIR = 0 (0h) (00) "Reverse"
1103         L_PACKET = 49 (31h) (0000000110001)
1104         T_MAR = 25 (19h) (00011001)
1105         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
1106         T_CYCRQST = 10 (Ah) (00001010)
1107     Packet 58 - TrackToTrain - Pos Report Params
1108         NID_PACKET = 58 (3Ah) (00111010)
1109         Q_DIR = 0 (0h) (00) "Reverse"
1110         L_PACKET = 72 (48h) (0000001001000)
1111         Q_SCALE = 1 (1h) (01) "1 m scale"
1112         T_CYCLOC = 10 (Ah) (00001010)
1113         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
1114         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1115     N_ITER = 1 (1h) (00001)
1116         [0] D_LOC = 745 (2E9h) (000001011101001) "745m"
1117         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1118     Packet 5 - TrackToTrain - Linking
1119         NID_PACKET = 5 (5h) (00000101)
1120         Q_DIR = 0 (0h) (00) "Reverse"
1121         L_PACKET = 108 (6Ch) (0000001101100)
1122         Q_SCALE = 1 (1h) (01) "1 m scale"
1123         D_LINK = 634 (27Ah) (000001001111010) "634m"
1124     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1125         NID_BG = 1013 (3F5h) (00001111110101)
1126         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
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1127         Q_LINKREACTION = 2 (2h) (10) "No reaction"
1128         Q_LOCACC = 1 (1h) (000001)
1129     N_ITER = 1 (1h) (00001)
1130         [0] D_LINK = 195 (C3h) (000000011000011) "195m"
1131     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1132         [0] NID_BG = 1019 (3FBh) (00001111111011)
1133         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1134         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1135         [0] Q_LOCACC = 1 (1h) (000001)
1136     Packet 27 - TrackToTrain - International SSP
1137         NID_PACKET = 27 (1Bh) (00011011)
1138         Q_DIR = 0 (0h) (00) "Reverse"
1139         L_PACKET = 86 (56h) (0000001010110)
1140         Q_SCALE = 1 (1h) (01) "1 m scale"
1141         D_STATIC = 0 (0h) (000000000000000) "0m"
1142         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1143         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
1144     N_ITER = 0 (0h) (00000)
1145     N_ITER = 1 (1h) (00001)
1146         [0] D_STATIC = 1002 (3EAh) (000001111101010)
        "1002m"
1147         [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
1148         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
1149     [0] N_ITER = 0 (0h) (00000)
1150     Packet 21 - TrackToTrain - Gradient Profile
1151         NID_PACKET = 21 (15h) (00010101)
1152         Q_DIR = 0 (0h) (00) "Reverse"
1153         L_PACKET = 126 (7Eh) (0000001111110)
1154         Q_SCALE = 1 (1h) (01) "1 m scale"
1155         D_GRADIENT = 0 (0h) (000000000000000) "0m"
1156         Q_GDIR = 1 (1h) (1) "Uphill"
1157         G_A = 15 (Fh) (00001111) "15 o/oo"
1158     N_ITER = 3 (3h) (00011)
1159         [0] D_GRADIENT = 601 (259h) (000001001011001)
        "601m"
1160         [0] Q_GDIR = 1 (1h) (1) "Uphill"
1161         [0] G_A = 5 (5h) (00000101) "5 o/oo"
1162         [1] D_GRADIENT = 128 (80h) (000000010000000)
        "128m"
1163         [1] Q_GDIR = 1 (1h) (1) "Uphill"
1164         [1] G_A = 15 (Fh) (00001111) "15 o/oo"

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1165         [2] D_GRADIENT = 273 (111h) (000000100010001)
           "273m"
1166         [2] Q_GDIR = 0 (0h) (0) "Downhill"
1167         [2] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
1168 09:47:32.123738 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
           :192.168.0.132
1169         10000100 00000110 10000010 11010001 11010001 01010111
           10010111 00100000 01110100 00000100 00000000 00001000
           00010000 00000010 00001111 11011100 11000111
           11000000 00000000 00110010 00000000 01100100 10000000
           11111000 00010100 00000011
1170         NID_MESSAGE = 132 (84h) (10000100)
1171         L_MESSAGE = 26 (1Ah) (0000011010)
1172         T_TRAIN = 189220190 (B47455Eh)
           (00001011010001110100010101011110)
1173         NID_ENGINE = 6062544 (5C81D0h)
           (010111001000000111010000)
1174         Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
           the perturbation location reached"
1175         Packet 0 - TrainToTrack - Pos Report
1176         NID_PACKET = 0 (0h) (00000000)
1177         L_PACKET = 129 (81h) (00000100000001)
1178         Q_SCALE = 0 (0h) (00) "10 cm scale"
1179         NID_LRBG = 33783 (83F7h) (000000001000001111110111)
1180         NID_C = 2 (2h) (0000000010)
1181         NID_BG = 1015 (3F7h) (00001111110111)
1182         D_LRBG = 6392 (18F8h) (001100011111000) "639.2m
           "
1183         Q_DIRLRBG = 0 (0h) (00) "Reverse"
1184         Q_DLRBG = 0 (0h) (00) "Reverse"
1185         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1186         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
           "
1187         Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
1188         L_TRAININT = 248 (F8h) (000000011111000)
1189         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1190         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
1191         M_MODE = 0 (0h) (0000) "Full Supervision"
1192         M_LEVEL = 3 (3h) (011) "Level 2"
1193 09:47:42.140784 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
           :192.168.0.132
1194         10000100 00000110 10000010 11010001 11010010 01010010
           00010111 00100000 01110100 00000100 00000000 00001000
           00010000 00000010 00001111 11010100 00101101
           00001000 00000000 00110010 00000000 01100100 10000000
           11111000 00010100 00000011

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1195     NID_MESSAGE = 132 (84h) (10000100)
1196     L_MESSAGE = 26 (1Ah) (0000011010)
1197     T_TRAIN = 189221192 (B474948h)
           (00001011010001110100100101001000)
1198     NID_ENGINE = 6062544 (5C81D0h)
           (010111001000000111010000)
1199     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
           the perturbation location reached"
1200     Packet 0 - TrainToTrack - Pos Report
1201         NID_PACKET = 0 (0h) (00000000)
1202         L_PACKET = 129 (81h) (0000010000001)
1203         Q_SCALE = 0 (0h) (00) "10 cm scale"
1204     NID_LRBG = 33781 (83F5h) (000000001000001111110101)
1205         NID_C = 2 (2h) (0000000010)
1206         NID_BG = 1013 (3F5h) (00001111110101)
1207         D_LRBG = 1441 (5A1h) (000010110100001) "144.1m"
1208         Q_DIRLRBG = 0 (0h) (00) "Reverse"
1209         Q_DLRBG = 0 (0h) (00) "Reverse"
1210         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1211         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
1212     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
1213         L_TRAININT = 248 (F8h) (000000011111000)
1214         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1215         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
1216         M_MODE = 0 (0h) (0000) "Full Supervision"
1217     M_LEVEL = 3 (3h) (011) "Level 2"
1218 09:47:42.169018 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
           (PK21) - Train 6062544 - Dest:192.168.0.134
1219     00000011 00010001 00000010 11010001 11010010 01010010
           00000000 00010000 01111110 10100001 11100000 00010110
           00010000 00000000 00000000 00000000 10111000
           00010000 00000000 00011111 10000111 00100000 00001100
           01000110 01111111 11110000 10100011 10100000
           00001001 00001000 01010111 11111111 11110010 00010000
           00001101 11110000 01010000 00001000 10101000
           00001100 00110000 01111111 01111000 00010000 00001101
           10000000 01010110 01000000 00000000 00001010
           10000000 00100000 01011100 00111111 10000000 00101010
           00000001 10011001 00000000 00000001 00000101
           00010000 00000101 11111000 01111000 00010001 00010111
           11111000
1220     NID_MESSAGE = 3 (3h) (00000011)
1221     L_MESSAGE = 68 (44h) (0001000100)
1222     T_TRAIN = 189221192 (B474948h)
           (00001011010001110100100101001000)
1223     M_ACK = 0 (0h) (0) "No acknowledgement required"
1224     NID_LRBG = 33781 (83F5h) (000000001000001111110101)

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1225         NID_C = 2 (2h) (0000000010)
1226         NID_BG = 1013 (3F5h) (0000111110101)
1227     Packet 15 - TrackToTrain - Level 2/3 MA
1228         NID_PACKET = 15 (Fh) (00001111)
1229         Q_DIR = 0 (0h) (00) "Reverse"
1230         L_PACKET = 88 (58h) (0000001011000)
1231         Q_SCALE = 1 (1h) (01) "1 m scale"
1232         V_EMA = 0 (0h) (00000000) "0 km/h"
1233         T_EMA = 0 (0h) (00000000000)
1234     N_ITER = 0 (0h) (000000)
1235         L_ENDSECTION = 368 (170h) (000000101110000)
1236         "368m"
1237     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
1238         information"
1239     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
1240         information"
1241     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
1242         follow"
1243         D_DP = 0 (0h) (0000000000000000) "0m"
1244         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
1245         calculated release speed"
1246     Q_OVERLAP = 0 (0h) (0) "No overlap information"
1247     Packet 57 - TrackToTrain - MA Request Params
1248         NID_PACKET = 57 (39h) (00111001)
1249         Q_DIR = 0 (0h) (00) "Reverse"
1250         L_PACKET = 49 (31h) (0000000110001)
1251         T_MAR = 25 (19h) (00011001)
1252         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
1253         request triggering with regards to this
1254         function"
1255         T_CYCRQST = 10 (Ah) (00001010)
1256     Packet 58 - TrackToTrain - Pos Report Params
1257         NID_PACKET = 58 (3Ah) (00111010)
1258         Q_DIR = 0 (0h) (00) "Reverse"
1259         L_PACKET = 72 (48h) (0000001001000)
1260         Q_SCALE = 1 (1h) (01) "1 m scale"
1261         T_CYCLOC = 10 (Ah) (00001010)
1262         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
1263         train has not to report cyclically its
1264         position"
1265         M_LOC = 1 (1h) (001) "Every LRBG compliant
1266         balise group"
1267     N_ITER = 1 (1h) (00001)
1268         [0] D_LOC = 111 (6Fh) (000000001101111) "111m"
1269         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1270     Packet 5 - TrackToTrain - Linking
1271         NID_PACKET = 5 (5h) (00000101)
1272         Q_DIR = 0 (0h) (00) "Reverse"
1273         L_PACKET = 69 (45h) (0000001000101)

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1264             Q_SCALE = 1 (1h) (01) "1 m scale"
1265             D_LINK = 195 (C3h) (000000011000011) "195m"
1266     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1267             NID_BG = 1019 (3FBh) (00001111111011)
1268             Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1269             Q_LINKREACTION = 2 (2h) (10) "No reaction"
1270             Q_LOACC = 1 (1h) (000001)
1271     N_ITER = 0 (0h) (00000)
1272     Packet 27 - TrackToTrain - International SSP
1273             NID_PACKET = 27 (1Bh) (00011011)
1274             Q_DIR = 0 (0h) (00) "Reverse"
1275             L_PACKET = 86 (56h) (0000001010110)
1276             Q_SCALE = 1 (1h) (01) "1 m scale"
1277             D_STATIC = 0 (0h) (000000000000000) "0m"
1278             V_STATIC = 10 (Ah) (0001010) "50 km/h"
1279             Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
1280     N_ITER = 0 (0h) (00000)
1281     N_ITER = 1 (1h) (00001)
1282     [0] D_STATIC = 368 (170h) (000000101110000)
           "368m"
1283     [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
1284     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
1285     [0] N_ITER = 0 (0h) (00000)
1286     Packet 21 - TrackToTrain - Gradient Profile
1287             NID_PACKET = 21 (15h) (00010101)
1288             Q_DIR = 0 (0h) (00) "Reverse"
1289             L_PACKET = 102 (66h) (0000001100110)
1290             Q_SCALE = 1 (1h) (01) "1 m scale"
1291             D_GRADIENT = 0 (0h) (000000000000000) "0m"
1292             Q_GDIR = 1 (1h) (1) "Uphill"
1293             G_A = 5 (5h) (00000101) "5 o/oo"
1294     N_ITER = 2 (2h) (00010)
1295     [0] D_GRADIENT = 95 (5Fh) (000000001011111) "95
           m"
1296     [0] Q_GDIR = 1 (1h) (1) "Uphill"
1297     [0] G_A = 15 (Fh) (00001111) "15 o/oo"
1298     [1] D_GRADIENT = 273 (111h) (000000100010001)
           "273m"
1299     [1] Q_GDIR = 0 (0h) (0) "Downhill"
1300     [1] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient

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description ends at D_GRADIENT(n)"
1301 09:47:43.140032 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
1302      10000100 00000110 10000010 11010001 11010010 01101011
          00010111 00100000 01110100 00000100 00000000 00001000
          00010000 00000010 00001111 11010100 00110001
          01100000 00000000 00110010 00000000 01100100 10000000
          11111000 00010100 00000011
1303      NID_MESSAGE = 132 (84h) (10000100)
1304      L_MESSAGE = 26 (1Ah) (0000011010)
1305      T_TRAIN = 189221292 (B4749ACh)
          (00001011010001110100100110101100)
1306      NID_ENGINE = 6062544 (5C81D0h)
          (010111001000000111010000)
1307      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
1308      Packet 0 - TrainToTrack - Pos Report
1309      NID_PACKET = 0 (0h) (00000000)
1310      L_PACKET = 129 (81h) (00000100000001)
1311      Q_SCALE = 0 (0h) (00) "10 cm scale"
1312      NID_LRBG = 33781 (83F5h) (000000001000001111110101)
1313      NID_C = 2 (2h) (0000000010)
1314      NID_BG = 1013 (3F5h) (00001111110101)
1315      D_LRBG = 1580 (62Ch) (000011000101100) "158.0m"
1316      Q_DIRLRBG = 0 (0h) (00) "Reverse"
1317      Q_DLRBG = 0 (0h) (00) "Reverse"
1318      L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1319      L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
          "
1320      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
1321      L_TRAININT = 248 (F8h) (000000011111000)
1322      V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1323      Q_DIRTRAIN = 0 (0h) (00) "Reverse"
1324      M_MODE = 0 (0h) (0000) "Full Supervision"
1325      M_LEVEL = 3 (3h) (011) "Level 2"
1326 09:47:47.836623 # VL Release Request (MsgId 3) - Dest
      :192.168.0.132
1327      Preamble = 65535 (FFFh) (1111111111111111)
1328      Length of PDU = 14 (0Eh) (0000000000001110)
1329      Message ID = 3 (03h) (00000011)
1330      Channel ID = 128 (80h) (10000000)
1331      DATA [0] = 2 (02h) (00000010)
1332      DATA [1] = 3 (03h) (00000011)
1333      DATA [2] = 0 (00h) (00000000)
1334      DATA [3] = 3 (03h) (00000011)
1335      DATA [4] = 16 (10h) (00010000)
1336      DATA [5] = 0 (00h) (00000000)
1337      DATA [6] = 0 (00h) (00000000)

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1338     DATA [7] = 2 (02h) (00000010)
1339     DATA [8] = 5 (05h) (00000101)
1340     DATA [9] = 0 (00h) (00000000)
1341     DATA [10] = 1 (01h) (00000001)
1342     DATA [11] = 128 (80h) (10000000)
1343 09:50:10.565945 # MA (MsgId 3) (PK15) (PK3) (PK57) (PK41) (PK58)
      (PK5) (PK27) (PK21) - Train 6062544 - Dest:192.168.0.134
1344     00000011 00100000 00000010 11010001 11100000 11001101
      10000000 00010000 01111111 01000001 11101000 00010110
      00010000 00000000 00000000 00000001 00001010
      10010000 00000000 00011111 10000000 01110000 01001001
      11011111 11111111 11100000 00010000 00000000
      00001000 00010000 00110000 01100000 00000000 00000000
      10011011 00000000 00100000 00000001 11100111
      11111000 00000000 00000100 01111001 11111111 11111100
      11110101 00011001 00010100 11000100 10110110
      01011010 01100010 01011101 00000000 00000001 01011000
      00000111 11001110 01010000 00011000 10001100
      11111111 11100001 01000101 00101000 00010110 01010000
      00000111 01101100 00000011 01111000 01001000
      10100000 00000110 11110011 10100100 00001001 00001000
      01010111 11111111 11110010 00010000 00000100
      01010000 01010100 00010111 01001000 00000010 10000000
      01111111 10001000 00010001 10000000 00011000
      00001000 00001001 10000001 00000000 10001100 00001111
      11011001 00000010 00000001 10101100 00011111
      10100010 00000100 01101101 00000010 10110010 00000000
      00000000 01010100 00000001 00000100 00101011
      11111100 00000001 01010100 00001001 11001000 00000000
      00001000 00000000 01000001 00001010 10111111
      11000000
1345     NID_MESSAGE = 3 (3h) (00000011)
1346     L_MESSAGE = 128 (80h) (0010000000)
1347     T_TRAIN = 189236022 (B478336h)
      (00001011010001111000001100110110)
1348     M_ACK = 0 (0h) (0) "No acknowledgement required"
1349     NID_LRBG = 33786 (83FAh) (000000001000001111111010)
1350         NID_C = 2 (2h) (0000000010)
1351         NID_BG = 1018 (3FAh) (000011111111010)
1352     Packet 15 - TrackToTrain - Level 2/3 MA
1353         NID_PACKET = 15 (Fh) (00001111)
1354         Q_DIR = 1 (1h) (01) "Nominal"
1355         L_PACKET = 88 (58h) (0000001011000)
1356         Q_SCALE = 1 (1h) (01) "1 m scale"
1357         V_EMA = 0 (0h) (00000000) "0 km/h"
1358         T_EMA = 0 (0h) (0000000000)
1359     N_ITER = 0 (0h) (00000)
1360         L_ENDSECTION = 533 (215h) (000001000010101)
      "533m"

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1361 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
1362 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
1363 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
1364     D_DP = 0 (0h) (0000000000000000) "0m"
1365     V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
1366 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1367 Packet 3 - TrackToTrain - National Values
1368     NID_PACKET = 3 (3h) (00000011)
1369     Q_DIR = 2 (2h) (10) "Both directions"
1370     L_PACKET = 295 (127h) (0000100100111)
1371     Q_SCALE = 1 (1h) (01) "1 m scale"
1372     D_VALIDNV = 32767 (7FFFh) (111111111111111)
      "32767m"
1373     NID_C = 2 (2h) (0000000010)
1374 N_ITER = 0 (0h) (00000)
1375     V_NVSHUNT = 0 (0h) (0000000) "0 km/h"
1376     V_NVSTFF = 8 (8h) (0001000) "40 km/h"
1377     V_NVONSIGHT = 8 (8h) (0001000) "40 km/h"
1378     V_NVLIMSUPERV = 12 (Ch) (0001100) "60 km/h"
1379     V_NVUNFIT = 12 (Ch) (0001100) "60 km/h"
1380     V_NVREL = 0 (0h) (0000000) "0 km/h"
1381     D_NVROLL = 4 (4h) (000000000000100) "4m"
1382     Q_NVSBTSMPerm = 1 (1h) (1) "Yes"
1383     Q_NVEMRRLS = 1 (1h) (1) "Revoke emergency brake
      command when permitted speed supervision
      limit is no longer exceeded"
1384     Q_NVGUIPERM = 0 (0h) (0) "No"
1385     Q_NVSBFBPerm = 1 (1h) (1) "Yes"
1386     Q_NVINHSMICPerm = 1 (1h) (1) "Yes"
1387     V_NVALLOWOVTRP = 0 (0h) (0000000) "0 km/h"
1388     V_NVSUPOVTRP = 8 (8h) (0001000) "40 km/h"
1389     D_NVVOVTRP = 60 (3Ch) (000000000111100) "60m"
1390     T_NVVOVTRP = 255 (FFh) (11111111)
1391     D_NVPOTRP = 0 (0h) (0000000000000000) "0m"
1392     M_NVCONTACT = 1 (1h) (01) "Apply service brake"
1393     T_NVCONTACT = 30 (1Eh) (00011110)
1394     M_NVDERUN = 0 (0h) (0) "No"
1395     D_NVSTFF = 32767 (7FFFh) (111111111111111) "
      Infinity"
1396     Q_NVDRIVER_ADHES = 0 (0h) (0) "Not allowed"
1397     A_NVMAXREDADH = 30 (1Eh) (011110) "1.50 m/s^2"
1398     A_NVMAXREDADH = 40 (28h) (101000) "2.00 m/s^2"
1399     A_NVMAXREDADH = 50 (32h) (110010) "2.50 m/s^2"
1400     Q_NVLOCACC = 10 (Ah) (001010) "10 m"
1401     M_NVAVADH = 12 (Ch) (01100) "0.60"

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1402           M_NVEBCL = 4 (4h) (0100) "Confidence level =
              99.99 %"
1403           Q_NVKINT = 1 (1h) (1) "Integrated correction
              factors follow"
1404           Q_NVKVINTSET = 1 (1h) (01) "Conventional
              passenger trains"
1405           A_NVP = 44 (2Ch) (101100) "2.20 m/s^2"
1406           A_NVP = 45 (2Dh) (101101) "2.25 m/s^2"
1407           V_NVKVINT = 24 (18h) (0011000) "120 km/h"
1408           M_NVKVINT = 75 (4Bh) (1001011) "1.50"
1409           M_NVKVINT = 80 (50h) (1010000) "1.60"
1410           N_ITER = 0 (0h) (00000)
1411           N_ITER = 0 (0h) (00000)
1412           L_NVKRINT = 10 (Ah) (01010) "600m"
1413           M_NVKRINT = 24 (18h) (11000) "1.20"
1414           N_ITER = 0 (0h) (00000)
1415           M_NVKTINT = 31 (1Fh) (11111) "1.55"
1416           Packet 57 - TrackToTrain - MA Request Params
1417           NID_PACKET = 57 (39h) (00111001)
1418           Q_DIR = 1 (1h) (01) "Nominal"
1419           L_PACKET = 49 (31h) (0000000110001)
1420           T_MAR = 25 (19h) (00011001)
1421           T_TIMEOURQST = 1023 (3FFh) (1111111111) "No MA
              request triggering with regards to this
              function"
1422           T_CYCRQST = 10 (Ah) (00001010)
1423           Packet 41 - TrackToTrain - Level Transition Order
1424           NID_PACKET = 41 (29h) (00101001)
1425           Q_DIR = 1 (1h) (01) "Nominal"
1426           L_PACKET = 89 (59h) (0000001011001)
1427           Q_SCALE = 1 (1h) (01) "1 m scale"
1428           D_LEVELTR = 59 (3Bh) (00000000111011) "59m"
1429           M_LEVELTR = 3 (3h) (011) "Level 2"
1430           L_ACKLEVELTR = 111 (6Fh) (000000001101111) "111
              m"
1431           N_ITER = 1 (1h) (00001)
1432           [0] M_LEVELTR = 1 (1h) (001) "Level NTC specified by
              NID_NTC"
1433           [0] NID_NTC = 20 (14h) (00010100)
1434           [0] L_ACKLEVELTR = 111 (6Fh) (000000001101111)
              "111m"
1435           Packet 58 - TrackToTrain - Pos Report Params
1436           NID_PACKET = 58 (3Ah) (00111010)
1437           Q_DIR = 1 (1h) (01) "Nominal"
1438           L_PACKET = 72 (48h) (0000001001000)
1439           Q_SCALE = 1 (1h) (01) "1 m scale"
1440           T_CYCLOC = 10 (Ah) (00001010)
1441           D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
              train has not to report cyclically its

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1442             position"
1443             M_LOC = 1 (1h) (001) "Every LRBG compliant
1444             balise group"
1443 N_ITER = 1 (1h) (00001)
1444 [0] D_LOC = 34 (22h) (000000000100010) "34m"
1445 [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1446 Packet 5 - TrackToTrain - Linking
1447 NID_PACKET = 5 (5h) (00000101)
1448 Q_DIR = 1 (1h) (01) "Nominal"
1449 L_PACKET = 186 (BAh) (0000010111010)
1450 Q_SCALE = 1 (1h) (01) "1 m scale"
1451 D_LINK = 40 (28h) (000000000101000) "40m"
1452 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
1453             administration, no NID_C follows"
1454 NID_BG = 1020 (3FCh) (00001111111100)
1455 Q_LINKORIENTATION = 0 (0h) (0) "The balise
1456             group is seen by the train in reverse
1457             direction"
1458 Q_LINKREACTION = 2 (2h) (10) "No reaction"
1459 Q_LOCACC = 1 (1h) (000001)
1460 N_ITER = 3 (3h) (00011)
1461 [0] D_LINK = 24 (18h) (000000000011000) "24m"
1462 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
1463             administration, no NID_C follows"
1464 [0] NID_BG = 1028 (404h) (00010000000100)
1465 [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
1466             group is seen by the train in nominal
1467             direction"
1468 [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1469 [0] Q_LOCACC = 1 (1h) (000001)
1470 [1] D_LINK = 70 (46h) (000000001000110) "70m"
1471 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
1472             administration, no NID_C follows"
1473 [1] NID_BG = 1014 (3F6h) (00001111110110)
1474 [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
1475             group is seen by the train in reverse
1476             direction"
1477 [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1478 [1] Q_LOCACC = 1 (1h) (000001)
1479 [2] D_LINK = 107 (6Bh) (000000001101011) "107m"
1480 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
1481             administration, no NID_C follows"
1482 [2] NID_BG = 1012 (3F4h) (00001111110100)
1483 [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
1484             group is seen by the train in reverse
1485             direction"
1486 [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1487 [2] Q_LOCACC = 1 (1h) (000001)
1488 Packet 27 - TrackToTrain - International SSP
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1477 NID_PACKET = 27 (1Bh) (00011011)
1478 Q_DIR = 1 (1h) (01) "Nominal"
1479 L_PACKET = 86 (56h) (0000001010110)
1480 Q_SCALE = 1 (1h) (01) "1 m scale"
1481 D_STATIC = 0 (0h) (000000000000000) "0m"
1482 V_STATIC = 10 (Ah) (0001010) "50 km/h"
1483 Q_FRONT = 1 (1h) (1) "No train length delay on
      validity end point of profile element"
1484 N_ITER = 0 (0h) (00000)
1485 N_ITER = 1 (1h) (00001)
1486 [0] D_STATIC = 533 (215h) (000001000010101)
      "533m"
1487 [0] V_STATIC = 127 (7Fh) (1111111) "Non
      numerical value telling that the static
      speed profile description ends at D_STATIC(n
      )"
1488 [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
1489 [0] N_ITER = 0 (0h) (00000)
1490 Packet 21 - TrackToTrain - Gradient Profile
1491 NID_PACKET = 21 (15h) (00010101)
1492 Q_DIR = 1 (1h) (01) "Nominal"
1493 L_PACKET = 78 (4Eh) (0000001001110)
1494 Q_SCALE = 1 (1h) (01) "1 m scale"
1495 D_GRADIENT = 0 (0h) (000000000000000) "0m"
1496 Q_GDIR = 1 (1h) (1) "Uphill"
1497 G_A = 0 (0h) (00000000) "0 o/oo"
1498 N_ITER = 1 (1h) (00001)
1499 [0] D_GRADIENT = 533 (215h) (000001000010101)
      "533m"
1500 [0] Q_GDIR = 0 (0h) (0) "Downhill"
1501 [0] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"
1502 09:50:11.082028 # MA (MsgId 3) (PK15) (PK3) (PK57) (PK41) (PK58)
      (PK5) (PK27) (PK21) - Train 6062544 - Dest:192.168.0.134
1503 00000011 00100001 11000010 11010001 11100000 11011100
      10000000 00010000 01111111 01000001 11101000 00010110
      00010000 00000000 00000000 00000001 01010101
      10010000 00000000 00011111 10000000 01110000 01001001
      11011111 11111111 11100000 00010000 00000000
      00001000 00010000 00110000 01100000 00000000 00000000
      10011011 00000000 00100000 00000001 11100111
      11111000 00000000 00000100 01111001 11111111 11111100
      11110101 00011001 00010100 11000100 10110110
      01011010 01100010 01011101 00000000 00000001 01011000
      00000111 11001110 01010000 00011000 10001100
      11111111 11100001 01000101 00101000 00010110 01010000
      00000111 01101100 00000011 01111000 01001000

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10100000 00000110 11110011 10100100 00001011 00001000
01010111 11111111 11110010 00100000 00000100
01010000 01000001 11010000 01010100 00011100 00101000
00000010 10000000 01111111 10001000 00010010
00000000 00011000 00001000 00001001 10000001 00000000
10001100 00001111 11011001 00000010 00000001
10101100 00011111 10100010 00000100 00001001 11000000
00111111 00100100 00001000 11011010 00000101
01100100 00000000 00000000 10101000 00000010 00001010
10101111 11111000 00000010 10101000 00010011
10010000 00000000 00010000 00000000 10000010 10101011
01111111 10000000
1504 NID_MESSAGE = 3 (3h) (00000011)
1505 L_MESSAGE = 135 (87h) (0010000111)
1506 T_TRAIN = 189236082 (B478372h)
      (00001011010001111000001101110010)
1507 M_ACK = 0 (0h) (0) "No acknowledgement required"
1508 NID_LRBG = 33786 (83FAh) (0000000010000011111111010)
1509 NID_C = 2 (2h) (0000000010)
1510 NID_BG = 1018 (3FAh) (000011111111010)
1511 Packet 15 - TrackToTrain - Level 2/3 MA
1512 NID_PACKET = 15 (Fh) (00001111)
1513 Q_DIR = 1 (1h) (01) "Nominal"
1514 L_PACKET = 88 (58h) (0000001011000)
1515 Q_SCALE = 1 (1h) (01) "1 m scale"
1516 V_EMA = 0 (0h) (00000000) "0 km/h"
1517 T_EMA = 0 (0h) (0000000000)
1518 N_ITER = 0 (0h) (00000)
1519 L_ENDSECTION = 683 (2ABh) (000001010101011)
      "683m"
1520 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
1521 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
1522 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
1523 D_DP = 0 (0h) (0000000000000000) "0m"
1524 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
1525 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1526 Packet 3 - TrackToTrain - National Values
1527 NID_PACKET = 3 (3h) (00000011)
1528 Q_DIR = 2 (2h) (10) "Both directions"
1529 L_PACKET = 295 (127h) (0000100100111)
1530 Q_SCALE = 1 (1h) (01) "1 m scale"
1531 D_VALIDNV = 32767 (7FFFh) (111111111111111)
      "32767m"
1532 NID_C = 2 (2h) (0000000010)
1533 N_ITER = 0 (0h) (00000)

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1534 V_NVSHUNT = 0 (0h) (0000000) "0 km/h"
1535 V_NVSTFF = 8 (8h) (0001000) "40 km/h"
1536 V_NVONSIGHT = 8 (8h) (0001000) "40 km/h"
1537 V_NVLIMSUPERV = 12 (Ch) (0001100) "60 km/h"
1538 V_NVUNFIT = 12 (Ch) (0001100) "60 km/h"
1539 V_NVREL = 0 (0h) (0000000) "0 km/h"
1540 D_NVROLL = 4 (4h) (000000000000100) "4m"
1541 Q_NVSBTSMPerm = 1 (1h) (1) "Yes"
1542 Q_NVEMRRLS = 1 (1h) (1) "Revoke emergency brake
      command when permitted speed supervision
      limit is no longer exceeded"
1543 Q_NVGUIPERM = 0 (0h) (0) "No"
1544 Q_NVSBFBPerm = 1 (1h) (1) "Yes"
1545 Q_NVINHSMICPerm = 1 (1h) (1) "Yes"
1546 V_NVALLOWOVTRP = 0 (0h) (0000000) "0 km/h"
1547 V_NVSUPOVTRP = 8 (8h) (0001000) "40 km/h"
1548 D_NVOVTRP = 60 (3Ch) (000000000111100) "60m"
1549 T_NVOVTRP = 255 (FFh) (11111111)
1550 D_NVPOTRP = 0 (0h) (000000000000000) "0m"
1551 M_NVCONTACT = 1 (1h) (01) "Apply service brake"
1552 T_NVCONTACT = 30 (1Eh) (00011110)
1553 M_NVDERUN = 0 (0h) (0) "No"
1554 D_NVSTFF = 32767 (7FFFh) (111111111111111) "
      Infinity"
1555 Q_NVDRIVER_ADHES = 0 (0h) (0) "Not allowed"
1556 A_NVMAXREDADH = 30 (1Eh) (011110) "1.50 m/s^2"
1557 A_NVMAXREDADH = 40 (28h) (101000) "2.00 m/s^2"
1558 A_NVMAXREDADH = 50 (32h) (110010) "2.50 m/s^2"
1559 Q_NVLOCACC = 10 (Ah) (001010) "10 m"
1560 M_NVAVADH = 12 (Ch) (01100) "0.60"
1561 M_NVEBCL = 4 (4h) (0100) "Confidence level =
      99.99 %"
1562 Q_NVKINT = 1 (1h) (1) "Integrated correction
      factors follow"
1563 Q_NVKVINTSET = 1 (1h) (01) "Conventional
      passenger trains"
1564 A_NVP = 44 (2Ch) (101100) "2.20 m/s^2"
1565 A_NVP = 45 (2Dh) (101101) "2.25 m/s^2"
1566 V_NVKVINT = 24 (18h) (0011000) "120 km/h"
1567 M_NVKVINT = 75 (4Bh) (1001011) "1.50"
1568 M_NVKVINT = 80 (50h) (1010000) "1.60"
1569 N_ITER = 0 (0h) (00000)
1570 N_ITER = 0 (0h) (00000)
1571 L_NVKRINT = 10 (Ah) (01010) "600m"
1572 M_NVKRINT = 24 (18h) (11000) "1.20"
1573 N_ITER = 0 (0h) (00000)
1574 M_NVKTINT = 31 (1Fh) (11111) "1.55"
1575 Packet 57 - TrackToTrain - MA Request Params
1576 NID_PACKET = 57 (39h) (00111001)

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1577         Q_DIR = 1 (1h) (01) "Nominal"
1578         L_PACKET = 49 (31h) (0000000110001)
1579         T_MAR = 25 (19h) (00011001)
1580         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
1581         T_CYCRQST = 10 (Ah) (00001010)
1582 Packet 41 - TrackToTrain - Level Transition Order
1583         NID_PACKET = 41 (29h) (00101001)
1584         Q_DIR = 1 (1h) (01) "Nominal"
1585         L_PACKET = 89 (59h) (0000001011001)
1586         Q_SCALE = 1 (1h) (01) "1 m scale"
1587         D_LEVELTR = 59 (3Bh) (00000000111011) "59m"
1588 M_LEVELTR = 3 (3h) (011) "Level 2"
1589         L_ACKLEVELTR = 111 (6Fh) (000000001101111) "111
           m"
1590 N_ITER = 1 (1h) (00001)
1591 [0] M_LEVELTR = 1 (1h) (001) "Level NTC specified by
           NID_NTC"
1592         [0] NID_NTC = 20 (14h) (00010100)
1593         [0] L_ACKLEVELTR = 111 (6Fh) (000000001101111)
           "111m"
1594 Packet 58 - TrackToTrain - Pos Report Params
1595         NID_PACKET = 58 (3Ah) (00111010)
1596         Q_DIR = 1 (1h) (01) "Nominal"
1597         L_PACKET = 88 (58h) (0000001011000)
1598         Q_SCALE = 1 (1h) (01) "1 m scale"
1599         T_CYCLOC = 10 (Ah) (00001010)
1600         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
1601         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1602 N_ITER = 2 (2h) (00010)
1603         [0] D_LOC = 34 (22h) (000000000100010) "34m"
1604         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1605         [1] D_LOC = 526 (20Eh) (000001000001110) "526m"
1606         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1607 Packet 5 - TrackToTrain - Linking
1608         NID_PACKET = 5 (5h) (00000101)
1609         Q_DIR = 1 (1h) (01) "Nominal"
1610         L_PACKET = 225 (E1h) (0000011100001)
1611         Q_SCALE = 1 (1h) (01) "1 m scale"
1612         D_LINK = 40 (28h) (000000000101000) "40m"
1613 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1614         NID_BG = 1020 (3FCh) (00001111111100)
1615         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse

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direction"
1616 Q_LINKREACTION = 2 (2h) (10) "No reaction"
1617 Q_LOCACC = 1 (1h) (000001)
1618 N_ITER = 4 (4h) (00100)
1619 [0] D_LINK = 24 (18h) (000000000011000) "24m"
1620 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
1621 [0] NID_BG = 1028 (404h) (00010000000100)
1622 [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
1623 [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1624 [0] Q_LOCACC = 1 (1h) (000001)
1625 [1] D_LINK = 70 (46h) (000000001000110) "70m"
1626 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
1627 [1] NID_BG = 1014 (3F6h) (00001111110110)
1628 [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
1629 [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1630 [1] Q_LOCACC = 1 (1h) (000001)
1631 [2] D_LINK = 107 (6Bh) (000000001101011) "107m"
1632 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
1633 [2] NID_BG = 1012 (3F4h) (00001111110100)
1634 [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
1635 [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1636 [2] Q_LOCACC = 1 (1h) (000001)
1637 [3] D_LINK = 312 (138h) (000000100111000) "312m
"
1638 [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
1639 [3] NID_BG = 1010 (3F2h) (00001111110010)
1640 [3] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
1641 [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1642 [3] Q_LOCACC = 1 (1h) (000001)
1643 Packet 27 - TrackToTrain - International SSP
1644 NID_PACKET = 27 (1Bh) (00011011)
1645 Q_DIR = 1 (1h) (01) "Nominal"
1646 L_PACKET = 86 (56h) (0000001010110)
1647 Q_SCALE = 1 (1h) (01) "1 m scale"
1648 D_STATIC = 0 (0h) (000000000000000) "0m"
1649 V_STATIC = 10 (Ah) (0001010) "50 km/h"
1650 Q_FRONT = 1 (1h) (1) "No train length delay on

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                                validity end point of profile element"
1651     N_ITER = 0 (0h) (00000)
1652     N_ITER = 1 (1h) (00001)
1653     [0] D_STATIC = 683 (2ABh) (000001010101011)
           "683m"
1654     [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
1655     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
1656     [0] N_ITER = 0 (0h) (00000)
1657     Packet 21 - TrackToTrain - Gradient Profile
1658     NID_PACKET = 21 (15h) (00010101)
1659     Q_DIR = 1 (1h) (01) "Nominal"
1660     L_PACKET = 78 (4Eh) (0000001001110)
1661     Q_SCALE = 1 (1h) (01) "1 m scale"
1662     D_GRADIENT = 0 (0h) (000000000000000) "0m"
1663     Q_GDIR = 1 (1h) (1) "Uphill"
1664     G_A = 0 (0h) (00000000) "0 o/oo"
1665     N_ITER = 1 (1h) (00001)
1666     [0] D_GRADIENT = 683 (2ABh) (000001010101011)
           "683m"
1667     [0] Q_GDIR = 0 (0h) (0) "Downhill"
1668     [0] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
1669 09:50:12.104090 # MA (MsgId 3) (PK15) (PK3) (PK57) (PK41) (PK58)
           (PK5) (PK27) - Train 6062544 - Dest:192.168.0.134
1670 00000011 00100011 01000010 11010001 11100000 11110101
           10000000 00010000 01111111 01000001 11101000 00010110
           00010000 00000000 00000000 00000011 00000011
           00010000 00000000 00011111 10000000 01110000 01001001
           11011111 11111111 11100000 00010000 00000000
           00001000 00010000 00110000 01100000 00000000 00000000
           10011011 00000000 00100000 00000001 11100111
           11111000 00000000 00000100 01111001 11111111 11111100
           11110101 00011001 00010100 11000100 10110110
           01011010 01100010 01011101 00000000 00000001 01011000
           00000111 11001110 01010000 00011000 10001100
           11111111 11100001 01000101 00101000 00010110 01010000
           00000111 01101100 00000011 01111000 01001000
           10100000 00000110 11110011 10100100 00001101 00001000
           01010111 11111111 11110010 00110000 00000100
           01010000 01000001 11010000 00010010 11010000 01010100
           00100001 00001000 00000010 10000000 01111111
           10001000 00010010 10000000 00011000 00001000 00001001
           10000001 00000000 10001100 00001111 11011001
           00000010 00000001 10101100 00011111 10100010 00000100

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00001001 11000000 00111111 00100100 00001000
00101111 00010000 01111110 00001000 00010001 10110100
00001010 11001000 00000000 00000001 01010000
00000100 00110000 00110111 11110000 00000101 01010000
00100111 00100000 00000000 00100000 00000001
00001100 00001100 11111111
1671 NID_MESSAGE = 3 (3h) (00000011)
1672 L_MESSAGE = 141 (8Dh) (0010001101)
1673 T_TRAIN = 189236182 (B4783D6h)
(00001011010001111000001111010110)
1674 M_ACK = 0 (0h) (0) "No acknowledgement required"
1675 NID_LRBG = 33786 (83FAh) (000000001000001111111010)
1676 NID_C = 2 (2h) (0000000010)
1677 NID_BG = 1018 (3FAh) (00001111111010)
1678 Packet 15 - TrackToTrain - Level 2/3 MA
1679 NID_PACKET = 15 (Fh) (00001111)
1680 Q_DIR = 1 (1h) (01) "Nominal"
1681 L_PACKET = 88 (58h) (0000001011000)
1682 Q_SCALE = 1 (1h) (01) "1 m scale"
1683 V_EMA = 0 (0h) (00000000) "0 km/h"
1684 T_EMA = 0 (0h) (0000000000)
1685 N_ITER = 0 (0h) (000000)
1686 L_ENDSECTION = 1542 (606h) (000011000000110)
"1542m"
1687 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
1688 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
1689 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
1690 D_DP = 0 (0h) (0000000000000000) "0m"
1691 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
1692 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1693 Packet 3 - TrackToTrain - National Values
1694 NID_PACKET = 3 (3h) (00000011)
1695 Q_DIR = 2 (2h) (10) "Both directions"
1696 L_PACKET = 295 (127h) (0000100100111)
1697 Q_SCALE = 1 (1h) (01) "1 m scale"
1698 D_VALIDNV = 32767 (7FFFh) (111111111111111)
"32767m"
1699 NID_C = 2 (2h) (0000000010)
1700 N_ITER = 0 (0h) (000000)
1701 V_NVSHUNT = 0 (0h) (00000000) "0 km/h"
1702 V_NVSTFF = 8 (8h) (00010000) "40 km/h"
1703 V_NVONSIGHT = 8 (8h) (00010000) "40 km/h"
1704 V_NVLIMSUPERV = 12 (Ch) (0001100) "60 km/h"
1705 V_NVUNFIT = 12 (Ch) (0001100) "60 km/h"
1706 V_NVREL = 0 (0h) (00000000) "0 km/h"

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C. Simulation Traces

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1707 D_NVROLL = 4 (4h) (000000000000100) "4m"
1708 Q_NVSBTSMPerm = 1 (1h) (1) "Yes"
1709 Q_NVEMRRLS = 1 (1h) (1) "Revoke emergency brake
      command when permitted speed supervision
      limit is no longer exceeded"
1710 Q_NVGUIPERM = 0 (0h) (0) "No"
1711 Q_NVSBFBPerm = 1 (1h) (1) "Yes"
1712 Q_NVINHSMICPerm = 1 (1h) (1) "Yes"
1713 V_NVALLOWOVTRP = 0 (0h) (0000000) "0 km/h"
1714 V_NVSUPOVTRP = 8 (8h) (0001000) "40 km/h"
1715 D_NVOVTRP = 60 (3Ch) (000000000111100) "60m"
1716 T_NVOVTRP = 255 (FFh) (11111111)
1717 D_NVPOTRP = 0 (0h) (000000000000000) "0m"
1718 M_NVCONTACT = 1 (1h) (01) "Apply service brake"
1719 T_NVCONTACT = 30 (1Eh) (00011110)
1720 M_NVDERUN = 0 (0h) (0) "No"
1721 D_NVSTFF = 32767 (7FFFh) (111111111111111) "
      Infinity"
1722 Q_NVDRIVER_ADHES = 0 (0h) (0) "Not allowed"
1723 A_NVMAXREDADH = 30 (1Eh) (011110) "1.50 m/s^2"
1724 A_NVMAXREDADH = 40 (28h) (101000) "2.00 m/s^2"
1725 A_NVMAXREDADH = 50 (32h) (110010) "2.50 m/s^2"
1726 Q_NVLOCACC = 10 (Ah) (001010) "10 m"
1727 M_NVAVADH = 12 (Ch) (01100) "0.60"
1728 M_NVEBCL = 4 (4h) (0100) "Confidence level =
      99.99 %"
1729 Q_NVKINT = 1 (1h) (1) "Integrated correction
      factors follow"
1730 Q_NVKVINTSET = 1 (1h) (01) "Conventional
      passenger trains"
1731 A_NVVP = 44 (2Ch) (101100) "2.20 m/s^2"
1732 A_NVVP = 45 (2Dh) (101101) "2.25 m/s^2"
1733 V_NVKVINT = 24 (18h) (0011000) "120 km/h"
1734 M_NVKVINT = 75 (4Bh) (1001011) "1.50"
1735 M_NVKVINT = 80 (50h) (1010000) "1.60"
1736 N_ITER = 0 (0h) (00000)
1737 N_ITER = 0 (0h) (00000)
1738 L_NVKRINT = 10 (Ah) (01010) "600m"
1739 M_NVKRINT = 24 (18h) (11000) "1.20"
1740 N_ITER = 0 (0h) (00000)
1741 M_NVKTINT = 31 (1Fh) (11111) "1.55"
1742 Packet 57 - TrackToTrain - MA Request Params
1743 NID_PACKET = 57 (39h) (00111001)
1744 Q_DIR = 1 (1h) (01) "Nominal"
1745 L_PACKET = 49 (31h) (0000000110001)
1746 T_MAR = 25 (19h) (00011001)
1747 T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
      request triggering with regards to this
      function"

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1748         T_CYCRQST = 10 (Ah) (00001010)
1749 Packet 41 - TrackToTrain - Level Transition Order
1750         NID_PACKET = 41 (29h) (00101001)
1751         Q_DIR = 1 (1h) (01) "Nominal"
1752         L_PACKET = 89 (59h) (0000001011001)
1753         Q_SCALE = 1 (1h) (01) "1 m scale"
1754         D_LEVELTR = 59 (3Bh) (000000000111011) "59m"
1755 M_LEVELTR = 3 (3h) (011) "Level 2"
1756         L_ACKLEVELTR = 111 (6Fh) (000000001101111) "111
           m"
1757 N_ITER = 1 (1h) (00001)
1758 [0] M_LEVELTR = 1 (1h) (001) "Level NTC specified by
           NID_NTC"
1759         [0] NID_NTC = 20 (14h) (00010100)
1760         [0] L_ACKLEVELTR = 111 (6Fh) (000000001101111)
           "111m"
1761 Packet 58 - TrackToTrain - Pos Report Params
1762         NID_PACKET = 58 (3Ah) (00111010)
1763         Q_DIR = 1 (1h) (01) "Nominal"
1764         L_PACKET = 104 (68h) (0000001101000)
1765         Q_SCALE = 1 (1h) (01) "1 m scale"
1766         T_CYCLOC = 10 (Ah) (00001010)
1767         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
1768         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1769 N_ITER = 3 (3h) (00011)
1770         [0] D_LOC = 34 (22h) (000000000100010) "34m"
1771         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1772         [1] D_LOC = 526 (20Eh) (000001000001110) "526m"
1773         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1774         [2] D_LOC = 150 (96h) (000000010010110) "150m"
1775         [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1776 Packet 5 - TrackToTrain - Linking
1777         NID_PACKET = 5 (5h) (00000101)
1778         Q_DIR = 1 (1h) (01) "Nominal"
1779         L_PACKET = 264 (108h) (0000100001000)
1780         Q_SCALE = 1 (1h) (01) "1 m scale"
1781         D_LINK = 40 (28h) (000000000101000) "40m"
1782 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1783         NID_BG = 1020 (3FCh) (000011111111100)
1784         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
1785         Q_LINKREACTION = 2 (2h) (10) "No reaction"
1786         Q_LOCACCC = 1 (1h) (000001)
1787 N_ITER = 5 (5h) (00101)

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1788          [0] D_LINK = 24 (18h) (000000000011000) "24m"
1789 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1790          [0] NID_BG = 1028 (404h) (00010000000100)
1791          [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
1792          [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1793          [0] Q_LOCACC = 1 (1h) (000001)
1794          [1] D_LINK = 70 (46h) (000000001000110) "70m"
1795 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1796          [1] NID_BG = 1014 (3F6h) (00001111110110)
1797          [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1798          [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1799          [1] Q_LOCACC = 1 (1h) (000001)
1800          [2] D_LINK = 107 (6Bh) (000000001101011) "107m"
1801 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1802          [2] NID_BG = 1012 (3F4h) (00001111110100)
1803          [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1804          [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1805          [2] Q_LOCACC = 1 (1h) (000001)
1806          [3] D_LINK = 312 (138h) (000000100111000) "312m
      "
1807 [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1808          [3] NID_BG = 1010 (3F2h) (00001111110010)
1809          [3] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1810          [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1811          [3] Q_LOCACC = 1 (1h) (000001)
1812          [4] D_LINK = 753 (2F1h) (000001011110001) "753m
      "
1813 [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1814          [4] NID_BG = 1008 (3F0h) (00001111110000)
1815          [4] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1816          [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1817          [4] Q_LOCACC = 1 (1h) (000001)
1818 Packet 27 - TrackToTrain - International SSP
1819          NID_PACKET = 27 (1Bh) (00011011)
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1820         Q_DIR = 1 (1h) (01) "Nominal"
1821         L_PACKET = 86 (56h) (0000001010110)
1822         Q_SCALE = 1 (1h) (01) "1 m scale"
1823         D_STATIC = 0 (0h) (0000000000000000) "0m"
1824         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1825         Q_FRONT = 1 (1h) (1) "No train length delay on
            validity end point of profile element"
1826     N_ITER = 0 (0h) (00000)
1827     N_ITER = 1 (1h) (00001)
1828         [0] D_STATIC = 1542 (606h) (000011000000110)
            "1542m"
1829         [0] V_STATIC = 127 (7Fh) (1111111) "Non
            numerical value telling that the static
            speed profile description ends at D_STATIC(n
            )"
1830         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
            validity end point of profile element"
1831     [0] N_ITER = 0 (0h) (00000)
1832     Packet 21 - TrackToTrain - Gradient Profile
1833         NID_PACKET = 21 (15h) (00010101)
1834         Q_DIR = 1 (1h) (01) "Nominal"
1835         L_PACKET = 78 (4Eh) (0000001001110)
1836         Q_SCALE = 1 (1h) (01) "1 m scale"
1837         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
1838         Q_GDIR = 1 (1h) (1) "Uphill"
1839         G_A = 0 (0h) (00000000) "0 o/oo"
1840     N_ITER = 1 (1h) (00001)
1841         [0] D_GRADIENT = 1542 (606h) (000011000000110)
            "1542m"
1842         [0] Q_GDIR = 0 (0h) (0) "Downhill"
1843         [0] G_A = 255 (FFh) (11111111) "Non numerical
            value telling that the current gradient
            description ends at D_GRADIENT(n)"
1844 09:51:00.965730 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
            (PK21) - Train 6062544 - Dest:192.168.0.134
1845     00000011 00010011 11000010 11010001 11100101 10111011
            11000000 00010000 01111110 01000001 11100000 00010110
            00010000 00000000 00000000 00000101 10011001
            00010000 00000000 00011111 10000111 00100000 00001100
            01000110 01111111 11110000 10100011 10100000
            00001101 00001000 01010111 11111111 11110010 00110000
            00000000 11110000 00010010 11010000 01101011
            01110000 01010000 00010010 01101000 00101111 00010000
            01111110 00001000 00010001 00000100 11111100
            00000111 11001000 10000001 00000101 10011110 00001111
            10111001 00000010 00110110 00000001 01011001
            00000000 00000000 00101010 00000000 10001011 00110010
            11111110 00000000 10101000 00000100 11100100
            00000000 00000100 00000000 00100010 11001100 10011111

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11100000
1846 NID_MESSAGE = 3 (3h) (00000011)
1847 L_MESSAGE = 79 (4Fh) (0001001111)
1848 T_TRAIN = 189241071 (B4796EFh)
      (00001011010001111001011011101111)
1849 M_ACK = 0 (0h) (0) "No acknowledgement required"
1850 NID_LRBG = 33778 (83F2h) (000000001000001111110010)
1851 NID_C = 2 (2h) (0000000010)
1852 NID_BG = 1010 (3F2h) (00001111110010)
1853 Packet 15 - TrackToTrain - Level 2/3 MA
1854 NID_PACKET = 15 (Fh) (00001111)
1855 Q_DIR = 0 (0h) (00) "Reverse"
1856 L_PACKET = 88 (58h) (0000001011000)
1857 Q_SCALE = 1 (1h) (01) "1 m scale"
1858 V_EMA = 0 (0h) (00000000) "0 km/h"
1859 T_EMA = 0 (0h) (0000000000)
1860 N_ITER = 0 (0h) (00000)
1861 L_ENDSECTION = 2866 (B32h) (000101100110010)
      "2866m"
1862 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
1863 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
1864 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
1865 D_DP = 0 (0h) (0000000000000000) "0m"
1866 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
1867 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1868 Packet 57 - TrackToTrain - MA Request Params
1869 NID_PACKET = 57 (39h) (00111001)
1870 Q_DIR = 0 (0h) (00) "Reverse"
1871 L_PACKET = 49 (31h) (0000000110001)
1872 T_MAR = 25 (19h) (00011001)
1873 T_TIMEOUSRQST = 1023 (3FFh) (1111111111) "No MA
      request triggering with regards to this
      function"
1874 T_CYCRQST = 10 (Ah) (00001010)
1875 Packet 58 - TrackToTrain - Pos Report Params
1876 NID_PACKET = 58 (3Ah) (00111010)
1877 Q_DIR = 0 (0h) (00) "Reverse"
1878 L_PACKET = 104 (68h) (0000001101000)
1879 Q_SCALE = 1 (1h) (01) "1 m scale"
1880 T_CYCLOC = 10 (Ah) (00001010)
1881 D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
      train has not to report cyclically its
      position"
1882 M_LOC = 1 (1h) (001) "Every LRBG compliant
      balise group"

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1883     N_ITER = 3 (3h) (00011)
1884     [0] D_LOC = 7 (7h) (000000000000111) "7m"
1885     [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1886     [1] D_LOC = 150 (96h) (000000010010110) "150m"
1887     [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1888     [2] D_LOC = 859 (35Bh) (000001101011011) "859m"
1889     [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1890     Packet 5 - TrackToTrain - Linking
1891     NID_PACKET = 5 (5h) (00000101)
1892     Q_DIR = 0 (0h) (00) "Reverse"
1893     L_PACKET = 147 (93h) (0000010010011)
1894     Q_SCALE = 1 (1h) (01) "1 m scale"
1895     D_LINK = 753 (2F1h) (000001011110001) "753m"
1896     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1897     NID_BG = 1008 (3F0h) (00001111110000)
1898     Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1899     Q_LINKREACTION = 2 (2h) (10) "No reaction"
1900     Q_LOCACC = 1 (1h) (000001)
1901     N_ITER = 2 (2h) (00010)
1902     [0] D_LINK = 1276 (4FCh) (000010011111100)
      "1276m"
1903     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1904     [0] NID_BG = 996 (3E4h) (00001111100100)
1905     [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1906     [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1907     [0] Q_LOCACC = 1 (1h) (000001)
1908     [1] D_LINK = 719 (2CFh) (000001011001111) "719m
      "
1909     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1910     [1] NID_BG = 1006 (3EEh) (00001111101110)
1911     [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1912     [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1913     [1] Q_LOCACC = 1 (1h) (000001)
1914     Packet 27 - TrackToTrain - International SSP
1915     NID_PACKET = 27 (1Bh) (00011011)
1916     Q_DIR = 0 (0h) (00) "Reverse"
1917     L_PACKET = 86 (56h) (0000001010110)
1918     Q_SCALE = 1 (1h) (01) "1 m scale"
1919     D_STATIC = 0 (0h) (000000000000000) "0m"
1920     V_STATIC = 10 (Ah) (0001010) "50 km/h"

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1921          Q_FRONT = 1 (1h) (1) "No train length delay on
              validity end point of profile element"
1922          N_ITER = 0 (0h) (00000)
1923          N_ITER = 1 (1h) (00001)
1924          [0] D_STATIC = 2866 (B32h) (000101100110010)
              "2866m"
1925          [0] V_STATIC = 127 (7Fh) (1111111) "Non
              numerical value telling that the static
              speed profile description ends at D_STATIC(n
              )"
1926          [0] Q_FRONT = 0 (0h) (0) "Train length delay on
              validity end point of profile element"
1927          [0] N_ITER = 0 (0h) (00000)
1928          Packet 21 - TrackToTrain - Gradient Profile
1929          NID_PACKET = 21 (15h) (00010101)
1930          Q_DIR = 0 (0h) (00) "Reverse"
1931          L_PACKET = 78 (4Eh) (0000001001110)
1932          Q_SCALE = 1 (1h) (01) "1 m scale"
1933          D_GRADIENT = 0 (0h) (000000000000000) "0m"
1934          Q_GDIR = 1 (1h) (1) "Uphill"
1935          G_A = 0 (0h) (00000000) "0 o/oo"
1936          N_ITER = 1 (1h) (00001)
1937          [0] D_GRADIENT = 2866 (B32h) (000101100110010)
              "2866m"
1938          [0] Q_GDIR = 0 (0h) (0) "Downhill"
1939          [0] G_A = 255 (FFh) (11111111) "Non numerical
              value telling that the current gradient
              description ends at D_GRADIENT(n)"
1940          09:51:55.185136 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
              (PK21) - Train 6062544 - Dest:192.168.0.134
1941          00000011 00010100 10000010 11010001 11101011 00000111
              00000000 00010000 01111110 00000001 11100000 00010110
              00010000 00000000 00000000 00000101 01001010
              00010000 00000000 00011111 10000111 00100000 00001100
              01000110 01111111 11110000 10100011 10100000
              00001011 00001000 01010111 11111111 11110010 00100000
              00100000 11110000 11101010 10110000 01010000
              00010111 01001000 01001111 11000000 01111100 10001000
              00010001 10000010 11001111 00000111 11011100
              10000001 00000001 00100110 00001111 10110001 00000010
              00000111 00111000 00100000 00010010 00000100
              01101100 00000010 10110010 00000000 00000000 01010100
              00000001 00010101 00101001 11111100 00000001
              01010000 00001001 11001000 00000000 00001000 00000000
              01000101 01001010 00111111 11000000
1942          NID_MESSAGE = 3 (3h) (00000011)
1943          L_MESSAGE = 82 (52h) (0001010010)
1944          T_TRAIN = 189246492 (B47AC1Ch)
              (00001011010001111010110000011100)

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1945 M_ACK = 0 (0h) (0) "No acknowledgement required"
1946 NID_LRBG = 33776 (83F0h) (000000001000001111110000)
1947 NID_C = 2 (2h) (0000000010)
1948 NID_BG = 1008 (3F0h) (00001111110000)
1949 Packet 15 - TrackToTrain - Level 2/3 MA
1950 NID_PACKET = 15 (Fh) (00001111)
1951 Q_DIR = 0 (0h) (00) "Reverse"
1952 L_PACKET = 88 (58h) (0000001011000)
1953 Q_SCALE = 1 (1h) (01) "1 m scale"
1954 V_EMA = 0 (0h) (00000000) "0 km/h"
1955 T_EMA = 0 (0h) (0000000000)
1956 N_ITER = 0 (0h) (000000)
1957 L_ENDSECTION = 2708 (A94h) (000101010010100)
      "2708m"
1958 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
1959 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
1960 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
1961 D_DP = 0 (0h) (0000000000000000) "0m"
1962 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
1963 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1964 Packet 57 - TrackToTrain - MA Request Params
1965 NID_PACKET = 57 (39h) (00111001)
1966 Q_DIR = 0 (0h) (00) "Reverse"
1967 L_PACKET = 49 (31h) (0000000110001)
1968 T_MAR = 25 (19h) (00011001)
1969 T_TIMEOURQST = 1023 (3FFh) (1111111111) "No MA
      request triggering with regards to this
      function"
1970 T_CYCRQST = 10 (Ah) (00001010)
1971 Packet 58 - TrackToTrain - Pos Report Params
1972 NID_PACKET = 58 (3Ah) (00111010)
1973 Q_DIR = 0 (0h) (00) "Reverse"
1974 L_PACKET = 88 (58h) (0000001011000)
1975 Q_SCALE = 1 (1h) (01) "1 m scale"
1976 T_CYCLOC = 10 (Ah) (00001010)
1977 D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
      train has not to report cyclically its
      position"
1978 M_LOC = 1 (1h) (001) "Every LRBG compliant
      balise group"
1979 N_ITER = 2 (2h) (00010)
1980 [0] D_LOC = 263 (107h) (000000100000111) "263m"
1981 [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1982 [1] D_LOC = 1877 (755h) (000011101010101) "1877
      m"

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C. Simulation Traces

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1983      [1] Q_LGTLLOC = 1 (1h) (1) "Max safe front end"
1984      Packet 5 - TrackToTrain - Linking
1985      NID_PACKET = 5 (5h) (00000101)
1986      Q_DIR = 0 (0h) (00) "Reverse"
1987      L_PACKET = 186 (BAh) (0000010111010)
1988      Q_SCALE = 1 (1h) (01) "1 m scale"
1989      D_LINK = 1276 (4FCh) (000010011111100) "1276m"
1990      Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1991      NID_BG = 996 (3E4h) (00001111100100)
1992      Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
1993      Q_LINKREACTION = 2 (2h) (10) "No reaction"
1994      Q_LOCACC = 1 (1h) (000001)
1995      N_ITER = 3 (3h) (00011)
1996      [0] D_LINK = 719 (2CFh) (000001011001111) "719m
      "
1997      [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
1998      [0] NID_BG = 1006 (3EEh) (00001111101110)
1999      [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
2000      [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2001      [0] Q_LOCACC = 1 (1h) (000001)
2002      [1] D_LINK = 147 (93h) (000000010010011) "147m"
2003      [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
2004      [1] NID_BG = 1004 (3ECh) (00001111101100)
2005      [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
2006      [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2007      [1] Q_LOCACC = 1 (1h) (000001)
2008      [2] D_LINK = 462 (1CEh) (000000111001110) "462m
      "
2009      [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
2010      [2] NID_BG = 1026 (402h) (00010000000010)
2011      [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
2012      [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2013      [2] Q_LOCACC = 1 (1h) (000001)
2014      Packet 27 - TrackToTrain - International SSP
2015      NID_PACKET = 27 (1Bh) (00011011)
2016      Q_DIR = 0 (0h) (00) "Reverse"
2017      L_PACKET = 86 (56h) (0000001010110)

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2018           Q_SCALE = 1 (1h) (01) "1 m scale"
2019           D_STATIC = 0 (0h) (0000000000000000) "0m"
2020           V_STATIC = 10 (Ah) (0001010) "50 km/h"
2021           Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
2022     N_ITER = 0 (0h) (00000)
2023     N_ITER = 1 (1h) (00001)
2024           [0] D_STATIC = 2708 (A94h) (000101010010100)
                "2708m"
2025           [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
2026           [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
2027     [0] N_ITER = 0 (0h) (00000)
2028     Packet 21 - TrackToTrain - Gradient Profile
2029           NID_PACKET = 21 (15h) (00010101)
2030           Q_DIR = 0 (0h) (00) "Reverse"
2031           L_PACKET = 78 (4Eh) (0000001001110)
2032           Q_SCALE = 1 (1h) (01) "1 m scale"
2033           D_GRADIENT = 0 (0h) (0000000000000000) "0m"
2034           Q_GDIR = 1 (1h) (1) "Uphill"
2035           G_A = 0 (0h) (00000000) "0 o/oo"
2036     N_ITER = 1 (1h) (00001)
2037           [0] D_GRADIENT = 2708 (A94h) (000101010010100)
                "2708m"
2038           [0] Q_GDIR = 0 (0h) (0) "Downhill"
2039           [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2040 09:51:56.166622 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
                (PK21) - Train 6062544 - Dest:192.168.0.134
2041     00000011 00011001 11000010 11010001 11101011 00100000
                00000000 00010000 01111110 00000001 11100000 00010110
                00010000 00000000 00000000 00000101 10111110
                00010000 00000000 00011111 10000111 00100000 00001100
                01000110 01111111 11110000 10100011 10100000
                00001101 00001000 01010111 11111111 11110010 00110000
                00100000 11110000 11101010 10110000 01001010
                01110000 01010000 00101010 11001000 01001111 11000000
                01111100 10001000 00010011 10000010 11001111
                00000111 11011100 10000001 00000001 00100110 00001111
                10110001 00000010 00000111 00111000 00100000
                00010010 00000100 00000011 01111000 00111110 10101100
                00001000 00000101 10000000 01111100 11001000
                00010000 00000101 00000001 00000010 00010000 00100000
                00010100 01000010 00000011 00100000 01000110
                11000000 00101011 00100000 00000000 00000101 01000000

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C. Simulation Traces

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                00010001 01101111 10011111 11000000 00010101
                00000000 10011100 10000000 00000000 10000000 00000100
                01011011 11100011 11111100
2042      NID_MESSAGE = 3 (3h) (00000011)
2043      L_MESSAGE = 103 (67h) (0001100111)
2044      T_TRAIN = 189246592 (B47AC80h)
                (00001011010001111010110010000000)
2045      M_ACK = 0 (0h) (0) "No acknowledgement required"
2046      NID_LRBG = 33776 (83F0h) (000000001000001111110000)
2047      NID_C = 2 (2h) (0000000010)
2048      NID_BG = 1008 (3F0h) (00001111110000)
2049      Packet 15 - TrackToTrain - Level 2/3 MA
2050      NID_PACKET = 15 (Fh) (00001111)
2051      Q_DIR = 0 (0h) (00) "Reverse"
2052      L_PACKET = 88 (58h) (0000001011000)
2053      Q_SCALE = 1 (1h) (01) "1 m scale"
2054      V_EMA = 0 (0h) (00000000) "0 km/h"
2055      T_EMA = 0 (0h) (0000000000)
2056      N_ITER = 0 (0h) (000000)
2057      L_ENDSECTION = 2940 (B7Ch) (000101101111100)
                "2940m"
2058      Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
                information"
2059      Q_ENDTIMER = 0 (0h) (0) "No End Section timer
                information"
2060      Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
                follow"
2061      D_DP = 0 (0h) (0000000000000000) "0m"
2062      V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
                calculated release speed"
2063      Q_OVERLAP = 0 (0h) (0) "No overlap information"
2064      Packet 57 - TrackToTrain - MA Request Params
2065      NID_PACKET = 57 (39h) (00111001)
2066      Q_DIR = 0 (0h) (00) "Reverse"
2067      L_PACKET = 49 (31h) (0000000110001)
2068      T_MAR = 25 (19h) (00011001)
2069      T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
                request triggering with regards to this
                function"
2070      T_CYCRQST = 10 (Ah) (00001010)
2071      Packet 58 - TrackToTrain - Pos Report Params
2072      NID_PACKET = 58 (3Ah) (00111010)
2073      Q_DIR = 0 (0h) (00) "Reverse"
2074      L_PACKET = 104 (68h) (0000001101000)
2075      Q_SCALE = 1 (1h) (01) "1 m scale"
2076      T_CYCLOC = 10 (Ah) (00001010)
2077      D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
                train has not to report cyclically its
                position"

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2078             M_LOC = 1 (1h) (001) "Every LRBG compliant
                balise group"
2079     N_ITER = 3 (3h) (00011)
2080             [0] D_LOC = 263 (107h) (000000100000111) "263m"
2081             [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2082             [1] D_LOC = 1877 (755h) (000011101010101) "1877
                m"
2083             [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2084             [2] D_LOC = 595 (253h) (000001001010011) "595m"
2085             [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2086     Packet 5 - TrackToTrain - Linking
2087             NID_PACKET = 5 (5h) (00000101)
2088             Q_DIR = 0 (0h) (00) "Reverse"
2089             L_PACKET = 342 (156h) (0000101010110)
2090             Q_SCALE = 1 (1h) (01) "1 m scale"
2091             D_LINK = 1276 (4FCh) (000010011111100) "1276m"
2092     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2093             NID_BG = 996 (3E4h) (00001111100100)
2094             Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2095             Q_LINKREACTION = 2 (2h) (10) "No reaction"
2096             Q_LOCACC = 1 (1h) (000001)
2097     N_ITER = 7 (7h) (00111)
2098             [0] D_LINK = 719 (2CFh) (000001011001111) "719m
                "
2099             [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2100             [0] NID_BG = 1006 (3EEh) (00001111101110)
2101             [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2102             [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2103             [0] Q_LOCACC = 1 (1h) (000001)
2104             [1] D_LINK = 147 (93h) (000000010010011) "147m"
2105             [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2106             [1] NID_BG = 1004 (3ECh) (00001111101100)
2107             [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2108             [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2109             [1] Q_LOCACC = 1 (1h) (000001)
2110             [2] D_LINK = 462 (1CEh) (000000111001110) "462m
                "
2111             [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2112             [2] NID_BG = 1026 (402h) (00010000000010)

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2113         [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2114         [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2115         [2] Q_LOCACC = 1 (1h) (000001)
2116         [3] D_LINK = 111 (6Fh) (000000001101111) "111m"
2117     [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2118         [3] NID_BG = 1002 (3EAh) (00001111101010)
2119         [3] Q_LINKORIENTATION = 1 (1h) (1) "The balise
                group is seen by the train in nominal
                direction"
2120         [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2121         [3] Q_LOCACC = 1 (1h) (000001)
2122         [4] D_LINK = 88 (58h) (000000001011000) "88m"
2123     [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2124         [4] NID_BG = 998 (3E6h) (00001111100110)
2125         [4] Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2126         [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2127         [4] Q_LOCACC = 1 (1h) (000001)
2128         [5] D_LINK = 40 (28h) (000000000101000) "40m"
2129     [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2130         [5] NID_BG = 1032 (408h) (00010000001000)
2131         [5] Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2132         [5] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2133         [5] Q_LOCACC = 1 (1h) (000001)
2134         [6] D_LINK = 81 (51h) (000000001010001) "81m"
2135     [6] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2136         [6] NID_BG = 1030 (406h) (00010000000110)
2137         [6] Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2138         [6] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2139         [6] Q_LOCACC = 1 (1h) (000001)
2140     Packet 27 - TrackToTrain - International SSP
2141         NID_PACKET = 27 (1Bh) (00011011)
2142         Q_DIR = 0 (0h) (00) "Reverse"
2143         L_PACKET = 86 (56h) (0000001010110)
2144         Q_SCALE = 1 (1h) (01) "1 m scale"
2145         D_STATIC = 0 (0h) (000000000000000) "0m"
2146         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2147         Q_FRONT = 1 (1h) (1) "No train length delay on

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                validity end point of profile element"
2148     N_ITER = 0 (0h) (00000)
2149     N_ITER = 1 (1h) (00001)
2150     [0] D_STATIC = 2940 (B7Ch) (000101101111100)
                "2940m"
2151     [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
2152     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
2153     [0] N_ITER = 0 (0h) (00000)
2154     Packet 21 - TrackToTrain - Gradient Profile
2155     NID_PACKET = 21 (15h) (00010101)
2156     Q_DIR = 0 (0h) (00) "Reverse"
2157     L_PACKET = 78 (4Eh) (0000001001110)
2158     Q_SCALE = 1 (1h) (01) "1 m scale"
2159     D_GRADIENT = 0 (0h) (000000000000000) "0m"
2160     Q_GDIR = 1 (1h) (1) "Uphill"
2161     G_A = 0 (0h) (00000000) "0 o/oo"
2162     N_ITER = 1 (1h) (00001)
2163     [0] D_GRADIENT = 2940 (B7Ch) (000101101111100)
                "2940m"
2164     [0] Q_GDIR = 0 (0h) (0) "Downhill"
2165     [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2166 09:53:27.097573 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
                (PK21) - Train 6062544 - Dest:192.168.0.134
2167 00000011 00011011 00000010 11010001 11110100 00000000
                10000000 00010000 01111100 10000001 11100000 00010110
                00010000 00000000 00000000 00000101 10010001
                10010000 00000000 00011111 10000111 00100000 00001100
                01000110 01111111 11110000 10100011 10100000
                00001101 00001000 01010111 11111111 11110010 00110000
                01101100 00010000 01001010 01110000 00011101
                00010000 01010000 00101111 10101000 00101100 11110000
                01111101 11001000 00010100 00000000 10010011
                00000111 11011000 10000001 00000011 10011100 00010000
                00001001 00000010 00000001 10111100 00011111
                01010110 00000100 00000010 11000000 00111110 01100100
                00001000 00000010 10000000 10000001 00001000
                00010000 00001010 00100001 00000001 10010000 00100000
                10001111 01000011 11110000 01100000 01000000
                10010001 00000111 11011110 11000000 10001101 10000000
                01010110 01000000 00000000 00001010 10000000
                00100010 11001000 11111111 10000000 00101010 00000001
                00111001 00000000 00000001 00000000 00001000
                10110010 00110111 11111000

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2168     NID_MESSAGE = 3 (3h) (00000011)
2169     L_MESSAGE = 108 (6Ch) (0001101100)
2170     T_TRAIN = 189255682 (B47D002h)
           (00001011010001111101000000000010)
2171     M_ACK = 0 (0h) (0) "No acknowledgement required"
2172     NID_LRBG = 33764 (83E4h) (000000001000001111100100)
2173         NID_C = 2 (2h) (0000000010)
2174         NID_BG = 996 (3E4h) (00001111100100)
2175     Packet 15 - TrackToTrain - Level 2/3 MA
2176         NID_PACKET = 15 (Fh) (00001111)
2177         Q_DIR = 0 (0h) (00) "Reverse"
2178         L_PACKET = 88 (58h) (0000001011000)
2179         Q_SCALE = 1 (1h) (01) "1 m scale"
2180         V_EMA = 0 (0h) (00000000) "0 km/h"
2181         T_EMA = 0 (0h) (0000000000)
2182     N_ITER = 0 (0h) (00000)
2183         L_ENDSECTION = 2851 (B23h) (000101100100011)
           "2851m"
2184     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
2185     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
2186     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
2187         D_DP = 0 (0h) (0000000000000000) "0m"
2188         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
2189     Q_OVERLAP = 0 (0h) (0) "No overlap information"
2190     Packet 57 - TrackToTrain - MA Request Params
2191         NID_PACKET = 57 (39h) (00111001)
2192         Q_DIR = 0 (0h) (00) "Reverse"
2193         L_PACKET = 49 (31h) (0000000110001)
2194         T_MAR = 25 (19h) (00011001)
2195         T_TIMEOUSRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
2196         T_CYCRQST = 10 (Ah) (00001010)
2197     Packet 58 - TrackToTrain - Pos Report Params
2198         NID_PACKET = 58 (3Ah) (00111010)
2199         Q_DIR = 0 (0h) (00) "Reverse"
2200         L_PACKET = 104 (68h) (0000001101000)
2201         Q_SCALE = 1 (1h) (01) "1 m scale"
2202         T_CYCLOC = 10 (Ah) (00001010)
2203         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
2204         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
2205     N_ITER = 3 (3h) (00011)
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2206 [0] D_LOC = 864 (360h) (000001101100000) "864m"
2207 [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2208 [1] D_LOC = 595 (253h) (000001001010011) "595m"
2209 [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2210 [2] D_LOC = 232 (E8h) (000000011101000) "232m"
2211 [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2212 Packet 5 - TrackToTrain - Linking
2213 NID_PACKET = 5 (5h) (00000101)
2214 Q_DIR = 0 (0h) (00) "Reverse"
2215 L_PACKET = 381 (17Dh) (0000101111101)
2216 Q_SCALE = 1 (1h) (01) "1 m scale"
2217 D_LINK = 719 (2CFh) (000001011001111) "719m"
2218 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2219 NID_BG = 1006 (3EEh) (00001111101110)
2220 Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
2221 Q_LINKREACTION = 2 (2h) (10) "No reaction"
2222 Q_LOCAC = 1 (1h) (000001)
2223 N_ITER = 8 (8h) (01000)
2224 [0] D_LINK = 147 (93h) (000000010010011) "147m"
2225 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2226 [0] NID_BG = 1004 (3ECh) (00001111101100)
2227 [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
2228 [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2229 [0] Q_LOCAC = 1 (1h) (000001)
2230 [1] D_LINK = 462 (1CEh) (000000111001110) "462m
"
2231 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2232 [1] NID_BG = 1026 (402h) (00010000000010)
2233 [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
2234 [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2235 [1] Q_LOCAC = 1 (1h) (000001)
2236 [2] D_LINK = 111 (6Fh) (000000001101111) "111m"
2237 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2238 [2] NID_BG = 1002 (3EAh) (00001111101010)
2239 [2] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
2240 [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2241 [2] Q_LOCAC = 1 (1h) (000001)

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C. Simulation Traces

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2242          [3] D_LINK = 88 (58h) (000000001011000) "88m"
2243 [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
2244          [3] NID_BG = 998 (3E6h) (00001111100110)
2245          [3] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
2246          [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2247          [3] Q_LOCACC = 1 (1h) (000001)
2248          [4] D_LINK = 40 (28h) (000000000101000) "40m"
2249 [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
2250          [4] NID_BG = 1032 (408h) (00010000001000)
2251          [4] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
2252          [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2253          [4] Q_LOCACC = 1 (1h) (000001)
2254          [5] D_LINK = 81 (51h) (000000001010001) "81m"
2255 [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
2256          [5] NID_BG = 1030 (406h) (00010000000110)
2257          [5] Q_LINKORIENTATION = 0 (0h) (0) "The balise
      group is seen by the train in reverse
      direction"
2258          [5] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2259          [5] Q_LOCACC = 1 (1h) (000001)
2260          [6] D_LINK = 573 (23Dh) (000001000111101) "573m
      "
2261 [6] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
2262          [6] NID_BG = 2016 (7E0h) (00011111100000)
2263          [6] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
2264          [6] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2265          [6] Q_LOCACC = 1 (1h) (000001)
2266          [7] D_LINK = 290 (122h) (000000100100010) "290m
      "
2267 [7] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
2268          [7] NID_BG = 2014 (7DEh) (00011111011110)
2269          [7] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
2270          [7] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2271          [7] Q_LOCACC = 1 (1h) (000001)
2272 Packet 27 - TrackToTrain - International SSP
2273          NID_PACKET = 27 (1Bh) (00011011)
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2274         Q_DIR = 0 (0h) (00) "Reverse"
2275         L_PACKET = 86 (56h) (0000001010110)
2276         Q_SCALE = 1 (1h) (01) "1 m scale"
2277         D_STATIC = 0 (0h) (000000000000000) "0m"
2278         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2279         Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
2280     N_ITER = 0 (0h) (00000)
2281     N_ITER = 1 (1h) (00001)
2282     [0] D_STATIC = 2851 (B23h) (000101100100011)
                "2851m"
2283     [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
2284     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
2285     [0] N_ITER = 0 (0h) (00000)
2286     Packet 21 - TrackToTrain - Gradient Profile
2287         NID_PACKET = 21 (15h) (00010101)
2288         Q_DIR = 0 (0h) (00) "Reverse"
2289         L_PACKET = 78 (4Eh) (0000001001110)
2290         Q_SCALE = 1 (1h) (01) "1 m scale"
2291         D_GRADIENT = 0 (0h) (000000000000000) "0m"
2292         Q_GDIR = 1 (1h) (1) "Uphill"
2293         G_A = 0 (0h) (00000000) "0 o/oo"
2294     N_ITER = 1 (1h) (00001)
2295     [0] D_GRADIENT = 2851 (B23h) (000101100100011)
                "2851m"
2296     [0] Q_GDIR = 0 (0h) (0) "Downhill"
2297     [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2298 09:54:18.867454 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
                (PK21) - Train 6062544 - Dest:192.168.0.134
2299     00000011 00011010 11000010 11010001 11111001 00001111
                01000000 00010000 01111101 11000001 11100000 00010000
                10010000 00000000 00000000 00000101 10000101
                10000001 11001000 00000011 00010001 10011111 11111100
                00101000 11101000 00000011 11000010 00010101
                11111111 11111100 10010000 00000100 10001100 00010010
                10011100 00000111 01000100 00100101 00001100
                00010100 00001011 11101010 00000010 01001100 00011111
                01100010 00000101 00000000 01110011 10000010
                00000001 00100000 01000000 00110111 10000011 11101010
                11000000 10000000 01011000 00000111 11001100
                10000001 00000000 01010000 00010000 00100001 00000010
                00000001 01000100 00100000 00110010 00000100
                00010001 11101000 01111110 00001100 00001000 00010010

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C. Simulation Traces

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00100000 11111011 11011000 00010000 00101011
00100001 11110111 00110000 00100011 01100000 00010101
10010000 00000000 00000010 10100000 00001000
10110000 10111111 11100000 00001010 10000000 01001110
01000000 00000000 01000000 00000010 00101100
00101101 11111110
2300 NID_MESSAGE = 3 (3h) (00000011)
2301 L_MESSAGE = 107 (6Bh) (0001101011)
2302 T_TRAIN = 189260861 (B47E43Dh)
      (00001011010001111110010000111101)
2303 M_ACK = 0 (0h) (0) "No acknowledgement required"
2304 NID_LRBG = 33774 (83EEh) (000000001000001111101110)
2305 NID_C = 2 (2h) (0000000010)
2306 NID_BG = 1006 (3EEh) (0000111101110)
2307 Packet 15 - TrackToTrain - Level 2/3 MA
2308 NID_PACKET = 15 (Fh) (00001111)
2309 Q_DIR = 0 (0h) (00) "Reverse"
2310 L_PACKET = 66 (42h) (0000001000010)
2311 Q_SCALE = 1 (1h) (01) "1 m scale"
2312 V_EMA = 0 (0h) (00000000) "0 km/h"
2313 T_EMA = 0 (0h) (0000000000)
2314 N_ITER = 0 (0h) (000000)
2315 L_ENDSECTION = 2827 (B0Bh) (000101100001011)
      "2827m"
2316 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
2317 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
2318 Q_DANGERPOINT = 0 (0h) (0) "No danger point information"
2319 Q_OVERLAP = 0 (0h) (0) "No overlap information"
2320 Packet 57 - TrackToTrain - MA Request Params
2321 NID_PACKET = 57 (39h) (00111001)
2322 Q_DIR = 0 (0h) (00) "Reverse"
2323 L_PACKET = 49 (31h) (0000000110001)
2324 T_MAR = 25 (19h) (00011001)
2325 T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
      request triggering with regards to this
      function"
2326 T_CYCRQST = 10 (Ah) (00001010)
2327 Packet 58 - TrackToTrain - Pos Report Params
2328 NID_PACKET = 58 (3Ah) (00111010)
2329 Q_DIR = 0 (0h) (00) "Reverse"
2330 L_PACKET = 120 (78h) (0000001111000)
2331 Q_SCALE = 1 (1h) (01) "1 m scale"
2332 T_CYCLOC = 10 (Ah) (00001010)
2333 D_CYCLOC = 32767 (7FFFh) (1111111111111) "The
      train has not to report cyclically its
      position"
2334 M_LOC = 1 (1h) (001) "Every LRBG compliant

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                balise group"
2335     N_ITER = 4 (4h) (00100)
2336         [0] D_LOC = 145 (91h) (000000010010001) "145m"
2337         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2338         [1] D_LOC = 595 (253h) (000001001010011) "595m"
2339         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2340         [2] D_LOC = 232 (E8h) (000000011101000) "232m"
2341         [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2342         [3] D_LOC = 1185 (4A1h) (000010010100001) "1185
                m"
2343         [3] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2344     Packet 5 - TrackToTrain - Linking
2345         NID_PACKET = 5 (5h) (00000101)
2346         Q_DIR = 0 (0h) (00) "Reverse"
2347         L_PACKET = 381 (17Dh) (0000101111101)
2348         Q_SCALE = 1 (1h) (01) "1 m scale"
2349         D_LINK = 147 (93h) (000000010010011) "147m"
2350     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2351         NID_BG = 1004 (3ECh) (00001111101100)
2352         Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2353         Q_LINKREACTION = 2 (2h) (10) "No reaction"
2354         Q_LOCACC = 1 (1h) (000001)
2355     N_ITER = 8 (8h) (01000)
2356         [0] D_LINK = 462 (1CEh) (000000111001110) "462m
                "
2357         [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2358             [0] NID_BG = 1026 (402h) (00010000000010)
2359             [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
2360             [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2361             [0] Q_LOCACC = 1 (1h) (000001)
2362             [1] D_LINK = 111 (6Fh) (000000001101111) "111m"
2363         [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2364             [1] NID_BG = 1002 (3EAh) (00001111101010)
2365             [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
                group is seen by the train in nominal
                direction"
2366             [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2367             [1] Q_LOCACC = 1 (1h) (000001)
2368             [2] D_LINK = 88 (58h) (000000001011000) "88m"
2369         [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
2370             [2] NID_BG = 998 (3E6h) (000011111001110)

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C. Simulation Traces

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2371         [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
2372         [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2373         [2] Q_LOCACC = 1 (1h) (000001)
2374         [3] D_LINK = 40 (28h) (000000000101000) "40m"
2375     [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2376         [3] NID_BG = 1032 (408h) (00010000001000)
2377         [3] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
2378         [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2379         [3] Q_LOCACC = 1 (1h) (000001)
2380         [4] D_LINK = 81 (51h) (000000001010001) "81m"
2381     [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2382         [4] NID_BG = 1030 (406h) (00010000000110)
2383         [4] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
2384         [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2385         [4] Q_LOCACC = 1 (1h) (000001)
2386         [5] D_LINK = 573 (23Dh) (000001000111101) "573m
           "
2387     [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2388         [5] NID_BG = 2016 (7E0h) (00011111100000)
2389         [5] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
2390         [5] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2391         [5] Q_LOCACC = 1 (1h) (000001)
2392         [6] D_LINK = 290 (122h) (000000100100010) "290m
           "
2393     [6] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2394         [6] NID_BG = 2014 (7DEh) (00011111011110)
2395         [6] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
2396         [6] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2397         [6] Q_LOCACC = 1 (1h) (000001)
2398         [7] D_LINK = 345 (159h) (000000101011001) "345m
           "
2399     [7] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2400         [7] NID_BG = 2012 (7DCh) (00011111011100)
2401         [7] Q_LINKORIENTATION = 1 (1h) (1) "The balise
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                group is seen by the train in nominal
                direction"
2402             [7] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2403             [7] Q_LOCACCC = 1 (1h) (000001)
2404     Packet 27 - TrackToTrain - International SSP
2405             NID_PACKET = 27 (1Bh) (00011011)
2406             Q_DIR = 0 (0h) (00) "Reverse"
2407             L_PACKET = 86 (56h) (0000001010110)
2408             Q_SCALE = 1 (1h) (01) "1 m scale"
2409             D_STATIC = 0 (0h) (0000000000000000) "0m"
2410             V_STATIC = 10 (Ah) (0001010) "50 km/h"
2411             Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
2412     N_ITER = 0 (0h) (00000)
2413     N_ITER = 1 (1h) (00001)
2414             [0] D_STATIC = 2827 (B0Bh) (000101100001011)
                "2827m"
2415             [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
2416             [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
2417     [0] N_ITER = 0 (0h) (00000)
2418     Packet 21 - TrackToTrain - Gradient Profile
2419             NID_PACKET = 21 (15h) (00010101)
2420             Q_DIR = 0 (0h) (00) "Reverse"
2421             L_PACKET = 78 (4Eh) (0000001001110)
2422             Q_SCALE = 1 (1h) (01) "1 m scale"
2423             D_GRADIENT = 0 (0h) (0000000000000000) "0m"
2424             Q_GDIR = 1 (1h) (1) "Uphill"
2425             G_A = 0 (0h) (00000000) "0 o/oo"
2426     N_ITER = 1 (1h) (00001)
2427             [0] D_GRADIENT = 2827 (B0Bh) (000101100001011)
                "2827m"
2428             [0] Q_GDIR = 0 (0h) (0) "Downhill"
2429             [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2430 09:55:02.663907 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
                (PK21) - Train 6062544 - Dest:192.168.0.134
2431     00000011 00011001 00000010 11010001 11111101 01010110
                01000000 00010000 10000000 01000001 11100000 00010000
                10010000 00000000 00000000 00000101 01001100
                10000001 11001000 00000011 00010001 10011111 11111100
                00101000 11101000 00000011 01000010 00010101
                11111111 11111100 10001100 00000100 00011100 00000111
                01000100 00100101 00001100 00010100 00001010
                10110010 00000001 10111100 00011111 01010110 00000100

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11100000 00010110 00000001 11110011 00100000
01000000 00010100 00000100 00001000 01000000 10000000
01010001 00001000 00001100 10000001 00000100
01111010 00011111 10000011 00000010 00000100 10001000
00111110 11110110 00000100 00001010 11001000
01111101 11001100 00001000 01001001 11000000 11111011
01001000 00010001 10110000 00001010 11001000
00000000 00000001 01010000 00000100 01010100 11001111
11110000 00000101 01000000 00100111 00100000
00000000 00100000 00000001 00010101 00110010 11111111
2432 NID_MESSAGE = 3 (3h) (00000011)
2433 L_MESSAGE = 100 (64h) (0001100100)
2434 T_TRAIN = 189265241 (B47F559h)
      (00001011010001111111010101011001)
2435 M_ACK = 0 (0h) (0) "No acknowledgement required"
2436 NID_LRBG = 33794 (8402h) (0000000010000100000000010)
2437 NID_C = 2 (2h) (0000000010)
2438 NID_BG = 1026 (402h) (000100000000010)
2439 Packet 15 - TrackToTrain - Level 2/3 MA
2440 NID_PACKET = 15 (Fh) (00001111)
2441 Q_DIR = 0 (0h) (00) "Reverse"
2442 L_PACKET = 66 (42h) (00000010000010)
2443 Q_SCALE = 1 (1h) (01) "1 m scale"
2444 V_EMA = 0 (0h) (00000000) "0 km/h"
2445 T_EMA = 0 (0h) (0000000000)
2446 N_ITER = 0 (0h) (00000)
2447 L_ENDSECTION = 2713 (A99h) (000101010011001)
      "2713m"
2448 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
2449 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
2450 Q_DANGERPOINT = 0 (0h) (0) "No danger point information"
2451 Q_OVERLAP = 0 (0h) (0) "No overlap information"
2452 Packet 57 - TrackToTrain - MA Request Params
2453 NID_PACKET = 57 (39h) (00111001)
2454 Q_DIR = 0 (0h) (00) "Reverse"
2455 L_PACKET = 49 (31h) (0000000110001)
2456 T_MAR = 25 (19h) (00011001)
2457 T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
      request triggering with regards to this
      function"
2458 T_CYCRQST = 10 (Ah) (00001010)
2459 Packet 58 - TrackToTrain - Pos Report Params
2460 NID_PACKET = 58 (3Ah) (00111010)
2461 Q_DIR = 0 (0h) (00) "Reverse"
2462 L_PACKET = 104 (68h) (0000001101000)
2463 Q_SCALE = 1 (1h) (01) "1 m scale"
2464 T_CYCLOC = 10 (Ah) (00001010)
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2465         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
2466         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
2467     N_ITER = 3 (3h) (00011)
2468         [0] D_LOC = 131 (83h) (000000010000011) "131m"
2469         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2470         [1] D_LOC = 232 (E8h) (000000011101000) "232m"
2471         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2472         [2] D_LOC = 1185 (4A1h) (000010010100001) "1185
           m"
2473         [2] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2474     Packet 5 - TrackToTrain - Linking
2475         NID_PACKET = 5 (5h) (00000101)
2476         Q_DIR = 0 (0h) (00) "Reverse"
2477         L_PACKET = 342 (156h) (0000101010110)
2478         Q_SCALE = 1 (1h) (01) "1 m scale"
2479         D_LINK = 111 (6Fh) (000000001101111) "111m"
2480     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2481         NID_BG = 1002 (3EAh) (00001111101010)
2482         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
2483         Q_LINKREACTION = 2 (2h) (10) "No reaction"
2484         Q_LOCACC = 1 (1h) (000001)
2485     N_ITER = 7 (7h) (00111)
2486         [0] D_LINK = 88 (58h) (000000001011000) "88m"
2487     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2488         [0] NID_BG = 998 (3E6h) (00001111100110)
2489         [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
2490         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2491         [0] Q_LOCACC = 1 (1h) (000001)
2492         [1] D_LINK = 40 (28h) (000000000101000) "40m"
2493     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2494         [1] NID_BG = 1032 (408h) (00010000001000)
2495         [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
2496         [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2497         [1] Q_LOCACC = 1 (1h) (000001)
2498         [2] D_LINK = 81 (51h) (000000001010001) "81m"
2499     [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"

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2500          [2] NID_BG = 1030 (406h) (00010000000110)
2501          [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
              group is seen by the train in reverse
              direction"
2502          [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2503          [2] Q_LOCACC = 1 (1h) (000001)
2504          [3] D_LINK = 573 (23Dh) (000001000111101) "573m
              "
2505          [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
              administration, no NID_C follows"
2506          [3] NID_BG = 2016 (7E0h) (00011111100000)
2507          [3] Q_LINKORIENTATION = 1 (1h) (1) "The balise
              group is seen by the train in nominal
              direction"
2508          [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2509          [3] Q_LOCACC = 1 (1h) (000001)
2510          [4] D_LINK = 290 (122h) (000000100100010) "290m
              "
2511          [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
              administration, no NID_C follows"
2512          [4] NID_BG = 2014 (7DEh) (00011111011110)
2513          [4] Q_LINKORIENTATION = 1 (1h) (1) "The balise
              group is seen by the train in nominal
              direction"
2514          [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2515          [4] Q_LOCACC = 1 (1h) (000001)
2516          [5] D_LINK = 345 (159h) (000000101011001) "345m
              "
2517          [5] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
              administration, no NID_C follows"
2518          [5] NID_BG = 2012 (7DCh) (00011111011100)
2519          [5] Q_LINKORIENTATION = 1 (1h) (1) "The balise
              group is seen by the train in nominal
              direction"
2520          [5] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2521          [5] Q_LOCACC = 1 (1h) (000001)
2522          [6] D_LINK = 1180 (49Ch) (000010010011100)
              "1180m"
2523          [6] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
              administration, no NID_C follows"
2524          [6] NID_BG = 2010 (7DAh) (00011111011010)
2525          [6] Q_LINKORIENTATION = 0 (0h) (0) "The balise
              group is seen by the train in reverse
              direction"
2526          [6] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2527          [6] Q_LOCACC = 1 (1h) (000001)
2528          Packet 27 - TrackToTrain - International SSP
2529          NID_PACKET = 27 (1Bh) (00011011)
2530          Q_DIR = 0 (0h) (00) "Reverse"
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2531 L_PACKET = 86 (56h) (0000001010110)
2532 Q_SCALE = 1 (1h) (01) "1 m scale"
2533 D_STATIC = 0 (0h) (000000000000000) "0m"
2534 V_STATIC = 10 (Ah) (0001010) "50 km/h"
2535 Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
2536 N_ITER = 0 (0h) (00000)
2537 N_ITER = 1 (1h) (00001)
2538 [0] D_STATIC = 2713 (A99h) (000101010011001)
        "2713m"
2539 [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
2540 [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
2541 [0] N_ITER = 0 (0h) (00000)
2542 Packet 21 - TrackToTrain - Gradient Profile
2543 NID_PACKET = 21 (15h) (00010101)
2544 Q_DIR = 0 (0h) (00) "Reverse"
2545 L_PACKET = 78 (4Eh) (0000001001110)
2546 Q_SCALE = 1 (1h) (01) "1 m scale"
2547 D_GRADIENT = 0 (0h) (000000000000000) "0m"
2548 Q_GDIR = 1 (1h) (1) "Uphill"
2549 G_A = 0 (0h) (00000000) "0 o/oo"
2550 N_ITER = 1 (1h) (00001)
2551 [0] D_GRADIENT = 2713 (A99h) (000101010011001)
        "2713m"
2552 [0] Q_GDIR = 0 (0h) (0) "Downhill"
2553 [0] G_A = 255 (FFh) (11111111) "Non numerical
        value telling that the current gradient
        description ends at D_GRADIENT(n)"
2554 09:56:06.953630 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
        (PK21) - Train 6062544 - Dest:192.168.0.134
2555 00000011 00010011 11000010 11010010 00000011 10011101
        10000000 00010000 11111100 00000001 11101000 00010000
        10010000 00000000 00000000 00000101 00000010
        10000001 11001010 00000011 00010001 10011111 11111100
        00101000 11101001 00000010 11000010 00010101
        11111111 11111100 10001000 00010100 01111100 00110000
        11101100 00010101 00000101 11010010 00000100
        10001000 00111110 11110110 00000100 01100000 01010110
        01000011 11101110 01100000 01000010 01001110
        00000111 11011010 01000000 10000001 10000110 00001111
        10110000 10000001 00011011 01000000 10101100
        10000000 00000000 00010101 00000000 01000101 00000010
        11111111 00000000 01010101 00000010 01110010
        00000000 00000010 00000000 00010001 01000000 10101111
        11110000

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C. Simulation Traces

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2556     NID_MESSAGE = 3 (3h) (00000011)
2557     L_MESSAGE = 79 (4Fh) (0001001111)
2558     T_TRAIN = 189271670 (B480E76h)
           (00001011010010000000111001110110)
2559     M_ACK = 0 (0h) (0) "No acknowledgement required"
2560     NID_LRBG = 34784 (87E0h) (000000001000011111100000)
2561         NID_C = 2 (2h) (0000000010)
2562         NID_BG = 2016 (7E0h) (00011111100000)
2563     Packet 15 - TrackToTrain - Level 2/3 MA
2564         NID_PACKET = 15 (Fh) (00001111)
2565         Q_DIR = 1 (1h) (01) "Nominal"
2566         L_PACKET = 66 (42h) (0000001000010)
2567         Q_SCALE = 1 (1h) (01) "1 m scale"
2568         V_EMA = 0 (0h) (00000000) "0 km/h"
2569         T_EMA = 0 (0h) (0000000000)
2570     N_ITER = 0 (0h) (00000)
2571         L_ENDSECTION = 2565 (A05h) (000101000000101)
           "2565m"
2572     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
2573     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
2574     Q_DANGERPOINT = 0 (0h) (0) "No danger point information"
2575     Q_OVERLAP = 0 (0h) (0) "No overlap information"
2576     Packet 57 - TrackToTrain - MA Request Params
2577         NID_PACKET = 57 (39h) (00111001)
2578         Q_DIR = 1 (1h) (01) "Nominal"
2579         L_PACKET = 49 (31h) (0000000110001)
2580         T_MAR = 25 (19h) (00011001)
2581         T_TIMEOUSRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
2582         T_CYCRQST = 10 (Ah) (00001010)
2583     Packet 58 - TrackToTrain - Pos Report Params
2584         NID_PACKET = 58 (3Ah) (00111010)
2585         Q_DIR = 1 (1h) (01) "Nominal"
2586         L_PACKET = 88 (58h) (0000001011000)
2587         Q_SCALE = 1 (1h) (01) "1 m scale"
2588         T_CYCLOC = 10 (Ah) (00001010)
2589         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
2590         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
2591     N_ITER = 2 (2h) (00010)
2592         [0] D_LOC = 655 (28Fh) (000001010001111) "655m"
2593         [0] Q_LGTLLOC = 1 (1h) (1) "Max safe front end"
2594         [1] D_LOC = 1565 (61Dh) (000011000011101) "1565
           m"

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2595 [1] Q_LGTLLOC = 1 (1h) (1) "Max safe front end"
2596 Packet 5 - TrackToTrain - Linking
2597 NID_PACKET = 5 (5h) (00000101)
2598 Q_DIR = 1 (1h) (01) "Nominal"
2599 L_PACKET = 186 (BAh) (0000010111010)
2600 Q_SCALE = 1 (1h) (01) "1 m scale"
2601 D_LINK = 290 (122h) (000000100100010) "290m"
2602 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2603 NID_BG = 2014 (7DEh) (00011111011110)
2604 Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
2605 Q_LINKREACTION = 2 (2h) (10) "No reaction"
2606 Q_LOCACC = 1 (1h) (000001)
2607 N_ITER = 3 (3h) (00011)
2608 [0] D_LINK = 345 (159h) (000000101011001) "345m
"
2609 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2610 [0] NID_BG = 2012 (7DCh) (00011111011100)
2611 [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
2612 [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2613 [0] Q_LOCACC = 1 (1h) (000001)
2614 [1] D_LINK = 1180 (49Ch) (000010010011100)
"1180m"
2615 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2616 [1] NID_BG = 2010 (7DAh) (00011111011010)
2617 [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
2618 [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2619 [1] Q_LOCACC = 1 (1h) (000001)
2620 [2] D_LINK = 390 (186h) (000000110000110) "390m
"
2621 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
2622 [2] NID_BG = 2008 (7D8h) (00011111011000)
2623 [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
2624 [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
2625 [2] Q_LOCACC = 1 (1h) (000001)
2626 Packet 27 - TrackToTrain - International SSP
2627 NID_PACKET = 27 (1Bh) (00011011)
2628 Q_DIR = 1 (1h) (01) "Nominal"

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C. Simulation Traces

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2629         L_PACKET = 86 (56h) (0000001010110)
2630         Q_SCALE = 1 (1h) (01) "1 m scale"
2631         D_STATIC = 0 (0h) (0000000000000000) "0m"
2632         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2633         Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
2634     N_ITER = 0 (0h) (00000)
2635     N_ITER = 1 (1h) (00001)
2636         [0] D_STATIC = 2565 (A05h) (000101000000101)
                "2565m"
2637         [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
2638         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
2639     [0] N_ITER = 0 (0h) (00000)
2640     Packet 21 - TrackToTrain - Gradient Profile
2641         NID_PACKET = 21 (15h) (00010101)
2642         Q_DIR = 1 (1h) (01) "Nominal"
2643         L_PACKET = 78 (4Eh) (0000001001110)
2644         Q_SCALE = 1 (1h) (01) "1 m scale"
2645         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
2646         Q_GDIR = 1 (1h) (1) "Uphill"
2647         G_A = 0 (0h) (00000000) "0 o/oo"
2648     N_ITER = 1 (1h) (00001)
2649         [0] D_GRADIENT = 2565 (A05h) (000101000000101)
                "2565m"
2650         [0] Q_GDIR = 0 (0h) (0) "Downhill"
2651         [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2652 09:56:08.234438 # VL Release Request (MsgId 3) - Dest
                :192.168.0.132
2653         Preamble = 65535 (FFFFh) (1111111111111111)
2654         Length of PDU = 14 (0Eh) (0000000000001110)
2655         Message ID = 3 (03h) (00000011)
2656         Channel ID = 128 (80h) (10000000)
2657         DATA [0] = 2 (02h) (00000010)
2658         DATA [1] = 3 (03h) (00000011)
2659         DATA [2] = 0 (00h) (00000000)
2660         DATA [3] = 3 (03h) (00000011)
2661         DATA [4] = 16 (10h) (00010000)
2662         DATA [5] = 0 (00h) (00000000)
2663         DATA [6] = 0 (00h) (00000000)
2664         DATA [7] = 2 (02h) (00000010)
2665         DATA [8] = 5 (05h) (00000101)
2666         DATA [9] = 0 (00h) (00000000)
2667         DATA [10] = 1 (01h) (00000001)

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DATA [11] = 128 (80h) (10000000)

Lower Train Runs Until Obstruction (Filtered)

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1 11:04:31.737862 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
  :192.168.0.132
2      10000100 00000110 10000010 11010011 10010100 01101010
      01010111 00100000 01110100 00000010 00000000 00001000
      00010000 00000010 00011111 10000000 01010000
      10100000 00000000 00110010 00000000 01100100 10000000
      11111000 00000001 00110011
3  NID_MESSAGE = 132 (84h) (10000100)
4  L_MESSAGE = 26 (1Ah) (0000011010)
5  T_TRAIN = 189682089 (B4E51A9h)
      (00001011010011100101000110101001)
6  NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
7  Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
      driver"
8  Packet 0 - TrainToTrack - Pos Report
9      NID_PACKET = 0 (0h) (00000000)
10     L_PACKET = 129 (81h) (0000010000001)
11     Q_SCALE = 0 (0h) (00) "10 cm scale"
12     NID_LRBG = 34784 (87E0h) (000000001000011111100000)
13     NID_C = 2 (2h) (0000000010)
14     NID_BG = 2016 (7E0h) (00011111100000)
15     D_LRBG = 2580 (A14h) (000101000010100) "258.0m"
16     Q_DIRLRBG = 0 (0h) (00) "Reverse"
17     Q_DLRBG = 0 (0h) (00) "Reverse"
18     L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
19     L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
20     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
21     L_TRAININT = 248 (F8h) (000000011111000)
22     V_TRAIN = 0 (0h) (0000000) "0 km/h"
23     Q_DIRTRAIN = 2 (2h) (10) "Unknown"
24     M_MODE = 6 (6h) (0110) "Stand By"
25     M_LEVEL = 3 (3h) (011) "Level 2"
26 11:04:32.511919 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
  :192.168.0.132
27     10000100 00000110 10000010 11010011 10010100 01111110
      11010111 00100000 01110100 00000010 00000000 00001000
      00010000 00000010 00011111 10000000 01010000
      10100000 00000000 00110010 00000000 01100100 10000000
      11111000 00000001 00010011
28     NID_MESSAGE = 132 (84h) (10000100)
29     L_MESSAGE = 26 (1Ah) (0000011010)
30     T_TRAIN = 189682171 (B4E51FBh)

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C. Simulation Traces

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(00001011010011100101000111111011)
31 NID_ENGINE = 6062544 (5C81D0h)
(010111001000000111010000)
32 Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
driver"
33 Packet 0 - TrainToTrack - Pos Report
34 NID_PACKET = 0 (0h) (00000000)
35 L_PACKET = 129 (81h) (00000100000001)
36 Q_SCALE = 0 (0h) (00) "10 cm scale"
37 NID_LRBG = 34784 (87E0h) (000000001000011111100000)
38 NID_C = 2 (2h) (0000000010)
39 NID_BG = 2016 (7E0h) (00011111100000)
40 D_LRBG = 2580 (A14h) (000101000010100) "258.0m"
41 Q_DIRLRBG = 0 (0h) (00) "Reverse"
42 Q_DLRBG = 0 (0h) (00) "Reverse"
43 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
44 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
"
45 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
46 L_TRAININT = 248 (F8h) (0000000111111000)
47 V_TRAIN = 0 (0h) (00000000) "0 km/h"
48 Q_DIRTRAIN = 2 (2h) (10) "Unknown"
49 M_MODE = 2 (2h) (0010) "Staff Responsible"
50 M_LEVEL = 3 (3h) (011) "Level 2"
51 11:05:32.144948 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
:192.168.0.132
52 10000100 00000110 10000010 11010011 10011010 01011011
00010111 00100000 01110100 00000010 00000000 00001000
00010000 00000010 00001111 10101000 00000010
11000000 00000000 00110010 00000000 01100100 10000000
11111000 00001110 00010011
53 NID_MESSAGE = 132 (84h) (10000100)
54 L_MESSAGE = 26 (1Ah) (0000011010)
55 T_TRAIN = 189688172 (B4E696Ch)
(00001011010011100110100101101100)
56 NID_ENGINE = 6062544 (5C81D0h)
(010111001000000111010000)
57 Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
driver"
58 Packet 0 - TrainToTrack - Pos Report
59 NID_PACKET = 0 (0h) (00000000)
60 L_PACKET = 129 (81h) (00000100000001)
61 Q_SCALE = 0 (0h) (00) "10 cm scale"
62 NID_LRBG = 33770 (83EAh) (000000001000001111101010)
63 NID_C = 2 (2h) (0000000010)
64 NID_BG = 1002 (3EAh) (00001111101010)
65 D_LRBG = 88 (58h) (000000001011000) "8.8m"
66 Q_DIRLRBG = 0 (0h) (00) "Reverse"

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67         Q_DLRBG = 0 (0h) (00) "Reverse"
68         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
69         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
70         "
71         Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
72         integrity monitoring device"
73         L_TRAININT = 248 (F8h) (000000011111000)
74         V_TRAIN = 7 (7h) (0000111) "35 km/h"
75         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
76         M_MODE = 2 (2h) (0010) "Staff Responsible"
77         M_LEVEL = 3 (3h) (011) "Level 2"
78 11:06:32.295817 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
79 :192.168.0.132
80 10000100 00000110 10000010 11010011 10100000 00110111
81 01010111 00100000 01110100 00000010 00000000 00001000
82 00010000 00000010 00010000 00001000 10001001
83 01011010 10000000 00110010 00000000 01100100 10000000
84 11111000 00001110 10010011
85 NID_MESSAGE = 132 (84h) (10000100)
86 L_MESSAGE = 26 (1Ah) (0000011010)
87 T_TRAIN = 189694173 (B4E80DDh)
88 (00001011010011101000000011011101)
89 NID_ENGINE = 6062544 (5C81D0h)
90 (010111001000000111010000)
91 Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
92 driver"
93 Packet 0 - TrainToTrack - Pos Report
94 NID_PACKET = 0 (0h) (00000000)
95 L_PACKET = 129 (81h) (0000010000001)
96 Q_SCALE = 0 (0h) (00) "10 cm scale"
97 NID_LRBG = 33794 (8402h) (0000000010000100000000010)
98 NID_C = 2 (2h) (0000000010)
99 NID_BG = 1026 (402h) (000100000000010)
100 D_LRBG = 4395 (112Bh) (001000100101011) "439.5m"
101 "
102 Q_DIRLRBG = 1 (1h) (01) "Nominal"
103 Q_DLRBG = 1 (1h) (01) "Nominal"
104 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
105 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
106 "
107 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
108 integrity monitoring device"
109 L_TRAININT = 248 (F8h) (000000011111000)
110 V_TRAIN = 7 (7h) (0000111) "35 km/h"
111 Q_DIRTRAIN = 1 (1h) (01) "Nominal"
112 M_MODE = 2 (2h) (0010) "Staff Responsible"
113 M_LEVEL = 3 (3h) (011) "Level 2"
114 11:07:32.308737 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
115 :192.168.0.132

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C. Simulation Traces

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102      10000100 00000110 10000010 11010011 10100110 00010011
      10010111 00100000 01110100 00000010 00000000 00001000
      00010000 00000010 00001111 10111000 01110100
      01010010 10000000 00110010 00000000 01100100 10000000
      11111000 00001110 10010011
103      NID_MESSAGE = 132 (84h) (10000100)
104      L_MESSAGE = 26 (1Ah) (0000011010)
105      T_TRAIN = 189700174 (B4E984Eh)
      (00001011010011101001100001001110)
106      NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
107      Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
      driver"
108      Packet 0 - TrainToTrack - Pos Report
109      NID_PACKET = 0 (0h) (00000000)
110      L_PACKET = 129 (81h) (0000010000001)
111      Q_SCALE = 0 (0h) (00) "10 cm scale"
112      NID_LRBG = 33774 (83EEh) (000000001000001111101110)
113      NID_C = 2 (2h) (0000000010)
114      NID_BG = 1006 (3EEh) (00001111101110)
115      D_LRBG = 3722 (E8Ah) (000111010001010) "372.2m"
116      Q_DIRLRBG = 1 (1h) (01) "Nominal"
117      Q_DLRBG = 1 (1h) (01) "Nominal"
118      L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
119      L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
      "
120      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
121      L_TRAININT = 248 (F8h) (000000011111000)
122      V_TRAIN = 7 (7h) (0000111) "35 km/h"
123      Q_DIRTRAIN = 1 (1h) (01) "Nominal"
124      M_MODE = 2 (2h) (0010) "Staff Responsible"
125      M_LEVEL = 3 (3h) (011) "Level 2"
126      11:08:32.287057 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
127      10000100 00000110 10000010 11010011 10101011 11101111
      10010111 00100000 01110100 00000010 00000000 00001000
      00010000 00000010 00001111 10010000 00111100
      11100010 10000000 00110010 00000000 01100100 10000000
      11111000 00001110 10010011
128      NID_MESSAGE = 132 (84h) (10000100)
129      L_MESSAGE = 26 (1Ah) (0000011010)
130      T_TRAIN = 189706174 (B4EAFBEh)
      (00001011010011101010111110111110)
131      NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
132      Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
      driver"
133      Packet 0 - TrainToTrack - Pos Report
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134         NID_PACKET = 0 (0h) (00000000)
135         L_PACKET = 129 (81h) (00000100000001)
136         Q_SCALE = 0 (0h) (00) "10 cm scale"
137     NID_LRBG = 33764 (83E4h) (0000000010000011111100100)
138         NID_C = 2 (2h) (0000000010)
139         NID_BG = 996 (3E4h) (00001111100100)
140         D_LRBG = 1948 (79Ch) (000011110011100) "194.8m"
141         Q_DIRLRBG = 1 (1h) (01) "Nominal"
142         Q_DLRBG = 1 (1h) (01) "Nominal"
143         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
144         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
145         "
146     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
147         integrity monitoring device"
148         L_TRAININT = 248 (F8h) (000000011111000)
149         V_TRAIN = 7 (7h) (0000111) "35 km/h"
150         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
151         M_MODE = 2 (2h) (0010) "Staff Responsible"
152     M_LEVEL = 3 (3h) (011) "Level 2"
153 11:09:32.311042 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
154     :192.168.0.132
155     10000100 00000110 10000010 11010011 10110001 11001011
156     10010111 00100000 01110100 00000010 00000000 00001000
157     00010000 00000010 00001111 10010000 11100110
158     00100010 10000000 00110010 00000000 01100100 10000000
159     11111000 00001110 10010011
160     NID_MESSAGE = 132 (84h) (10000100)
161     L_MESSAGE = 26 (1Ah) (0000011010)
162     T_TRAIN = 189712174 (B4EC72Eh)
163     (00001011010011101100011100101110)
164     NID_ENGINE = 6062544 (5C81D0h)
165     (010111001000000111010000)
166     Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
167         driver"
168     Packet 0 - TrainToTrack - Pos Report
169         NID_PACKET = 0 (0h) (00000000)
170         L_PACKET = 129 (81h) (00000100000001)
171         Q_SCALE = 0 (0h) (00) "10 cm scale"
172     NID_LRBG = 33764 (83E4h) (0000000010000011111100100)
173         NID_C = 2 (2h) (0000000010)
174         NID_BG = 996 (3E4h) (00001111100100)
175         D_LRBG = 7364 (1CC4h) (001110011000100) "736.4m"
176         "
177         Q_DIRLRBG = 1 (1h) (01) "Nominal"
178         Q_DLRBG = 1 (1h) (01) "Nominal"
179         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
180         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
181         "
182     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by

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C. Simulation Traces

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    integrity monitoring device"
171         L_TRAININT = 248 (F8h) (000000011111000)
172         V_TRAIN = 7 (7h) (0000111) "35 km/h"
173         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
174         M_MODE = 2 (2h) (0010) "Staff Responsible"
175         M_LEVEL = 3 (3h) (011) "Level 2"
176 11:10:32.291573 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
    :192.168.0.132
177     10000100 00000110 10000010 11010011 10110111 10100111
        11010111 00100000 01110100 00000010 00000000 00001000
        00010000 00000010 00001111 10010001 10001111
        01100010 10000000 00110010 00000000 01100100 10000000
        11111000 00001110 10010011
178     NID_MESSAGE = 132 (84h) (10000100)
179     L_MESSAGE = 26 (1Ah) (0000011010)
180     T_TRAIN = 189718175 (B4EDE9Fh)
        (00001011010011101101111010011111)
181     NID_ENGINE = 6062544 (5C81D0h)
        (010111001000000111010000)
182     Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
        driver"
183     Packet 0 - TrainToTrack - Pos Report
184         NID_PACKET = 0 (0h) (00000000)
185         L_PACKET = 129 (81h) (00000100000001)
186         Q_SCALE = 0 (0h) (00) "10 cm scale"
187     NID_LRBG = 33764 (83E4h) (000000001000001111100100)
188         NID_C = 2 (2h) (0000000010)
189         NID_BG = 996 (3E4h) (00001111100100)
190         D_LRBG = 12780 (31ECh) (011000111101100)
        "1278.0m"
191         Q_DIRLRBG = 1 (1h) (01) "Nominal"
192         Q_DLRBG = 1 (1h) (01) "Nominal"
193         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
194         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
        "
195     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
        integrity monitoring device"
196         L_TRAININT = 248 (F8h) (000000011111000)
197         V_TRAIN = 7 (7h) (0000111) "35 km/h"
198         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
199         M_MODE = 2 (2h) (0010) "Staff Responsible"
200         M_LEVEL = 3 (3h) (011) "Level 2"
201 11:11:32.315428 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
    :192.168.0.132
202     10000100 00000110 10000010 11010011 10111101 10000100
        00010111 00100000 01110100 00000010 00000000 00001000
        00010000 00000010 00001111 11000000 10101001
        11110010 10000000 00110010 00000000 01100100 10000000
        11111000 00001110 10010011

```

```

203     NID_MESSAGE = 132 (84h) (10000100)
204     L_MESSAGE = 26 (1Ah) (0000011010)
205     T_TRAIN = 189724176 (B4EF610h)
          (00001011010011101111011000010000)
206     NID_ENGINE = 6062544 (5C81D0h)
          (010111001000000111010000)
207     Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
          driver"
208     Packet 0 - TrainToTrack - Pos Report
209             NID_PACKET = 0 (0h) (00000000)
210             L_PACKET = 129 (81h) (0000010000001)
211             Q_SCALE = 0 (0h) (00) "10 cm scale"
212     NID_LRBG = 33776 (83F0h) (000000001000001111110000)
213             NID_C = 2 (2h) (0000000010)
214             NID_BG = 1008 (3F0h) (00001111110000)
215             D_LRBG = 5438 (153Eh) (001010100111110) "543.8m
          "
216             Q_DIRLRBG = 1 (1h) (01) "Nominal"
217             Q_DLRBG = 1 (1h) (01) "Nominal"
218             L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
219             L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
          "
220     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
221             L_TRAININT = 248 (F8h) (000000011111000)
222             V_TRAIN = 7 (7h) (0000111) "35 km/h"
223             Q_DIRTRAIN = 1 (1h) (01) "Nominal"
224             M_MODE = 2 (2h) (0010) "Staff Responsible"
225     M_LEVEL = 3 (3h) (011) "Level 2"
226 11:12:32.289303 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
          :192.168.0.132
227     10000100 00000110 10000010 11010011 11000011 01100000
          01010111 00100000 01110100 00000010 00000000 00001000
          00010000 00000010 00001111 11010000 00000110
          10110010 10000000 00110010 00000000 01100100 10000000
          11111000 00001110 10010011
228     NID_MESSAGE = 132 (84h) (10000100)
229     L_MESSAGE = 26 (1Ah) (0000011010)
230     T_TRAIN = 189730177 (B4F0D81h)
          (00001011010011110000110110000001)
231     NID_ENGINE = 6062544 (5C81D0h)
          (010111001000000111010000)
232     Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
          driver"
233     Packet 0 - TrainToTrack - Pos Report
234             NID_PACKET = 0 (0h) (00000000)
235             L_PACKET = 129 (81h) (0000010000001)
236             Q_SCALE = 0 (0h) (00) "10 cm scale"
237     NID_LRBG = 33780 (83F4h) (000000001000001111110100)

```

C. Simulation Traces

```
238         NID_C = 2 (2h) (0000000010)
239         NID_BG = 1012 (3F4h) (00001111110100)
240         D_LRBG = 214 (D6h) (000000011010110) "21.4m"
241         Q_DIRLRBG = 1 (1h) (01) "Nominal"
242         Q_DLRBG = 1 (1h) (01) "Nominal"
243         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
244         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
245     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
246         L_TRAININT = 248 (F8h) (000000011111000)
247         V_TRAIN = 7 (7h) (0000111) "35 km/h"
248         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
249         M_MODE = 2 (2h) (0010) "Staff Responsible"
250     M_LEVEL = 3 (3h) (011) "Level 2"
251 11:12:44.256719 # VL Release Request (MsgId 3) - Dest
           :192.168.0.132
252     Preamble = 65535 (FFFFh) (1111111111111111)
253     Length of PDU = 14 (0Eh) (0000000000001110)
254     Message ID = 3 (03h) (00000011)
255     Channel ID = 128 (80h) (10000000)
256     DATA [0] = 2 (02h) (00000010)
257     DATA [1] = 3 (03h) (00000011)
258     DATA [2] = 0 (00h) (00000000)
259     DATA [3] = 3 (03h) (00000011)
260     DATA [4] = 16 (10h) (00010000)
261     DATA [5] = 0 (00h) (00000000)
262     DATA [6] = 0 (00h) (00000000)
263     DATA [7] = 2 (02h) (00000010)
264     DATA [8] = 5 (05h) (00000101)
265     DATA [9] = 0 (00h) (00000000)
266     DATA [10] = 1 (01h) (00000001)
267     DATA [11] = 128 (80h) (10000000)
```

Two Trains on a Single Track (Filtered)

```
1 12:06:27.912000 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
           :192.168.0.132
2     10000100 00000110 10000010 11010100 11111111 01010000
           01010111 00100000 01110100 00000010 00000000 00001000
           00010000 00000010 00011111 10000100 01101100
           11000000 00000000 00110010 00000000 01100100 10000000
           11111000 00000001 00110011
3     NID_MESSAGE = 132 (84h) (10000100)
4     L_MESSAGE = 26 (1Ah) (0000011010)
5     T_TRAIN = 190053697 (B53FD41h)
           (00001011010100111111110101000001)
6     NID_ENGINE = 6062544 (5C81D0h)
           (010111001000000111010000)
```



```

7       Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
      driver"
8       Packet 0 - TrainToTrack - Pos Report
9         NID_PACKET = 0 (0h) (00000000)
10        L_PACKET = 129 (81h) (0000010000001)
11        Q_SCALE = 0 (0h) (00) "10 cm scale"
12        NID_LRBG = 34785 (87E1h) (000000001000011111100001)
13        NID_C = 2 (2h) (0000000010)
14        NID_BG = 2017 (7E1h) (00011111100001)
15        D_LRBG = 3480 (D98h) (000110110011000) "348.0m"
16        Q_DIRLRBG = 0 (0h) (00) "Reverse"
17        Q_DLRBG = 0 (0h) (00) "Reverse"
18        L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
19        L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
20      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
21        L_TRAININT = 248 (F8h) (000000011111000)
22        V_TRAIN = 0 (0h) (0000000) "0 km/h"
23        Q_DIRTRAIN = 2 (2h) (10) "Unknown"
24        M_MODE = 6 (6h) (0110) "Stand By"
25      M_LEVEL = 3 (3h) (011) "Level 2"
26 12:06:29.315000 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062544 - Dest:192.168.0.134
27      00000011 00010010 11000010 11010100 11111111 01110011
      01000000 00010000 11111100 00100001 11100000 00010110
      00010000 00000000 00000000 00000000 11110100
      10010000 00000000 00011111 10000111 00100000 00001100
      01000110 01111111 11110000 10100011 10100000
      00001001 00001000 01010111 11111111 11110010 00010000
      00110000 00110000 01010000 00010010 01101000
      00010111 01110000 01111101 00010000 00010001 00000000
      00110110 00001000 00000011 00000001 00000000
      01010000 00001111 10100110 00000010 00110110 00000001
      01011001 00000000 00000000 00101010 00000000
      10000001 11101001 11111110 00000000 10101000 00000100
      11100100 00000000 00000100 00000000 00100000
      01111010 01011111 11100000
28      NID_MESSAGE = 3 (3h) (00000011)
29      L_MESSAGE = 75 (4Bh) (0001001011)
30      T_TRAIN = 190053837 (B53FDCDh)
      (00001011010100111111110111001101)
31      M_ACK = 0 (0h) (0) "No acknowledgement required"
32      NID_LRBG = 34785 (87E1h) (000000001000011111100001)
33        NID_C = 2 (2h) (0000000010)
34        NID_BG = 2017 (7E1h) (00011111100001)
35      Packet 15 - TrackToTrain - Level 2/3 MA
36        NID_PACKET = 15 (Fh) (00001111)
37        Q_DIR = 0 (0h) (00) "Reverse"

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C. Simulation Traces

```
38         L_PACKET = 88 (58h) (0000001011000)
39         Q_SCALE = 1 (1h) (01) "1 m scale"
40         V_EMA = 0 (0h) (0000000) "0 km/h"
41         T_EMA = 0 (0h) (00000000000)
42     N_ITER = 0 (0h) (00000)
43         L_ENDSECTION = 489 (1E9h) (000000111101001)
44             "489m"
45     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
46         information"
47     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
48         information"
49     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
50         follow"
51         D_DP = 0 (0h) (0000000000000000) "0m"
52         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
53             calculated release speed"
54     Q_OVERLAP = 0 (0h) (0) "No overlap information"
55     Packet 57 - TrackToTrain - MA Request Params
56         NID_PACKET = 57 (39h) (00111001)
57         Q_DIR = 0 (0h) (00) "Reverse"
58         L_PACKET = 49 (31h) (0000000110001)
59         T_MAR = 25 (19h) (00011001)
60         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
61             request triggering with regards to this
62             function"
63         T_CYCRQST = 10 (Ah) (00001010)
64     Packet 58 - TrackToTrain - Pos Report Params
65         NID_PACKET = 58 (3Ah) (00111010)
66         Q_DIR = 0 (0h) (00) "Reverse"
67         L_PACKET = 72 (48h) (0000001001000)
68         Q_SCALE = 1 (1h) (01) "1 m scale"
69         T_CYCLOC = 10 (Ah) (00001010)
70         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
71             train has not to report cyclically its
72             position"
73         M_LOC = 1 (1h) (001) "Every LRBG compliant
74             balise group"
75     N_ITER = 1 (1h) (00001)
76         [0] D_LOC = 385 (181h) (000000110000001) "385m"
77         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
78     Packet 5 - TrackToTrain - Linking
79         NID_PACKET = 5 (5h) (00000101)
80         Q_DIR = 0 (0h) (00) "Reverse"
81         L_PACKET = 147 (93h) (0000010010011)
82         Q_SCALE = 1 (1h) (01) "1 m scale"
83         D_LINK = 375 (177h) (000000101110111) "375m"
84     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
85         administration, no NID_C follows"
86         NID_BG = 1000 (3E8h) (00001111101000)
```

```

76         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
77         Q_LINKREACTION = 0 (0h) (00) "Train trip"
78         Q_LOCACCC = 1 (1h) (000001)
79     N_ITER = 2 (2h) (00010)
80         [0] D_LINK = 54 (36h) (000000000110110) "54m"
81     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
82         [0] NID_BG = 1025 (401h) (00010000000001)
83         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
84         [0] Q_LINKREACTION = 0 (0h) (00) "Train trip"
85         [0] Q_LOCACCC = 1 (1h) (000001)
86         [1] D_LINK = 40 (28h) (000000000101000) "40m"
87     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
88         [1] NID_BG = 1001 (3E9h) (00001111101001)
89         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
90         [1] Q_LINKREACTION = 0 (0h) (00) "Train trip"
91         [1] Q_LOCACCC = 1 (1h) (000001)
92     Packet 27 - TrackToTrain - International SSP
93         NID_PACKET = 27 (1Bh) (00011011)
94         Q_DIR = 0 (0h) (00) "Reverse"
95         L_PACKET = 86 (56h) (0000001010110)
96         Q_SCALE = 1 (1h) (01) "1 m scale"
97         D_STATIC = 0 (0h) (000000000000000) "0m"
98         V_STATIC = 10 (Ah) (0001010) "50 km/h"
99         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
100     N_ITER = 0 (0h) (00000)
101     N_ITER = 1 (1h) (00001)
102         [0] D_STATIC = 489 (1E9h) (000000111101001)
           "489m"
103         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
104         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
105     [0] N_ITER = 0 (0h) (00000)
106     Packet 21 - TrackToTrain - Gradient Profile
107         NID_PACKET = 21 (15h) (00010101)
108         Q_DIR = 0 (0h) (00) "Reverse"
109         L_PACKET = 78 (4Eh) (0000001001110)
110         Q_SCALE = 1 (1h) (01) "1 m scale"

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C. Simulation Traces

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111         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
112         Q_GDIR = 1 (1h) (1) "Uphill"
113         G_A = 0 (0h) (00000000) "0 o/oo"
114     N_ITER = 1 (1h) (00001)
115         [0] D_GRADIENT = 489 (1E9h) (000000111101001)
           "489m"
116         [0] Q_GDIR = 0 (0h) (0) "Downhill"
117         [0] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
118 12:06:30.112798 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
           :192.168.0.132
119     10000100 00000110 10000010 11010100 11111111 10001110
           11010111 00100000 01110100 00000100 00000000 00001000
           00010000 00000010 00011111 10000100 01101100
           11000000 00000000 00110010 00000000 01100100 10000000
           11111000 00000001 00000011
120     NID_MESSAGE = 132 (84h) (10000100)
121     L_MESSAGE = 26 (1Ah) (0000011010)
122     T_TRAIN = 190053947 (B53FE3Bh)
           (000010110101001111111111000111011)
123     NID_ENGINE = 6062544 (5C81D0h)
           (010111001000000111010000)
124     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
           the perturbation location reached"
125     Packet 0 - TrainToTrack - Pos Report
126         NID_PACKET = 0 (0h) (00000000)
127         L_PACKET = 129 (81h) (00000100000001)
128         Q_SCALE = 0 (0h) (00) "10 cm scale"
129     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
130         NID_C = 2 (2h) (0000000010)
131         NID_BG = 2017 (7E1h) (00011111100001)
132         D_LRBG = 3480 (D98h) (000110110011000) "348.0m"
133         Q_DIRLRBG = 0 (0h) (00) "Reverse"
134         Q_DLRBG = 0 (0h) (00) "Reverse"
135         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
136         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
137     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
138         L_TRAININT = 248 (F8h) (000000011111000)
139         V_TRAIN = 0 (0h) (00000000) "0 km/h"
140         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
141         M_MODE = 0 (0h) (0000) "Full Supervision"
142     M_LEVEL = 3 (3h) (011) "Level 2"
143 12:06:39.576685 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
           (PK21) - Train 6062544 - Dest:192.168.0.134
144     00000011 00010111 10000010 11010101 00000000 01111011
           10000000 00010000 01111101 00000001 11101000 00010110

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```

00010000 00000000 00000000 00000001 10000000
10010000 00000000 00011111 10000111 00101000 00001100
01000110 01111111 11110000 10100011 10100100
00001011 00001000 01010111 11111111 11110010 00100000
00000001 01010000 00010000 01110000 01010100
00100001 00001000 00000011 01100000 10000000 00111000
00010010 10000000 00101000 00000111 11010011
10000001 00000000 01001000 00001111 11111111 00000010
00000000 11010000 00100000 00011010 00000100
00000100 10100000 01000000 01111100 00001000 00011010
00110000 01111110 00111000 00010001 10110100
00001010 11001000 00000000 00000001 01010000 00000100
00011000 00001111 11110000 00000101 01010000
00110011 00100000 00000000 00100000 00000010 00000001
01100101 00000101 00000100 10011110 11111111
145 NID_MESSAGE = 3 (3h) (00000011)
146 L_MESSAGE = 94 (5Eh) (0001011110)
147 T_TRAIN = 190054894 (B5401EEh)
(0000101101010101000000000111101110)
148 M_ACK = 0 (0h) (0) "No acknowledgement required"
149 NID_LRBG = 33768 (83E8h) (000000001000001111101000)
150 NID_C = 2 (2h) (0000000010)
151 NID_BG = 1000 (3E8h) (00001111101000)
152 Packet 15 - TrackToTrain - Level 2/3 MA
153 NID_PACKET = 15 (Fh) (00001111)
154 Q_DIR = 1 (1h) (01) "Nominal"
155 L_PACKET = 88 (58h) (0000001011000)
156 Q_SCALE = 1 (1h) (01) "1 m scale"
157 V_EMA = 0 (0h) (00000000) "0 km/h"
158 T_EMA = 0 (0h) (0000000000)
159 N_ITER = 0 (0h) (000000)
160 L_ENDSECTION = 769 (301h) (0000011000000001)
"769m"
161 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
162 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
163 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
164 D_DP = 0 (0h) (0000000000000000) "0m"
165 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
166 Q_OVERLAP = 0 (0h) (0) "No overlap information"
167 Packet 57 - TrackToTrain - MA Request Params
168 NID_PACKET = 57 (39h) (00111001)
169 Q_DIR = 1 (1h) (01) "Nominal"
170 L_PACKET = 49 (31h) (0000000110001)
171 T_MAR = 25 (19h) (00011001)
172 T_TIMEOU TRQST = 1023 (3FFh) (1111111111) "No MA

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        request triggering with regards to this
        function"
173         T_CYCRQST = 10 (Ah) (00001010)
174 Packet 58 - TrackToTrain - Pos Report Params
175         NID_PACKET = 58 (3Ah) (00111010)
176         Q_DIR = 1 (1h) (01) "Nominal"
177         L_PACKET = 88 (58h) (0000001011000)
178         Q_SCALE = 1 (1h) (01) "1 m scale"
179         T_CYCLOC = 10 (Ah) (00001010)
180         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
        train has not to report cyclically its
        position"
181         M_LOC = 1 (1h) (001) "Every LRBG compliant
        balise group"
182 N_ITER = 2 (2h) (00010)
183         [0] D_LOC = 10 (Ah) (000000000001010) "10m"
184         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
185         [1] D_LOC = 131 (83h) (000000010000011) "131m"
186         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
187 Packet 5 - TrackToTrain - Linking
188         NID_PACKET = 5 (5h) (00000101)
189         Q_DIR = 1 (1h) (01) "Nominal"
190         L_PACKET = 264 (108h) (0000100001000)
191         Q_SCALE = 1 (1h) (01) "1 m scale"
192         D_LINK = 54 (36h) (000000000110110) "54m"
193 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
194         NID_BG = 1025 (401h) (00010000000001)
195         Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
196         Q_LINKREACTION = 2 (2h) (10) "No reaction"
197         Q_LOCACC = 1 (1h) (000001)
198 N_ITER = 5 (5h) (00101)
199         [0] D_LINK = 40 (28h) (000000000101000) "40m"
200 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
201         [0] NID_BG = 1001 (3E9h) (00001111101001)
202         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
203         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
204         [0] Q_LOCACC = 1 (1h) (000001)
205         [1] D_LINK = 36 (24h) (000000000100100) "36m"
206 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
207         [1] NID_BG = 1023 (3FFh) (00001111111111)
208         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal

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direction"
209 [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
210 [1] Q_LOCACCC = 1 (1h) (000001)
211 [2] D_LINK = 52 (34h) (000000000110100) "52m"
212 [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
213 [2] NID_BG = 1027 (403h) (00010000000011)
214 [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
group is seen by the train in reverse
direction"
215 [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
216 [2] Q_LOCACCC = 1 (1h) (000001)
217 [3] D_LINK = 148 (94h) (000000010010100) "148m"
218 [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
219 [3] NID_BG = 1031 (407h) (00010000000111)
220 [3] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
221 [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
222 [3] Q_LOCACCC = 1 (1h) (000001)
223 [4] D_LINK = 419 (1A3h) (000000110100011) "419m
"
224 [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
administration, no NID_C follows"
225 [4] NID_BG = 1009 (3F1h) (00001111110001)
226 [4] Q_LINKORIENTATION = 1 (1h) (1) "The balise
group is seen by the train in nominal
direction"
227 [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
228 [4] Q_LOCACCC = 1 (1h) (000001)
229 Packet 27 - TrackToTrain - International SSP
230 NID_PACKET = 27 (1Bh) (00011011)
231 Q_DIR = 1 (1h) (01) "Nominal"
232 L_PACKET = 86 (56h) (0000001010110)
233 Q_SCALE = 1 (1h) (01) "1 m scale"
234 D_STATIC = 0 (0h) (00000000000000) "0m"
235 V_STATIC = 10 (Ah) (0001010) "50 km/h"
236 Q_FRONT = 1 (1h) (1) "No train length delay on
validity end point of profile element"
237 N_ITER = 0 (0h) (00000)
238 N_ITER = 1 (1h) (00001)
239 [0] D_STATIC = 769 (301h) (000001100000001)
"769m"
240 [0] V_STATIC = 127 (7Fh) (1111111) "Non
numerical value telling that the static
speed profile description ends at D_STATIC(n
)"
241 [0] Q_FRONT = 0 (0h) (0) "Train length delay on

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                validity end point of profile element"
242 [0] N_ITER = 0 (0h) (00000)
243 Packet 21 - TrackToTrain - Gradient Profile
244     NID_PACKET = 21 (15h) (00010101)
245     Q_DIR = 1 (1h) (01) "Nominal"
246     L_PACKET = 102 (66h) (0000001100110)
247     Q_SCALE = 1 (1h) (01) "1 m scale"
248     D_GRADIENT = 0 (0h) (0000000000000000) "0m"
249     Q_GDIR = 1 (1h) (1) "Uphill"
250     G_A = 0 (0h) (00000000) "0 o/oo"
251 N_ITER = 2 (2h) (00010)
252 [0] D_GRADIENT = 178 (B2h) (000000010110010)
        "178m"
253 [0] Q_GDIR = 1 (1h) (1) "Uphill"
254 [0] G_A = 5 (5h) (00000101) "5 o/oo"
255 [1] D_GRADIENT = 591 (24Fh) (000001001001111)
        "591m"
256 [1] Q_GDIR = 0 (0h) (0) "Downhill"
257 [1] G_A = 255 (FFh) (11111111) "Non numerical
        value telling that the current gradient
        description ends at D_GRADIENT(n)"
258 12:06:40.472495 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
        :192.168.0.132
259 10000100 00000110 10000010 11010101 00000000 10001001
        01010111 00100000 01110100 00000100 00000000 00001000
        00010000 00000010 00001111 10100000 00000101
        01110010 10000000 00110010 00000000 01100100 10000000
        11111000 00001100 10000011
260 NID_MESSAGE = 132 (84h) (10000100)
261 L_MESSAGE = 26 (1Ah) (0000011010)
262 T_TRAIN = 190054949 (B540225h)
        (0000101101010101000000001000100101)
263 NID_ENGINE = 6062544 (5C81D0h)
        (010111001000000111010000)
264 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
        the perturbation location reached"
265 Packet 0 - TrainToTrack - Pos Report
266     NID_PACKET = 0 (0h) (00000000)
267     L_PACKET = 129 (81h) (00000100000001)
268     Q_SCALE = 0 (0h) (00) "10 cm scale"
269 NID_LRBG = 33768 (83E8h) (000000001000001111101000)
270     NID_C = 2 (2h) (0000000010)
271     NID_BG = 1000 (3E8h) (00001111101000)
272     D_LRBG = 174 (AEh) (000000010101110) "17.4m"
273     Q_DIRLRBG = 1 (1h) (01) "Nominal"
274     Q_DLRBG = 1 (1h) (01) "Nominal"
275     L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
276     L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
        "

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277         Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
278         L_TRAININT = 248 (F8h) (000000011111000)
279         V_TRAIN = 6 (6h) (0000110) "30 km/h"
280         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
281         M_MODE = 0 (0h) (0000) "Full Supervision"
282         M_LEVEL = 3 (3h) (011) "Level 2"
283 12:06:58.541947 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
           (PK21) - Train 6062544 - Dest:192.168.0.134
284         00000011 00010011 10000010 11010101 00000010 01010110
           10000000 00010000 10000000 01100001 11100000 00010110
           00010000 00000000 00000000 00000001 01110001
           00010000 00000000 00011111 10000111 00100000 00001100
           01000110 01111111 11110000 10100011 10100000
           00001001 00001000 01010111 11111111 11110010 00010000
           01001100 11010000 01010000 00010010 01101000
           00001001 01000000 10000000 11111000 00010001 00000001
           10100011 00000111 11100011 10000001 00000001
           00100000 00001111 11001111 00000010 00110110 00000001
           01011001 00000000 00000000 00101010 00000000
           10000010 11100010 11111110 00000000 10101000 00000110
           01100100 00000000 00000100 00010100 01000000
           10010100 01100000 00000000 00100100 01011111 11100000
285         NID_MESSAGE = 3 (3h) (00000011)
286         L_MESSAGE = 78 (4Eh) (0001001110)
287         T_TRAIN = 190056794 (B54095Ah)
           (000010110101010000000100101011010)
288         M_ACK = 0 (0h) (0) "No acknowledgement required"
289         NID_LRBG = 33795 (8403h) (0000000010000100000000011)
290         NID_C = 2 (2h) (0000000010)
291         NID_BG = 1027 (403h) (000100000000011)
292         Packet 15 - TrackToTrain - Level 2/3 MA
293         NID_PACKET = 15 (Fh) (00001111)
294         Q_DIR = 0 (0h) (00) "Reverse"
295         L_PACKET = 88 (58h) (0000001011000)
296         Q_SCALE = 1 (1h) (01) "1 m scale"
297         V_EMA = 0 (0h) (0000000) "0 km/h"
298         T_EMA = 0 (0h) (0000000000)
299         N_ITER = 0 (0h) (00000)
300         L_ENDSECTION = 738 (2E2h) (000001011100010)
           "738m"
301         Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
302         Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
303         Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
304         D_DP = 0 (0h) (000000000000000) "0m"
305         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard

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        calculated release speed"
306     Q_OVERLAP = 0 (0h) (0) "No overlap information"
307     Packet 57 - TrackToTrain - MA Request Params
308         NID_PACKET = 57 (39h) (00111001)
309         Q_DIR = 0 (0h) (00) "Reverse"
310         L_PACKET = 49 (31h) (0000000110001)
311         T_MAR = 25 (19h) (00011001)
312         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
        request triggering with regards to this
        function"
313         T_CYCRQST = 10 (Ah) (00001010)
314     Packet 58 - TrackToTrain - Pos Report Params
315         NID_PACKET = 58 (3Ah) (00111010)
316         Q_DIR = 0 (0h) (00) "Reverse"
317         L_PACKET = 72 (48h) (0000001001000)
318         Q_SCALE = 1 (1h) (01) "1 m scale"
319         T_CYCLOC = 10 (Ah) (00001010)
320         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
        train has not to report cyclically its
        position"
321         M_LOC = 1 (1h) (001) "Every LRBG compliant
        balise group"
322     N_ITER = 1 (1h) (00001)
323     [0] D_LOC = 614 (266h) (000001001100110) "614m"
324     [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
325     Packet 5 - TrackToTrain - Linking
326         NID_PACKET = 5 (5h) (00000101)
327         Q_DIR = 0 (0h) (00) "Reverse"
328         L_PACKET = 147 (93h) (0000010010011)
329         Q_SCALE = 1 (1h) (01) "1 m scale"
330         D_LINK = 148 (94h) (000000010010100) "148m"
331     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
332         NID_BG = 1031 (407h) (00010000000111)
333         Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
334         Q_LINKREACTION = 2 (2h) (10) "No reaction"
335         Q_LOCAC = 1 (1h) (000001)
336     N_ITER = 2 (2h) (00010)
337     [0] D_LINK = 419 (1A3h) (000000110100011) "419m
        "
338     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
339     [0] NID_BG = 1009 (3F1h) (00001111110001)
340     [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
341     [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
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342             [0] Q_LOCACCC = 1 (1h) (000001)
343             [1] D_LINK = 144 (90h) (000000010010000) "144m"
344 [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
345             [1] NID_BG = 1011 (3F3h) (00001111110011)
346             [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
347             [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
348             [1] Q_LOCACCC = 1 (1h) (000001)
349 Packet 27 - TrackToTrain - International SSP
350             NID_PACKET = 27 (1Bh) (00011011)
351             Q_DIR = 0 (0h) (00) "Reverse"
352             L_PACKET = 86 (56h) (0000001010110)
353             Q_SCALE = 1 (1h) (01) "1 m scale"
354             D_STATIC = 0 (0h) (000000000000000) "0m"
355             V_STATIC = 10 (Ah) (0001010) "50 km/h"
356             Q_FRONT = 1 (1h) (1) "No train length delay on
      validity end point of profile element"
357 N_ITER = 0 (0h) (00000)
358 N_ITER = 1 (1h) (00001)
359             [0] D_STATIC = 738 (2E2h) (000001011100010)
      "738m"
360             [0] V_STATIC = 127 (7Fh) (1111111) "Non
      numerical value telling that the static
      speed profile description ends at D_STATIC(n
      )"
361             [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
362 [0] N_ITER = 0 (0h) (00000)
363 Packet 21 - TrackToTrain - Gradient Profile
364             NID_PACKET = 21 (15h) (00010101)
365             Q_DIR = 0 (0h) (00) "Reverse"
366             L_PACKET = 102 (66h) (0000001100110)
367             Q_SCALE = 1 (1h) (01) "1 m scale"
368             D_GRADIENT = 0 (0h) (000000000000000) "0m"
369             Q_GDIR = 1 (1h) (1) "Uphill"
370             G_A = 5 (5h) (00000101) "5 o/oo"
371 N_ITER = 2 (2h) (00010)
372             [0] D_GRADIENT = 593 (251h) (000001001010001)
      "593m"
373             [0] Q_GDIR = 1 (1h) (1) "Uphill"
374             [0] G_A = 0 (0h) (00000000) "0 o/oo"
375             [1] D_GRADIENT = 145 (91h) (000000010010001)
      "145m"
376             [1] Q_GDIR = 0 (0h) (0) "Downhill"
377             [1] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"

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378 12:07:10.534145 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
379      10000100 00000110 10000010 11010101 00000011 10000011
      01010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00010000 00011100 00010100
      00000010 10000000 00110010 00000000 01100100 10000000
      11111000 00010100 10000011
380      NID_MESSAGE = 132 (84h) (10000100)
381      L_MESSAGE = 26 (1Ah) (0000011010)
382      T_TRAIN = 190057997 (B540E0Dh)
      (000010110101010000000111000001101)
383      NID_ENGINE = 6062544 (5C81D0h)
      (0101110010000000111010000)
384      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
385      Packet 0 - TrainToTrack - Pos Report
386      NID_PACKET = 0 (0h) (00000000)
387      L_PACKET = 129 (81h) (00000100000001)
388      Q_SCALE = 0 (0h) (00) "10 cm scale"
389      NID_LRBG = 33799 (8407h) (0000000010000100000000111)
390      NID_C = 2 (2h) (0000000010)
391      NID_BG = 1031 (407h) (000100000000111)
392      D_LRBG = 640 (280h) (0000010100000000) "64.0m"
393      Q_DIRLRBG = 1 (1h) (01) "Nominal"
394      Q_DLRBG = 1 (1h) (01) "Nominal"
395      L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
396      L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
397      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
398      L_TRAININT = 248 (F8h) (000000011111000)
399      V_TRAIN = 10 (Ah) (0001010) "50 km/h"
400      Q_DIRTRAIN = 1 (1h) (01) "Nominal"
401      M_MODE = 0 (0h) (0000) "Full Supervision"
402      M_LEVEL = 3 (3h) (011) "Level 2"
403 12:07:10.563471 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062544 - Dest:192.168.0.134
404      00000011 00010010 01000010 11010101 00000011 10000011
      01000000 00010000 10000000 11100001 11101000 00010110
      00010000 00000000 00000000 00000001 00100111
      00010000 00000000 00011111 10000111 00101000 00001100
      01000110 01111111 11110000 10100011 10100100
      00001001 00001000 01010111 11111111 11110010 00010000
      00111010 01010000 01010100 00001101 10001000
      00011010 00110000 01111110 00111000 00010000 10000000
      10010000 00000111 11100111 10000001 00011011
      01000000 10101100 10000000 00000000 00010101 00000000
      01000001 00100111 01111111 00000000 01010101
      00000011 00110010 00000000 00000010 00001010 00100000

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00110111 10110000 00000000 00010010 00101111
11110000
405 NID_MESSAGE = 3 (3h) (00000011)
406 L_MESSAGE = 73 (49h) (0001001001)
407 T_TRAIN = 190057997 (B540E0Dh)
(00001011010101000000111000001101)
408 M_ACK = 0 (0h) (0) "No acknowledgement required"
409 NID_LRBG = 33799 (8407h) (0000000010000100000000111)
410 NID_C = 2 (2h) (0000000010)
411 NID_BG = 1031 (407h) (000100000000111)
412 Packet 15 - TrackToTrain - Level 2/3 MA
413 NID_PACKET = 15 (Fh) (00001111)
414 Q_DIR = 1 (1h) (01) "Nominal"
415 L_PACKET = 88 (58h) (0000001011000)
416 Q_SCALE = 1 (1h) (01) "1 m scale"
417 V_EMA = 0 (0h) (00000000) "0 km/h"
418 T_EMA = 0 (0h) (0000000000)
419 N_ITER = 0 (0h) (00000)
420 L_ENDSECTION = 590 (24Eh) (000001001001110)
"590m"
421 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
422 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
423 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
424 D_DP = 0 (0h) (0000000000000000) "0m"
425 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
426 Q_OVERLAP = 0 (0h) (0) "No overlap information"
427 Packet 57 - TrackToTrain - MA Request Params
428 NID_PACKET = 57 (39h) (00111001)
429 Q_DIR = 1 (1h) (01) "Nominal"
430 L_PACKET = 49 (31h) (0000000110001)
431 T_MAR = 25 (19h) (00011001)
432 T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
request triggering with regards to this
function"
433 T_CYCRQST = 10 (Ah) (00001010)
434 Packet 58 - TrackToTrain - Pos Report Params
435 NID_PACKET = 58 (3Ah) (00111010)
436 Q_DIR = 1 (1h) (01) "Nominal"
437 L_PACKET = 72 (48h) (0000001001000)
438 Q_SCALE = 1 (1h) (01) "1 m scale"
439 T_CYCLOC = 10 (Ah) (00001010)
440 D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
train has not to report cyclically its
position"
441 M_LOC = 1 (1h) (001) "Every LRBG compliant

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                                balise group"
442     N_ITER = 1 (1h) (00001)
443         [0] D_LOC = 466 (1D2h) (000000111010010) "466m"
444         [0] Q_LGTLLOC = 1 (1h) (1) "Max safe front end"
445     Packet 5 - TrackToTrain - Linking
446         NID_PACKET = 5 (5h) (00000101)
447         Q_DIR = 1 (1h) (01) "Nominal"
448         L_PACKET = 108 (6Ch) (0000001101100)
449         Q_SCALE = 1 (1h) (01) "1 m scale"
450         D_LINK = 419 (1A3h) (000000110100011) "419m"
451     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
452         NID_BG = 1009 (3F1h) (00001111110001)
453         Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
454         Q_LINKREACTION = 2 (2h) (10) "No reaction"
455         Q_LOCACC = 1 (1h) (000001)
456     N_ITER = 1 (1h) (00001)
457         [0] D_LINK = 144 (90h) (000000010010000) "144m"
458     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
459         [0] NID_BG = 1011 (3F3h) (00001111110011)
460         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
461         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
462         [0] Q_LOCACC = 1 (1h) (000001)
463     Packet 27 - TrackToTrain - International SSP
464         NID_PACKET = 27 (1Bh) (00011011)
465         Q_DIR = 1 (1h) (01) "Nominal"
466         L_PACKET = 86 (56h) (0000001010110)
467         Q_SCALE = 1 (1h) (01) "1 m scale"
468         D_STATIC = 0 (0h) (000000000000000) "0m"
469         V_STATIC = 10 (Ah) (0001010) "50 km/h"
470         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
471     N_ITER = 0 (0h) (00000)
472     N_ITER = 1 (1h) (00001)
473         [0] D_STATIC = 590 (24Eh) (000001001001110)
        "590m"
474         [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
475         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
476     [0] N_ITER = 0 (0h) (00000)
477     Packet 21 - TrackToTrain - Gradient Profile

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478 NID_PACKET = 21 (15h) (00010101)
479 Q_DIR = 1 (1h) (01) "Nominal"
480 L_PACKET = 102 (66h) (0000001100110)
481 Q_SCALE = 1 (1h) (01) "1 m scale"
482 D_GRADIENT = 0 (0h) (0000000000000000) "0m"
483 Q_GDIR = 1 (1h) (1) "Uphill"
484 G_A = 5 (5h) (00000101) "5 o/oo"
485 N_ITER = 2 (2h) (00010)
486 [0] D_GRADIENT = 445 (1BDh) (000000110111101)
      "445m"
487 [0] Q_GDIR = 1 (1h) (1) "Uphill"
488 [0] G_A = 0 (0h) (00000000) "0 o/oo"
489 [1] D_GRADIENT = 145 (91h) (000000010010001)
      "145m"
490 [1] Q_GDIR = 0 (0h) (0) "Downhill"
491 [1] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"
492 12:07:11.534343 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
493 10000100 00000110 10000010 11010101 00000011 10011100
      01010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00010000 00011100 00011000
      01010010 10000000 00110010 00000000 01100100 10000000
      11111000 00010100 10000011
494 NID_MESSAGE = 132 (84h) (10000100)
495 L_MESSAGE = 26 (1Ah) (0000011010)
496 T_TRAIN = 190058097 (B540E71h)
      (00001011010101000000111001110001)
497 NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
498 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
499 Packet 0 - TrainToTrack - Pos Report
500 NID_PACKET = 0 (0h) (00000000)
501 L_PACKET = 129 (81h) (0000010000001)
502 Q_SCALE = 0 (0h) (00) "10 cm scale"
503 NID_LRBG = 33799 (8407h) (0000000010000100000000111)
504 NID_C = 2 (2h) (0000000010)
505 NID_BG = 1031 (407h) (00010000000111)
506 D_LRBG = 778 (30Ah) (000001100001010) "77.8m"
507 Q_DIRLRBG = 1 (1h) (01) "Nominal"
508 Q_DLRBG = 1 (1h) (01) "Nominal"
509 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
510 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
511 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
512 L_TRAININT = 248 (F8h) (000000011111000)

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513         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
514         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
515         M_MODE = 0 (0h) (0000) "Full Supervision"
516     M_LEVEL = 3 (3h) (011) "Level 2"
517 12:07:21.545845 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
518     10000100 00000110 10000010 11010101 00000100 10010110
      10010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00010000 00011100 01000011
      10111010 10000000 00110010 00000000 01100100 10000000
      11111000 00010100 10000011
519     NID_MESSAGE = 132 (84h) (10000100)
520     L_MESSAGE = 26 (1Ah) (0000011010)
521     T_TRAIN = 190059098 (B54125Ah)
      (00001011010101000001001001011010)
522     NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
523     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
524     Packet 0 - TrainToTrack - Pos Report
525         NID_PACKET = 0 (0h) (00000000)
526         L_PACKET = 129 (81h) (00000100000001)
527         Q_SCALE = 0 (0h) (00) "10 cm scale"
528     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
529         NID_C = 2 (2h) (0000000010)
530         NID_BG = 1031 (407h) (000100000000111)
531         D_LRBG = 2167 (877h) (000100001110111) "216.7m"
532         Q_DIRLRBG = 1 (1h) (01) "Nominal"
533         Q_DLRBG = 1 (1h) (01) "Nominal"
534         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
535         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
536     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
537         L_TRAININT = 248 (F8h) (000000011111000)
538         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
539         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
540         M_MODE = 0 (0h) (0000) "Full Supervision"
541     M_LEVEL = 3 (3h) (011) "Level 2"
542 12:07:21.573885 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062544 - Dest:192.168.0.134
543     00000011 00010010 01000010 11010101 00000100 10010110
      10000000 00010000 10000000 11100001 11101000 00010110
      00010000 00000000 00000000 00000001 00100111
      00010000 00000000 00011111 10000111 00101000 00001100
      01000110 01111111 11110000 10100011 10100100
      00001001 00001000 01010111 11111111 11110010 00010000
      00111010 01010000 01010100 00001101 10001000
      00011010 00110000 01111110 00111000 00010000 10000000

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10010000 00000111 11100111 10000001 00011011
01000000 10101100 10000000 00000000 00010101 00000000
01000001 00100111 01111111 00000000 01010101
00000011 00110010 00000000 00000010 00001010 00100000
00110111 10110000 00000000 00010010 00101111
11110000
544 NID_MESSAGE = 3 (3h) (00000011)
545 L_MESSAGE = 73 (49h) (0001001001)
546 T_TRAIN = 190059098 (B54125Ah)
      (000010110101010000001001001011010)
547 M_ACK = 0 (0h) (0) "No acknowledgement required"
548 NID_LRBG = 33799 (8407h) (0000000010000100000000111)
549     NID_C = 2 (2h) (0000000010)
550     NID_BG = 1031 (407h) (000100000000111)
551 Packet 15 - TrackToTrain - Level 2/3 MA
552     NID_PACKET = 15 (Fh) (00001111)
553     Q_DIR = 1 (1h) (01) "Nominal"
554     L_PACKET = 88 (58h) (0000001011000)
555     Q_SCALE = 1 (1h) (01) "1 m scale"
556     V_EMA = 0 (0h) (00000000) "0 km/h"
557     T_EMA = 0 (0h) (0000000000)
558 N_ITER = 0 (0h) (00000)
559     L_ENDSECTION = 590 (24Eh) (000001001001110)
      "590m"
560 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
561 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
562 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
563     D_DP = 0 (0h) (0000000000000000) "0m"
564     V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
565 Q_OVERLAP = 0 (0h) (0) "No overlap information"
566 Packet 57 - TrackToTrain - MA Request Params
567     NID_PACKET = 57 (39h) (00111001)
568     Q_DIR = 1 (1h) (01) "Nominal"
569     L_PACKET = 49 (31h) (0000000110001)
570     T_MAR = 25 (19h) (00011001)
571     T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
      request triggering with regards to this
      function"
572     T_CYCRQST = 10 (Ah) (00001010)
573 Packet 58 - TrackToTrain - Pos Report Params
574     NID_PACKET = 58 (3Ah) (00111010)
575     Q_DIR = 1 (1h) (01) "Nominal"
576     L_PACKET = 72 (48h) (0000001001000)
577     Q_SCALE = 1 (1h) (01) "1 m scale"
578     T_CYCLOC = 10 (Ah) (00001010)

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C. Simulation Traces

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579         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
580         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
581     N_ITER = 1 (1h) (00001)
582         [0] D_LOC = 466 (1D2h) (000000111010010) "466m"
583         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
584     Packet 5 - TrackToTrain - Linking
585         NID_PACKET = 5 (5h) (00000101)
586         Q_DIR = 1 (1h) (01) "Nominal"
587         L_PACKET = 108 (6Ch) (0000001101100)
588         Q_SCALE = 1 (1h) (01) "1 m scale"
589         D_LINK = 419 (1A3h) (000000110100011) "419m"
590     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
591         NID_BG = 1009 (3F1h) (00001111110001)
592         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
593         Q_LINKREACTION = 2 (2h) (10) "No reaction"
594         Q_LOCACC = 1 (1h) (000001)
595     N_ITER = 1 (1h) (00001)
596         [0] D_LINK = 144 (90h) (000000010010000) "144m"
597     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
598         [0] NID_BG = 1011 (3F3h) (00001111110011)
599         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
600         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
601         [0] Q_LOCACC = 1 (1h) (000001)
602     Packet 27 - TrackToTrain - International SSP
603         NID_PACKET = 27 (1Bh) (00011011)
604         Q_DIR = 1 (1h) (01) "Nominal"
605         L_PACKET = 86 (56h) (0000001010110)
606         Q_SCALE = 1 (1h) (01) "1 m scale"
607         D_STATIC = 0 (0h) (000000000000000) "0m"
608         V_STATIC = 10 (Ah) (0001010) "50 km/h"
609         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
610     N_ITER = 0 (0h) (00000)
611     N_ITER = 1 (1h) (00001)
612         [0] D_STATIC = 590 (24Eh) (000001001001110)
           "590m"
613         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"

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614             [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
615     [0] N_ITER = 0 (0h) (00000)
616     Packet 21 - TrackToTrain - Gradient Profile
617             NID_PACKET = 21 (15h) (00010101)
618             Q_DIR = 1 (1h) (01) "Nominal"
619             L_PACKET = 102 (66h) (0000001100110)
620             Q_SCALE = 1 (1h) (01) "1 m scale"
621             D_GRADIENT = 0 (0h) (000000000000000) "0m"
622             Q_GDIR = 1 (1h) (1) "Uphill"
623             G_A = 5 (5h) (00000101) "5 o/oo"
624     N_ITER = 2 (2h) (00010)
625             [0] D_GRADIENT = 445 (1BDh) (000000110111101)
                "445m"
626             [0] Q_GDIR = 1 (1h) (1) "Uphill"
627             [0] G_A = 0 (0h) (00000000) "0 o/oo"
628             [1] D_GRADIENT = 145 (91h) (000000010010001)
                "145m"
629             [1] Q_GDIR = 0 (0h) (0) "Downhill"
630             [1] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
631 12:07:22.531937 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
                :192.168.0.132
632     10000100 00000110 10000010 11010101 00000100 10101111
                01010111 00100000 01110100 00000100 00000000 00001000
                00010000 00000010 00010000 00011100 01001000
                00010010 10000000 00110010 00000000 01100100 10000000
                11111000 00010100 10000011
633     NID_MESSAGE = 132 (84h) (10000100)
634     L_MESSAGE = 26 (1Ah) (0000011010)
635     T_TRAIN = 190059197 (B5412BDh)
                (00001011010101000001001010111101)
636     NID_ENGINE = 6062544 (5C81D0h)
                (010111001000000111010000)
637     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
638     Packet 0 - TrainToTrack - Pos Report
639             NID_PACKET = 0 (0h) (00000000)
640             L_PACKET = 129 (81h) (00000100000001)
641             Q_SCALE = 0 (0h) (00) "10 cm scale"
642     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
643             NID_C = 2 (2h) (0000000010)
644             NID_BG = 1031 (407h) (000100000000111)
645             D_LRBG = 2306 (902h) (0001001000000010) "230.6m"
646             Q_DIRLRBG = 1 (1h) (01) "Nominal"
647             Q_DLRBG = 1 (1h) (01) "Nominal"
648             L_DOUBTOVER = 50 (32h) (0000000000110010) "5.0m"
649             L_DOUBTUNDER = 50 (32h) (0000000000110010) "5.0m"

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C. Simulation Traces

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650         "
           Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
651         L_TRAININT = 248 (F8h) (000000011111000)
652         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
653         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
654         M_MODE = 0 (0h) (0000) "Full Supervision"
655         M_LEVEL = 3 (3h) (011) "Level 2"
656 12:07:28.253996 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
657         10000100 00000110 10000010 11010101 00000101 00110000
           10010111 00100000 01110100 01000010 00000000 00001000
           00010000 00000010 00011111 10000100 01101100
           11000000 00000000 00110010 00000000 01100100 10000000
           11111000 00000001 00110011
658         NID_MESSAGE = 132 (84h) (10000100)
659         L_MESSAGE = 26 (1Ah) (0000011010)
660         T_TRAIN = 190059714 (B5414C2h)
           (000010110101010000001010011000010)
661         NID_ENGINE = 6062545 (5C81D1h)
           (010111001000000111010001)
662         Q_MARQSTREASON = 1 (1h) (00001) "Start selected by
           driver"
663         Packet 0 - TrainToTrack - Pos Report
664         NID_PACKET = 0 (0h) (00000000)
665         L_PACKET = 129 (81h) (00000100000001)
666         Q_SCALE = 0 (0h) (00) "10 cm scale"
667         NID_LRBG = 34785 (87E1h) (000000001000011111100001)
668         NID_C = 2 (2h) (0000000010)
669         NID_BG = 2017 (7E1h) (00011111100001)
670         D_LRBG = 3480 (D98h) (000110110011000) "348.0m"
671         Q_DIRLRBG = 0 (0h) (00) "Reverse"
672         Q_DLRBG = 0 (0h) (00) "Reverse"
673         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
674         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
675         Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
676         L_TRAININT = 248 (F8h) (000000011111000)
677         V_TRAIN = 0 (0h) (0000000) "0 km/h"
678         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
679         M_MODE = 6 (6h) (0110) "Stand By"
680         M_LEVEL = 3 (3h) (011) "Level 2"
681 12:07:28.286966 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK80) (PK27)
           (PK21) - Train 6062545 - Dest:192.168.0.134
682         00000011 00010000 01000010 11010101 00000101 00110000
           10000000 00010000 11111100 00100001 11100000 00010110
           00010000 00000000 00000000 00000000 10110011
           00010000 00000000 00011111 10000111 00100000 00001100

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01000110 01111111 11110000 10100011 10100000
00000111 00001000 01010111 11111111 11110010 00000101
00000000 00001010 10101000 00000000 00000000
00110000 00010110 01100000 00000000 00000000 00001101
10000000 01010110 01000000 00000000 00001010
10000000 00100000 01011001 10111111 10000000 00101010
00000001 00111001 00000000 00000001 00000000
00001000 00010110 01100111 11111000
683 NID_MESSAGE = 3 (3h) (00000011)
684 L_MESSAGE = 65 (41h) (0001000001)
685 T_TRAIN = 190059714 (B5414C2h)
(00001011010101000001010011000010)
686 M_ACK = 0 (0h) (0) "No acknowledgement required"
687 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
688 NID_C = 2 (2h) (0000000010)
689 NID_BG = 2017 (7E1h) (00011111100001)
690 Packet 15 - TrackToTrain - Level 2/3 MA
691 NID_PACKET = 15 (Fh) (00001111)
692 Q_DIR = 0 (0h) (00) "Reverse"
693 L_PACKET = 88 (58h) (0000001011000)
694 Q_SCALE = 1 (1h) (01) "1 m scale"
695 V_EMA = 0 (0h) (00000000) "0 km/h"
696 T_EMA = 0 (0h) (0000000000)
697 N_ITER = 0 (0h) (00000)
698 L_ENDSECTION = 358 (166h) (000000101100110)
"358m"
699 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
700 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
701 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
702 D_DP = 0 (0h) (0000000000000000) "0m"
703 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
704 Q_OVERLAP = 0 (0h) (0) "No overlap information"
705 Packet 57 - TrackToTrain - MA Request Params
706 NID_PACKET = 57 (39h) (00111001)
707 Q_DIR = 0 (0h) (00) "Reverse"
708 L_PACKET = 49 (31h) (0000000110001)
709 T_MAR = 25 (19h) (00011001)
710 T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
request triggering with regards to this
function"
711 T_CYCRQST = 10 (Ah) (00001010)
712 Packet 58 - TrackToTrain - Pos Report Params
713 NID_PACKET = 58 (3Ah) (00111010)
714 Q_DIR = 0 (0h) (00) "Reverse"
715 L_PACKET = 56 (38h) (0000000111000)

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C. Simulation Traces

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716         Q_SCALE = 1 (1h) (01) "1 m scale"
717         T_CYCLOC = 10 (Ah) (00001010)
718         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
719         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
720     N_ITER = 0 (0h) (00000)
721     Packet 80 - TrackToTrain - Mode Profile
722         NID_PACKET = 80 (50h) (01010000)
723         Q_DIR = 0 (0h) (00) "Reverse"
724         L_PACKET = 85 (55h) (0000001010101)
725         Q_SCALE = 1 (1h) (01) "1 m scale"
726         D_MAMODE = 0 (0h) (0000000000000000) "0m"
727         M_MAMODE = 0 (0h) (00) "On Sight"
728         V_MAMODE = 6 (6h) (0000110) "30 km/h"
729         L_MAMODE = 358 (166h) (000000101100110) "358m"
730         L_ACKMAMODE = 0 (0h) (0000000000000000) "0m"
731         Q_MAMODE = 0 (0h) (0) "derive the SvL from the
           MA"
732     N_ITER = 0 (0h) (00000)
733     Packet 27 - TrackToTrain - International SSP
734         NID_PACKET = 27 (1Bh) (00011011)
735         Q_DIR = 0 (0h) (00) "Reverse"
736         L_PACKET = 86 (56h) (0000001010110)
737         Q_SCALE = 1 (1h) (01) "1 m scale"
738         D_STATIC = 0 (0h) (0000000000000000) "0m"
739         V_STATIC = 10 (Ah) (0001010) "50 km/h"
740         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
741     N_ITER = 0 (0h) (00000)
742     N_ITER = 1 (1h) (00001)
743         [0] D_STATIC = 358 (166h) (000000101100110)
           "358m"
744         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
745         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
746     [0] N_ITER = 0 (0h) (00000)
747     Packet 21 - TrackToTrain - Gradient Profile
748         NID_PACKET = 21 (15h) (00010101)
749         Q_DIR = 0 (0h) (00) "Reverse"
750         L_PACKET = 78 (4Eh) (0000001001110)
751         Q_SCALE = 1 (1h) (01) "1 m scale"
752         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
753         Q_GDIR = 1 (1h) (1) "Uphill"
754         G_A = 0 (0h) (00000000) "0 o/oo"
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755     N_ITER = 1 (1h) (00001)
756         [0] D_GRADIENT = 358 (166h) (000000101100110)
           "358m"
757         [0] Q_GDIR = 0 (0h) (0) "Downhill"
758         [0] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
759 12:07:29.372064 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
760     10000100 00000110 10000010 11010101 00000101 01001001
           10010111 00100000 01110100 01000100 00000000 00001000
           00010000 00000010 00011111 10000100 01101100
           11000000 00000000 00110010 00000000 01100100 10000000
           11111000 00000001 00001011
761     NID_MESSAGE = 132 (84h) (10000100)
762     L_MESSAGE = 26 (1Ah) (0000011010)
763     T_TRAIN = 190059814 (B541526h)
           (00001011010101000001010100100110)
764     NID_ENGINE = 6062545 (5C81D1h)
           (010111001000000111010001)
765     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
           the perturbation location reached"
766     Packet 0 - TrainToTrack - Pos Report
767         NID_PACKET = 0 (0h) (00000000)
768         L_PACKET = 129 (81h) (00000100000001)
769         Q_SCALE = 0 (0h) (00) "10 cm scale"
770     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
771     NID_C = 2 (2h) (0000000010)
772     NID_BG = 2017 (7E1h) (00011111100001)
773     D_LRBG = 3480 (D98h) (000110110011000) "348.0m"
774     Q_DIRLRBG = 0 (0h) (00) "Reverse"
775     Q_DLRBG = 0 (0h) (00) "Reverse"
776     L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
777     L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
778     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
779         L_TRAININT = 248 (F8h) (000000011111000)
780         V_TRAIN = 0 (0h) (0000000) "0 km/h"
781         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
782         M_MODE = 1 (1h) (0001) "On Sight"
783     M_LEVEL = 3 (3h) (011) "Level 2"
784 12:07:32.546374 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
           :192.168.0.132
785     10000100 00000110 10000010 11010101 00000101 10101001
           10010111 00100000 01110100 00000100 00000000 00001000
           00010000 00000010 00010000 00011100 01110011
           01111010 10000000 00110010 00000000 01100100 10000000
           11111000 00010100 10000011

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C. Simulation Traces

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786     NID_MESSAGE = 132 (84h) (10000100)
787     L_MESSAGE = 26 (1Ah) (0000011010)
788     T_TRAIN = 190060198 (B5416A6h)
          (000010110101010000001011010100110)
789     NID_ENGINE = 6062544 (5C81D0h)
          (0101110010000000111010000)
790     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
791     Packet 0 - TrainToTrack - Pos Report
792         NID_PACKET = 0 (0h) (00000000)
793         L_PACKET = 129 (81h) (00000100000001)
794         Q_SCALE = 0 (0h) (00) "10 cm scale"
795     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
796         NID_C = 2 (2h) (0000000010)
797         NID_BG = 1031 (407h) (000100000000111)
798         D_LRBG = 3695 (E6Fh) (000111001101111) "369.5m"
799         Q_DIRLRBG = 1 (1h) (01) "Nominal"
800         Q_DLRBG = 1 (1h) (01) "Nominal"
801         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
802         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
          "
803     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
804         L_TRAININT = 248 (F8h) (0000000111111000)
805         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
806         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
807         M_MODE = 0 (0h) (0000) "Full Supervision"
808     M_LEVEL = 3 (3h) (011) "Level 2"
809 12:07:32.569137 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
          (PK21) - Train 6062544 - Dest:192.168.0.134
810 00000011 00010010 01000010 11010101 00000101 10101001
          10000000 00010000 10000000 11100001 11101000 00010110
          00010000 00000000 00000000 00000001 00100111
          00010000 00000000 00011111 10000111 00101000 00001100
          01000110 01111111 11110000 10100011 10100100
          00001001 00001000 01010111 11111111 11110010 00010000
          00111010 01010000 01010100 00001101 10001000
          00011010 00110000 01111110 00111000 00010000 10000000
          10010000 00000111 11100111 10000001 00011011
          01000000 10101100 10000000 00000000 00010101 00000000
          01000001 00100111 01111111 00000000 01010101
          00000011 00110010 00000000 00000010 00001010 00100000
          00110111 10110000 00000000 00010010 00101111
          11110000
811     NID_MESSAGE = 3 (3h) (00000011)
812     L_MESSAGE = 73 (49h) (0001001001)
813     T_TRAIN = 190060198 (B5416A6h)
          (000010110101010000001011010100110)
814     M_ACK = 0 (0h) (0) "No acknowledgement required"

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815     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
816         NID_C = 2 (2h) (0000000010)
817         NID_BG = 1031 (407h) (000100000000111)
818     Packet 15 - TrackToTrain - Level 2/3 MA
819         NID_PACKET = 15 (Fh) (00001111)
820         Q_DIR = 1 (1h) (01) "Nominal"
821         L_PACKET = 88 (58h) (0000001011000)
822         Q_SCALE = 1 (1h) (01) "1 m scale"
823         V_EMA = 0 (0h) (00000000) "0 km/h"
824         T_EMA = 0 (0h) (00000000000)
825     N_ITER = 0 (0h) (00000)
826         L_ENDSECTION = 590 (24Eh) (0000010010011110)
            "590m"
827     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
            information"
828     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
            information"
829     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
            follow"
830         D_DP = 0 (0h) (0000000000000000) "0m"
831         V_RELEASEDP = 126 (7Eh) (11111110) "Use onboard
            calculated release speed"
832     Q_OVERLAP = 0 (0h) (0) "No overlap information"
833     Packet 57 - TrackToTrain - MA Request Params
834         NID_PACKET = 57 (39h) (00111001)
835         Q_DIR = 1 (1h) (01) "Nominal"
836         L_PACKET = 49 (31h) (0000000110001)
837         T_MAR = 25 (19h) (00011001)
838         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
            request triggering with regards to this
            function"
839         T_CYCRQST = 10 (Ah) (00001010)
840     Packet 58 - TrackToTrain - Pos Report Params
841         NID_PACKET = 58 (3Ah) (00111010)
842         Q_DIR = 1 (1h) (01) "Nominal"
843         L_PACKET = 72 (48h) (0000001001000)
844         Q_SCALE = 1 (1h) (01) "1 m scale"
845         T_CYCLOC = 10 (Ah) (00001010)
846         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
            train has not to report cyclically its
            position"
847         M_LOC = 1 (1h) (001) "Every LRBG compliant
            balise group"
848     N_ITER = 1 (1h) (00001)
849         [0] D_LOC = 466 (1D2h) (000000111010010) "466m"
850         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
851     Packet 5 - TrackToTrain - Linking
852         NID_PACKET = 5 (5h) (00000101)
853         Q_DIR = 1 (1h) (01) "Nominal"

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854         L_PACKET = 108 (6Ch) (0000001101100)
855         Q_SCALE = 1 (1h) (01) "1 m scale"
856         D_LINK = 419 (1A3h) (000000110100011) "419m"
857     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
858         NID_BG = 1009 (3F1h) (00001111110001)
859         Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
860         Q_LINKREACTION = 2 (2h) (10) "No reaction"
861         Q_LOCACC = 1 (1h) (000001)
862     N_ITER = 1 (1h) (00001)
863         [0] D_LINK = 144 (90h) (000000010010000) "144m"
864     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
      administration, no NID_C follows"
865         [0] NID_BG = 1011 (3F3h) (00001111110011)
866         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
      group is seen by the train in nominal
      direction"
867         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
868         [0] Q_LOCACC = 1 (1h) (000001)
869     Packet 27 - TrackToTrain - International SSP
870         NID_PACKET = 27 (1Bh) (00011011)
871         Q_DIR = 1 (1h) (01) "Nominal"
872         L_PACKET = 86 (56h) (0000001010110)
873         Q_SCALE = 1 (1h) (01) "1 m scale"
874         D_STATIC = 0 (0h) (000000000000000) "0m"
875         V_STATIC = 10 (Ah) (0001010) "50 km/h"
876         Q_FRONT = 1 (1h) (1) "No train length delay on
      validity end point of profile element"
877     N_ITER = 0 (0h) (00000)
878     N_ITER = 1 (1h) (00001)
879         [0] D_STATIC = 590 (24Eh) (000001001001110)
      "590m"
880         [0] V_STATIC = 127 (7Fh) (1111111) "Non
      numerical value telling that the static
      speed profile description ends at D_STATIC(n
      )"
881         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
882     [0] N_ITER = 0 (0h) (00000)
883     Packet 21 - TrackToTrain - Gradient Profile
884         NID_PACKET = 21 (15h) (00010101)
885         Q_DIR = 1 (1h) (01) "Nominal"
886         L_PACKET = 102 (66h) (0000001100110)
887         Q_SCALE = 1 (1h) (01) "1 m scale"
888         D_GRADIENT = 0 (0h) (000000000000000) "0m"
889         Q_GDIR = 1 (1h) (1) "Uphill"
890         G_A = 5 (5h) (00000101) "5 o/oo"

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891         N_ITER = 2 (2h) (00010)
892         [0] D_GRADIENT = 445 (1BDh) (000000110111101)
            "445m"
893         [0] Q_GDIR = 1 (1h) (1) "Uphill"
894         [0] G_A = 0 (0h) (00000000) "0 o/oo"
895         [1] D_GRADIENT = 145 (91h) (000000010010001)
            "145m"
896         [1] Q_GDIR = 0 (0h) (0) "Downhill"
897         [1] G_A = 255 (FFh) (11111111) "Non numerical
            value telling that the current gradient
            description ends at D_GRADIENT(n)"
898 12:07:33.525275 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
            :192.168.0.132
899         10000100 00000110 10000010 11010101 00000101 11000010
            00010111 00100000 01110100 00000100 00000000 00001000
            00010000 00000010 00010000 00011100 01110111
            11001010 10000000 00110010 00000000 01100100 10000000
            11111000 00010100 10000011
900         NID_MESSAGE = 132 (84h) (10000100)
901         L_MESSAGE = 26 (1Ah) (0000011010)
902         T_TRAIN = 190060296 (B541708h)
            (00001011010101000001011100001000)
903         NID_ENGINE = 6062544 (5C81D0h)
            (010111001000000111010000)
904         Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
            the perturbation location reached"
905         Packet 0 - TrainToTrack - Pos Report
906         NID_PACKET = 0 (0h) (00000000)
907         L_PACKET = 129 (81h) (0000010000001)
908         Q_SCALE = 0 (0h) (00) "10 cm scale"
909         NID_LRBG = 33799 (8407h) (0000000010000100000000111)
910         NID_C = 2 (2h) (0000000010)
911         NID_BG = 1031 (407h) (000100000000111)
912         D_LRBG = 3833 (EF9h) (000111011111001) "383.3m"
913         Q_DIRLRBG = 1 (1h) (01) "Nominal"
914         Q_DLRBG = 1 (1h) (01) "Nominal"
915         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
916         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
            "
917         Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
            integrity monitoring device"
918         L_TRAININT = 248 (F8h) (000000011111000)
919         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
920         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
921         M_MODE = 0 (0h) (0000) "Full Supervision"
922         M_LEVEL = 3 (3h) (011) "Level 2"
923 12:07:38.853646 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
            :192.168.0.132
924         10000100 00000110 10000010 11010101 00000110 01000100

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00010111 00100000 01110100 01000100 00000000 00001000
00010000 00000010 00011111 10000100 01101110
00000000 00000000 00110010 00000000 01100100 10000000
11111000 00000001 00001011
925 NID_MESSAGE = 132 (84h) (10000100)
926 L_MESSAGE = 26 (1Ah) (0000011010)
927 T_TRAIN = 190060816 (B541910h)
(000010110101010000001100100010000)
928 NID_ENGINE = 6062545 (5C81D1h)
(0101110010000000111010001)
929 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
the perturbation location reached"
930 Packet 0 - TrainToTrack - Pos Report
931 NID_PACKET = 0 (0h) (00000000)
932 L_PACKET = 129 (81h) (0000010000001)
933 Q_SCALE = 0 (0h) (00) "10 cm scale"
934 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
935 NID_C = 2 (2h) (0000000010)
936 NID_BG = 2017 (7E1h) (00011111100001)
937 D_LRBG = 3520 (DC0h) (000110111000000) "352.0m"
938 Q_DIRLRBG = 0 (0h) (00) "Reverse"
939 Q_DLRBG = 0 (0h) (00) "Reverse"
940 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
941 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
"
942 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
943 L_TRAININT = 248 (F8h) (0000000111111000)
944 V_TRAIN = 0 (0h) (00000000) "0 km/h"
945 Q_DIRTRAIN = 2 (2h) (10) "Unknown"
946 M_MODE = 1 (1h) (0001) "On Sight"
947 M_LEVEL = 3 (3h) (011) "Level 2"
948 12:07:38.874626 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK80) (PK27)
(PK21) - Train 6062545 - Dest:192.168.0.134
949 00000011 00010000 01000010 11010101 00000110 01000100
00000000 00010000 11111100 00100001 11100000 00010110
00010000 00000000 00000000 00000000 10110011
00010000 00000000 00011111 10000111 00100000 00001100
01000110 01111111 11110000 10100011 10100000
00000111 00001000 01010111 11111111 11110010 00000101
00000000 00001010 10101000 00000000 00000000
00110000 00010110 01100000 00000000 00000000 00001101
10000000 01010110 01000000 00000000 00000000 00001010
10000000 00100000 01011001 10111111 10000000 00101010
00000001 00111001 00000000 00000001 00000000
00001000 00010110 01100111 11111000
950 NID_MESSAGE = 3 (3h) (00000011)
951 L_MESSAGE = 65 (41h) (0001000001)
952 T_TRAIN = 190060816 (B541910h)

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          (00001011010101000001100100010000)
953 M_ACK = 0 (0h) (0) "No acknowledgement required"
954 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
955     NID_C = 2 (2h) (0000000010)
956     NID_BG = 2017 (7E1h) (00011111100001)
957 Packet 15 - TrackToTrain - Level 2/3 MA
958     NID_PACKET = 15 (Fh) (00001111)
959     Q_DIR = 0 (0h) (00) "Reverse"
960     L_PACKET = 88 (58h) (0000001011000)
961     Q_SCALE = 1 (1h) (01) "1 m scale"
962     V_EMA = 0 (0h) (0000000) "0 km/h"
963     T_EMA = 0 (0h) (0000000000)
964 N_ITER = 0 (0h) (00000)
965     L_ENDSECTION = 358 (166h) (000000101100110)
          "358m"
966 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
          information"
967 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
          information"
968 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
          follow"
969     D_DP = 0 (0h) (000000000000000) "0m"
970     V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
          calculated release speed"
971 Q_OVERLAP = 0 (0h) (0) "No overlap information"
972 Packet 57 - TrackToTrain - MA Request Params
973     NID_PACKET = 57 (39h) (00111001)
974     Q_DIR = 0 (0h) (00) "Reverse"
975     L_PACKET = 49 (31h) (0000000110001)
976     T_MAR = 25 (19h) (00011001)
977     T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
          request triggering with regards to this
          function"
978     T_CYCRQST = 10 (Ah) (00001010)
979 Packet 58 - TrackToTrain - Pos Report Params
980     NID_PACKET = 58 (3Ah) (00111010)
981     Q_DIR = 0 (0h) (00) "Reverse"
982     L_PACKET = 56 (38h) (0000000111000)
983     Q_SCALE = 1 (1h) (01) "1 m scale"
984     T_CYCLOC = 10 (Ah) (00001010)
985     D_CYCLOC = 32767 (7FFFh) (1111111111111) "The
          train has not to report cyclically its
          position"
986     M_LOC = 1 (1h) (001) "Every LRBG compliant
          balise group"
987 N_ITER = 0 (0h) (00000)
988 Packet 80 - TrackToTrain - Mode Profile
989     NID_PACKET = 80 (50h) (01010000)
990     Q_DIR = 0 (0h) (00) "Reverse"

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991         L_PACKET = 85 (55h) (0000001010101)
992         Q_SCALE = 1 (1h) (01) "1 m scale"
993         D_MAMODE = 0 (0h) (0000000000000000) "0m"
994         M_MAMODE = 0 (0h) (00) "On Sight"
995         V_MAMODE = 6 (6h) (0000110) "30 km/h"
996         L_MAMODE = 358 (166h) (000000101100110) "358m"
997         L_ACKMAMODE = 0 (0h) (0000000000000000) "0m"
998         Q_MAMODE = 0 (0h) (0) "derive the SvL from the
           MA"
999     N_ITER = 0 (0h) (00000)
1000     Packet 27 - TrackToTrain - International SSP
1001         NID_PACKET = 27 (1Bh) (00011011)
1002         Q_DIR = 0 (0h) (00) "Reverse"
1003         L_PACKET = 86 (56h) (0000001010110)
1004         Q_SCALE = 1 (1h) (01) "1 m scale"
1005         D_STATIC = 0 (0h) (0000000000000000) "0m"
1006         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1007         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
1008     N_ITER = 0 (0h) (00000)
1009     N_ITER = 1 (1h) (00001)
1010         [0] D_STATIC = 358 (166h) (000000101100110)
           "358m"
1011         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
1012         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
1013     [0] N_ITER = 0 (0h) (00000)
1014     Packet 21 - TrackToTrain - Gradient Profile
1015         NID_PACKET = 21 (15h) (00010101)
1016         Q_DIR = 0 (0h) (00) "Reverse"
1017         L_PACKET = 78 (4Eh) (0000001001110)
1018         Q_SCALE = 1 (1h) (01) "1 m scale"
1019         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
1020         Q_GDIR = 1 (1h) (1) "Uphill"
1021         G_A = 0 (0h) (00000000) "0 o/oo"
1022     N_ITER = 1 (1h) (00001)
1023         [0] D_GRADIENT = 358 (166h) (000000101100110)
           "358m"
1024         [0] Q_GDIR = 0 (0h) (0) "Downhill"
1025         [0] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
1026 12:07:39.703988 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
1027     10000100 00000110 10000010 11010101 00000110 01011100
           10010111 00100000 01110100 01000100 00000000 00001000

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00010000 00000010 00011111 10000100 01101110
00000000 00000000 00110010 00000000 01100100 10000000
11111000 00000001 00001011
1028 NID_MESSAGE = 132 (84h) (10000100)
1029 L_MESSAGE = 26 (1Ah) (0000011010)
1030 T_TRAIN = 190060914 (B541972h)
(0000101101010101000001100101110010)
1031 NID_ENGINE = 6062545 (5C81D1h)
(010111001000000111010001)
1032 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
the perturbation location reached"
1033 Packet 0 - TrainToTrack - Pos Report
1034 NID_PACKET = 0 (0h) (00000000)
1035 L_PACKET = 129 (81h) (0000010000001)
1036 Q_SCALE = 0 (0h) (00) "10 cm scale"
1037 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
1038 NID_C = 2 (2h) (0000000010)
1039 NID_BG = 2017 (7E1h) (00011111100001)
1040 D_LRBG = 3520 (DC0h) (000110111000000) "352.0m"
1041 Q_DIRLRBG = 0 (0h) (00) "Reverse"
1042 Q_DLRBG = 0 (0h) (00) "Reverse"
1043 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1044 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
"
1045 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
1046 L_TRAININT = 248 (F8h) (000000011111000)
1047 V_TRAIN = 0 (0h) (0000000) "0 km/h"
1048 Q_DIRTRAIN = 2 (2h) (10) "Unknown"
1049 M_MODE = 1 (1h) (0001) "On Sight"
1050 M_LEVEL = 3 (3h) (011) "Level 2"
1051 12:07:40.575525 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
(PK21) - Train 6062544 - Dest:192.168.0.134
1052 00000011 00010110 10000010 11010101 00000110 01110000
01000000 00010000 01111110 00100001 11101000 00010110
00010000 00000000 00000000 00000011 11111101
00010000 00000000 00011111 10000111 00101000 00001100
01000110 01111111 11110000 10100011 10100100
00001011 00001000 01010111 11111111 11110010 00100000
00000101 11110000 00010010 11110000 01010100
00001101 10001000 00001001 00000000 01111110 01111000
00010000 10000110 01011011 00000111 11110010
10000001 00011011 01000000 10101100 10000000 00000000
00010101 00000000 01000011 11111101 01111111
00000000 01010101 00000110 11110010 00000000 00000010
00001010 01110000 00000011 01010000 00000000
01000010 01000000 00100000 00100000 01010000 00000000
00110010 01010000 01100000 00100110 01010000
01000000 00111110 01110000 11110000 00000010 10101111

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11110000
1053 NID_MESSAGE = 3 (3h) (00000011)
1054 L_MESSAGE = 90 (5Ah) (0001011010)
1055 T_TRAIN = 190060993 (B5419C1h)
      (00001011010101000001100111000001)
1056 M_ACK = 0 (0h) (0) "No acknowledgement required"
1057 NID_LRBG = 33777 (83F1h) (000000001000001111110001)
1058 NID_C = 2 (2h) (0000000010)
1059 NID_BG = 1009 (3F1h) (00001111110001)
1060 Packet 15 - TrackToTrain - Level 2/3 MA
1061 NID_PACKET = 15 (Fh) (00001111)
1062 Q_DIR = 1 (1h) (01) "Nominal"
1063 L_PACKET = 88 (58h) (0000001011000)
1064 Q_SCALE = 1 (1h) (01) "1 m scale"
1065 V_EMA = 0 (0h) (00000000) "0 km/h"
1066 T_EMA = 0 (0h) (0000000000)
1067 N_ITER = 0 (0h) (000000)
1068 L_ENDSECTION = 2042 (7FAh) (000011111111010)
      "2042m"
1069 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
1070 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
1071 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
1072 D_DP = 0 (0h) (0000000000000000) "0m"
1073 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
1074 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1075 Packet 57 - TrackToTrain - MA Request Params
1076 NID_PACKET = 57 (39h) (00111001)
1077 Q_DIR = 1 (1h) (01) "Nominal"
1078 L_PACKET = 49 (31h) (0000000110001)
1079 T_MAR = 25 (19h) (00011001)
1080 T_TIMEOUSRQST = 1023 (3FFh) (111111111) "No MA
      request triggering with regards to this
      function"
1081 T_CYCRQST = 10 (Ah) (00001010)
1082 Packet 58 - TrackToTrain - Pos Report Params
1083 NID_PACKET = 58 (3Ah) (00111010)
1084 Q_DIR = 1 (1h) (01) "Nominal"
1085 L_PACKET = 88 (58h) (0000001011000)
1086 Q_SCALE = 1 (1h) (01) "1 m scale"
1087 T_CYCLOC = 10 (Ah) (00001010)
1088 D_CYCLOC = 32767 (7FFFh) (1111111111111) "The
      train has not to report cyclically its
      position"
1089 M_LOC = 1 (1h) (001) "Every LRBG compliant
      balise group"

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1090     N_ITER = 2 (2h) (00010)
1091         [0] D_LOC = 47 (2Fh) (000000000101111) "47m"
1092         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1093         [1] D_LOC = 151 (97h) (000000010010111) "151m"
1094         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1095     Packet 5 - TrackToTrain - Linking
1096         NID_PACKET = 5 (5h) (00000101)
1097         Q_DIR = 1 (1h) (01) "Nominal"
1098         L_PACKET = 108 (6Ch) (0000001101100)
1099         Q_SCALE = 1 (1h) (01) "1 m scale"
1100         D_LINK = 144 (90h) (000000010010000) "144m"
1101     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1102         NID_BG = 1011 (3F3h) (00001111110011)
1103         Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1104         Q_LINKREACTION = 2 (2h) (10) "No reaction"
1105         Q_LOCACCC = 1 (1h) (000001)
1106     N_ITER = 1 (1h) (00001)
1107         [0] D_LINK = 1627 (65Bh) (000011001011011)
        "1627m"
1108     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1109         [0] NID_BG = 1017 (3F9h) (00001111111001)
1110         [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
1111         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1112         [0] Q_LOCACCC = 1 (1h) (000001)
1113     Packet 27 - TrackToTrain - International SSP
1114         NID_PACKET = 27 (1Bh) (00011011)
1115         Q_DIR = 1 (1h) (01) "Nominal"
1116         L_PACKET = 86 (56h) (0000001010110)
1117         Q_SCALE = 1 (1h) (01) "1 m scale"
1118         D_STATIC = 0 (0h) (000000000000000) "0m"
1119         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1120         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
1121     N_ITER = 0 (0h) (00000)
1122     N_ITER = 1 (1h) (00001)
1123         [0] D_STATIC = 2042 (7FAh) (000011111111010)
        "2042m"
1124         [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
1125         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"

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1126     [0] N_ITER = 0 (0h) (00000)
1127     Packet 21 - TrackToTrain - Gradient Profile
1128         NID_PACKET = 21 (15h) (00010101)
1129         Q_DIR = 1 (1h) (01) "Nominal"
1130         L_PACKET = 222 (DEh) (0000011011110)
1131         Q_SCALE = 1 (1h) (01) "1 m scale"
1132         D_GRADIENT = 0 (0h) (000000000000000) "0m"
1133         Q_GDIR = 1 (1h) (1) "Uphill"
1134         G_A = 5 (5h) (00000101) "5 o/oo"
1135     N_ITER = 7 (7h) (00111)
1136     [0] D_GRADIENT = 26 (1Ah) (000000000011010) "26
1137         m"
1137     [0] Q_GDIR = 1 (1h) (1) "Uphill"
1138     [0] G_A = 0 (0h) (00000000) "0 o/oo"
1139     [1] D_GRADIENT = 530 (212h) (000001000010010)
1140         "530m"
1140     [1] Q_GDIR = 0 (0h) (0) "Downhill"
1141     [1] G_A = 2 (2h) (00000010) "2 o/oo"
1142     [2] D_GRADIENT = 258 (102h) (000000100000010)
1143         "258m"
1143     [2] Q_GDIR = 1 (1h) (1) "Uphill"
1144     [2] G_A = 0 (0h) (00000000) "0 o/oo"
1145     [3] D_GRADIENT = 402 (192h) (000000110010010)
1146         "402m"
1146     [3] Q_GDIR = 1 (1h) (1) "Uphill"
1147     [3] G_A = 6 (6h) (00000110) "6 o/oo"
1148     [4] D_GRADIENT = 306 (132h) (000000100110010)
1149         "306m"
1149     [4] Q_GDIR = 1 (1h) (1) "Uphill"
1150     [4] G_A = 4 (4h) (00000100) "4 o/oo"
1151     [5] D_GRADIENT = 499 (1F3h) (000000111110011)
1152         "499m"
1152     [5] Q_GDIR = 1 (1h) (1) "Uphill"
1153     [5] G_A = 15 (Fh) (00001111) "15 o/oo"
1154     [6] D_GRADIENT = 21 (15h) (00000000010101) "21
1155         m"
1155     [6] Q_GDIR = 0 (0h) (0) "Downhill"
1156     [6] G_A = 255 (FFh) (11111111) "Non numerical
1157         value telling that the current gradient
1158         description ends at D_GRADIENT(n)"
1157 12:07:49.720960 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
1158         :192.168.0.132
1158         10000100 00000110 10000010 11010101 00000111 01010110
1159         11010111 00100000 01110100 01000100 00000000 00001000
1160         00010000 00000010 00011111 10000100 01101110
1160         00000000 00000000 00110010 00000000 01100100 10000000
1160         11111000 00000001 00001011
1159     NID_MESSAGE = 132 (84h) (10000100)
1160     L_MESSAGE = 26 (1Ah) (0000011010)

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1161 T_TRAIN = 190061915 (B541D5Bh)
      (00001011010101000001110101011011)
1162 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
1163 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
1164 Packet 0 - TrainToTrack - Pos Report
1165 NID_PACKET = 0 (0h) (00000000)
1166 L_PACKET = 129 (81h) (0000010000001)
1167 Q_SCALE = 0 (0h) (00) "10 cm scale"
1168 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
1169 NID_C = 2 (2h) (0000000010)
1170 NID_BG = 2017 (7E1h) (00011111100001)
1171 D_LRBG = 3520 (DC0h) (000110111000000) "352.0m"
1172 Q_DIRLRBG = 0 (0h) (00) "Reverse"
1173 Q_DLRBG = 0 (0h) (00) "Reverse"
1174 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1175 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
1176 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
1177 L_TRAININT = 248 (F8h) (000000011111000)
1178 V_TRAIN = 0 (0h) (0000000) "0 km/h"
1179 Q_DIRTRAIN = 2 (2h) (10) "Unknown"
1180 M_MODE = 1 (1h) (0001) "On Sight"
1181 M_LEVEL = 3 (3h) (011) "Level 2"
1182 12:07:49.743401 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK80) (PK27)
      (PK21) - Train 6062545 - Dest:192.168.0.134
1183 00000011 00010000 01000010 11010101 00000111 01010110
      11000000 00010000 11111100 00100001 11100000 00010110
      00010000 00000000 00000000 00000000 10110011
      00010000 00000000 00011111 10000111 00100000 00001100
      01000110 01111111 11110000 10100011 10100000
      00000111 00001000 01010111 11111111 11110010 00000101
      00000000 00001010 10101000 00000000 00000000
      00110000 00010110 01100000 00000000 00000000 00001101
      10000000 01010110 01000000 00000000 00001010
      10000000 00100000 01011001 10111111 10000000 00101010
      00000001 00111001 00000000 00000001 00000000
      00001000 00010110 01100111 11111000
1184 NID_MESSAGE = 3 (3h) (00000011)
1185 L_MESSAGE = 65 (41h) (0001000001)
1186 T_TRAIN = 190061915 (B541D5Bh)
      (00001011010101000001110101011011)
1187 M_ACK = 0 (0h) (0) "No acknowledgement required"
1188 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
1189 NID_C = 2 (2h) (0000000010)
1190 NID_BG = 2017 (7E1h) (00011111100001)
1191 Packet 15 - TrackToTrain - Level 2/3 MA

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1192         NID_PACKET = 15 (Fh) (00001111)
1193         Q_DIR = 0 (0h) (00) "Reverse"
1194         L_PACKET = 88 (58h) (0000001011000)
1195         Q_SCALE = 1 (1h) (01) "1 m scale"
1196         V_EMA = 0 (0h) (0000000) "0 km/h"
1197         T_EMA = 0 (0h) (0000000000)
1198     N_ITER = 0 (0h) (00000)
1199         L_ENDSECTION = 358 (166h) (000000101100110)
            "358m"
1200     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
            information"
1201     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
            information"
1202     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
            follow"
1203         D_DP = 0 (0h) (000000000000000) "0m"
1204         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
            calculated release speed"
1205     Q_OVERLAP = 0 (0h) (0) "No overlap information"
1206     Packet 57 - TrackToTrain - MA Request Params
1207         NID_PACKET = 57 (39h) (00111001)
1208         Q_DIR = 0 (0h) (00) "Reverse"
1209         L_PACKET = 49 (31h) (0000000110001)
1210         T_MAR = 25 (19h) (00011001)
1211         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
            request triggering with regards to this
            function"
1212         T_CYCRQST = 10 (Ah) (00001010)
1213     Packet 58 - TrackToTrain - Pos Report Params
1214         NID_PACKET = 58 (3Ah) (00111010)
1215         Q_DIR = 0 (0h) (00) "Reverse"
1216         L_PACKET = 56 (38h) (0000000111000)
1217         Q_SCALE = 1 (1h) (01) "1 m scale"
1218         T_CYCLOC = 10 (Ah) (00001010)
1219         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
            train has not to report cyclically its
            position"
1220         M_LOC = 1 (1h) (001) "Every LRBG compliant
            balise group"
1221     N_ITER = 0 (0h) (00000)
1222     Packet 80 - TrackToTrain - Mode Profile
1223         NID_PACKET = 80 (50h) (01010000)
1224         Q_DIR = 0 (0h) (00) "Reverse"
1225         L_PACKET = 85 (55h) (0000001010101)
1226         Q_SCALE = 1 (1h) (01) "1 m scale"
1227         D_MAMODE = 0 (0h) (000000000000000) "0m"
1228         M_MAMODE = 0 (0h) (00) "On Sight"
1229         V_MAMODE = 6 (6h) (0000110) "30 km/h"
1230         L_MAMODE = 358 (166h) (000000101100110) "358m"

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1231         L_ACKMAMODE = 0 (0h) (0000000000000000) "0m"
1232         Q_MAMODE = 0 (0h) (0) "derive the SvL from the
           MA"
1233     N_ITER = 0 (0h) (00000)
1234     Packet 27 - TrackToTrain - International SSP
1235         NID_PACKET = 27 (1Bh) (00011011)
1236         Q_DIR = 0 (0h) (00) "Reverse"
1237         L_PACKET = 86 (56h) (0000001010110)
1238         Q_SCALE = 1 (1h) (01) "1 m scale"
1239         D_STATIC = 0 (0h) (0000000000000000) "0m"
1240         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1241         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
1242     N_ITER = 0 (0h) (00000)
1243     N_ITER = 1 (1h) (00001)
1244         [0] D_STATIC = 358 (166h) (000000101100110)
           "358m"
1245         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
1246         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
1247     [0] N_ITER = 0 (0h) (00000)
1248     Packet 21 - TrackToTrain - Gradient Profile
1249         NID_PACKET = 21 (15h) (00010101)
1250         Q_DIR = 0 (0h) (00) "Reverse"
1251         L_PACKET = 78 (4Eh) (0000001001110)
1252         Q_SCALE = 1 (1h) (01) "1 m scale"
1253         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
1254         Q_GDIR = 1 (1h) (1) "Uphill"
1255         G_A = 0 (0h) (00000000) "0 o/oo"
1256     N_ITER = 1 (1h) (00001)
1257         [0] D_GRADIENT = 358 (166h) (000000101100110)
           "358m"
1258         [0] Q_GDIR = 0 (0h) (0) "Downhill"
1259         [0] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
1260 12:07:50.706156 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
1261     10000100 00000110 10000010 11010101 00000111 01101111
           10010111 00100000 01110100 01000100 00000000 00001000
           00010000 00000010 00011111 10000100 01101110
           00000000 00000000 00110010 00000000 01100100 10000000
           11111000 00000001 00001011
1262     NID_MESSAGE = 132 (84h) (10000100)
1263     L_MESSAGE = 26 (1Ah) (0000011010)
1264     T_TRAIN = 190062014 (B541DBEh)

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(00001011010101000001110110111110)
1265 NID_ENGINE = 6062545 (5C81D1h)
(010111001000000111010001)
1266 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
the perturbation location reached"
1267 Packet 0 - TrainToTrack - Pos Report
1268 NID_PACKET = 0 (0h) (00000000)
1269 L_PACKET = 129 (81h) (00000100000001)
1270 Q_SCALE = 0 (0h) (00) "10 cm scale"
1271 NID_LRBG = 34785 (87E1h) (000000001000011111100001)
1272 NID_C = 2 (2h) (0000000010)
1273 NID_BG = 2017 (7E1h) (00011111100001)
1274 D_LRBG = 3520 (DC0h) (000110111000000) "352.0m"
1275 Q_DIRLRBG = 0 (0h) (00) "Reverse"
1276 Q_DLRBG = 0 (0h) (00) "Reverse"
1277 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1278 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
"
1279 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
1280 L_TRAININT = 248 (F8h) (000000011111000)
1281 V_TRAIN = 0 (0h) (00000000) "0 km/h"
1282 Q_DIRTRAIN = 2 (2h) (10) "Unknown"
1283 M_MODE = 1 (1h) (0001) "On Sight"
1284 M_LEVEL = 3 (3h) (011) "Level 2"
1285 12:07:58.002070 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK80) (PK5)
(PK27) (PK21) - Train 6062545 - Dest:192.168.0.134
1286 00000011 00010101 01000010 11010101 00001000 00100011
10000000 00010000 11111100 00100001 11100000 00010110
00010000 00000000 00000000 00000000 11110100
10010000 00000000 00011111 10000111 00100000 00001100
01000110 01111111 11110000 10100011 10100000
00001001 00001000 01010111 11111111 11110010 00010000
00110000 00110101 00000000 00001010 10101000
00000000 00000000 00110000 00010110 10000000 00000000
00000000 00000010 10000000 10010011 01000000
10111011 10000011 11101000 10000000 10001000 00000001
10110000 01000000 00011000 00001000 00000010
10000000 01111101 00110000 00010001 10110000 00001010
11001000 00000000 00000001 01010000 00000100
00001111 01001111 11110000 00000101 01000000 00100111
00100000 00000000 00100000 00000001 00000011
11010010 11111111
1287 NID_MESSAGE = 3 (3h) (00000011)
1288 L_MESSAGE = 85 (55h) (0001010101)
1289 T_TRAIN = 190062734 (B54208Eh)
(000010110101010000010000010001110)
1290 M_ACK = 0 (0h) (0) "No acknowledgement required"
1291 NID_LRBG = 34785 (87E1h) (000000001000011111100001)

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1292             NID_C = 2 (2h) (0000000010)
1293             NID_BG = 2017 (7E1h) (00011111100001)
1294 Packet 15 - TrackToTrain - Level 2/3 MA
1295             NID_PACKET = 15 (Fh) (00001111)
1296             Q_DIR = 0 (0h) (00) "Reverse"
1297             L_PACKET = 88 (58h) (0000001011000)
1298             Q_SCALE = 1 (1h) (01) "1 m scale"
1299             V_EMA = 0 (0h) (00000000) "0 km/h"
1300             T_EMA = 0 (0h) (00000000000)
1301 N_ITER = 0 (0h) (00000)
1302             L_ENDSECTION = 489 (1E9h) (000000111101001)
1303             "489m"
1304 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
1305             information"
1306 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
1307             information"
1308 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
1309             follow"
1310             D_DP = 0 (0h) (0000000000000000) "0m"
1311             V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
1312             calculated release speed"
1313 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1314 Packet 57 - TrackToTrain - MA Request Params
1315             NID_PACKET = 57 (39h) (00111001)
1316             Q_DIR = 0 (0h) (00) "Reverse"
1317             L_PACKET = 49 (31h) (0000000110001)
1318             T_MAR = 25 (19h) (00011001)
1319             T_TIMEOURQST = 1023 (3FFh) (1111111111) "No MA
1320             request triggering with regards to this
1321             function"
1322             T_CYCRQST = 10 (Ah) (00001010)
1323 Packet 58 - TrackToTrain - Pos Report Params
1324             NID_PACKET = 58 (3Ah) (00111010)
1325             Q_DIR = 0 (0h) (00) "Reverse"
1326             L_PACKET = 72 (48h) (0000001001000)
1327             Q_SCALE = 1 (1h) (01) "1 m scale"
1328             T_CYCLOC = 10 (Ah) (00001010)
1329             D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
1330             train has not to report cyclically its
             position"
1331             M_LOC = 1 (1h) (001) "Every LRBG compliant
             balise group"
1332 N_ITER = 1 (1h) (00001)
1333             [0] D_LOC = 385 (181h) (000000110000001) "385m"
1334             [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1335 Packet 80 - TrackToTrain - Mode Profile
1336             NID_PACKET = 80 (50h) (01010000)
1337             Q_DIR = 0 (0h) (00) "Reverse"
1338             L_PACKET = 85 (55h) (0000001010101)

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1331         Q_SCALE = 1 (1h) (01) "1 m scale"
1332         D_MAMODE = 0 (0h) (0000000000000000) "0m"
1333         M_MAMODE = 0 (0h) (00) "On Sight"
1334         V_MAMODE = 6 (6h) (0000110) "30 km/h"
1335         L_MAMODE = 360 (168h) (000000101101000) "360m"
1336         L_ACKMAMODE = 0 (0h) (0000000000000000) "0m"
1337         Q_MAMODE = 0 (0h) (0) "derive the SvL from the
           MA"
1338     N_ITER = 0 (0h) (00000)
1339     Packet 5 - TrackToTrain - Linking
1340         NID_PACKET = 5 (5h) (00000101)
1341         Q_DIR = 0 (0h) (00) "Reverse"
1342         L_PACKET = 147 (93h) (0000010010011)
1343         Q_SCALE = 1 (1h) (01) "1 m scale"
1344         D_LINK = 375 (177h) (000000101110111) "375m"
1345     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1346         NID_BG = 1000 (3E8h) (00001111101000)
1347         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1348         Q_LINKREACTION = 0 (0h) (00) "Train trip"
1349         Q_LOCACC = 1 (1h) (000001)
1350     N_ITER = 2 (2h) (00010)
1351         [0] D_LINK = 54 (36h) (000000000110110) "54m"
1352     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1353         [0] NID_BG = 1025 (401h) (00010000000001)
1354         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1355         [0] Q_LINKREACTION = 0 (0h) (00) "Train trip"
1356         [0] Q_LOCACC = 1 (1h) (000001)
1357         [1] D_LINK = 40 (28h) (000000000101000) "40m"
1358     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1359         [1] NID_BG = 1001 (3E9h) (00001111101001)
1360         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1361         [1] Q_LINKREACTION = 0 (0h) (00) "Train trip"
1362         [1] Q_LOCACC = 1 (1h) (000001)
1363     Packet 27 - TrackToTrain - International SSP
1364         NID_PACKET = 27 (1Bh) (00011011)
1365         Q_DIR = 0 (0h) (00) "Reverse"
1366         L_PACKET = 86 (56h) (0000001010110)
1367         Q_SCALE = 1 (1h) (01) "1 m scale"
1368         D_STATIC = 0 (0h) (0000000000000000) "0m"
1369         V_STATIC = 10 (Ah) (0001010) "50 km/h"

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1370             Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
1371     N_ITER = 0 (0h) (00000)
1372     N_ITER = 1 (1h) (00001)
1373     [0] D_STATIC = 489 (1E9h) (000000111101001)
                "489m"
1374     [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
1375     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
1376     [0] N_ITER = 0 (0h) (00000)
1377     Packet 21 - TrackToTrain - Gradient Profile
1378     NID_PACKET = 21 (15h) (00010101)
1379     Q_DIR = 0 (0h) (00) "Reverse"
1380     L_PACKET = 78 (4Eh) (0000001001110)
1381     Q_SCALE = 1 (1h) (01) "1 m scale"
1382     D_GRADIENT = 0 (0h) (000000000000000) "0m"
1383     Q_GDIR = 1 (1h) (1) "Uphill"
1384     G_A = 0 (0h) (00000000) "0 o/oo"
1385     N_ITER = 1 (1h) (00001)
1386     [0] D_GRADIENT = 489 (1E9h) (000000111101001)
                "489m"
1387     [0] Q_GDIR = 0 (0h) (0) "Downhill"
1388     [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
1389 12:07:58.872177 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
                :192.168.0.132
1390     10000100 00000110 10000010 11010101 00001000 00110111
                10010111 00100000 01110100 01000100 00000000 00001000
                00010000 00000010 00011111 10000100 01101110
                00000000 00000000 00110010 00000000 01100100 10000000
                11111000 00000001 00001011
1391     NID_MESSAGE = 132 (84h) (10000100)
1392     L_MESSAGE = 26 (1Ah) (0000011010)
1393     T_TRAIN = 190062814 (B5420DEh)
                (000010110101010000010000011011110)
1394     NID_ENGINE = 6062545 (5C81D1h)
                (010111001000000111010001)
1395     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
1396     Packet 0 - TrainToTrack - Pos Report
1397     NID_PACKET = 0 (0h) (00000000)
1398     L_PACKET = 129 (81h) (0000010000001)
1399     Q_SCALE = 0 (0h) (00) "10 cm scale"
1400     NID_LRBG = 34785 (87E1h) (000000001000011111100001)
1401     NID_C = 2 (2h) (0000000010)

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1402         NID_BG = 2017 (7E1h) (0001111100001)
1403         D_LRBG = 3520 (DC0h) (000110111000000) "352.0m"
1404         Q_DIRLRBG = 0 (0h) (00) "Reverse"
1405         Q_DLRBG = 0 (0h) (00) "Reverse"
1406         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1407         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
1408     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
1409         L_TRAININT = 248 (F8h) (000000011111000)
1410         V_TRAIN = 0 (0h) (0000000) "0 km/h"
1411         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
1412         M_MODE = 1 (1h) (0001) "On Sight"
1413     M_LEVEL = 3 (3h) (011) "Level 2"
1414 12:08:07.748051 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
           (PK21) - Train 6062545 - Dest:192.168.0.134
1415     00000011 00010111 10000010 11010101 00001001 00010111
           00000000 00010000 01111101 00000001 11101000 00010110
           00010000 00000000 00000000 00000001 10000000
           10010000 00000000 00011111 10000111 00101000 00001100
           01000110 01111111 11110000 10100011 10100100
           00001011 00001000 01010111 11111111 11110010 00100000
           00000001 01010000 00010000 01110000 01010100
           00100001 00001000 00000011 01100000 10000000 00111000
           00010010 10000000 00101000 00000111 11010011
           10000001 00000000 01001000 00001111 11111111 00000010
           00000000 11010000 00100000 00011010 00000100
           00000100 10100000 01000000 01111100 00001000 00011010
           00110000 01111110 00111000 00010001 10110100
           00001010 11001000 00000000 00000001 01010000 00000100
           00011000 00001111 11110000 00000101 01010000
           00110011 00100000 00000000 00100000 00000010 00000001
           01100101 00000101 00000100 10011110 11111111
1416     NID_MESSAGE = 3 (3h) (00000011)
1417     L_MESSAGE = 94 (5Eh) (0001011110)
1418     T_TRAIN = 190063708 (B54245Ch)
           (00001011010101000010010001011100)
1419     M_ACK = 0 (0h) (0) "No acknowledgement required"
1420     NID_LRBG = 33768 (83E8h) (000000001000001111101000)
1421         NID_C = 2 (2h) (0000000010)
1422         NID_BG = 1000 (3E8h) (00001111101000)
1423     Packet 15 - TrackToTrain - Level 2/3 MA
1424         NID_PACKET = 15 (Fh) (00001111)
1425         Q_DIR = 1 (1h) (01) "Nominal"
1426         L_PACKET = 88 (58h) (0000001011000)
1427         Q_SCALE = 1 (1h) (01) "1 m scale"
1428         V_EMA = 0 (0h) (0000000) "0 km/h"
1429         T_EMA = 0 (0h) (0000000000)
1430     N_ITER = 0 (0h) (00000)

```

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1431         L_ENDSECTION = 769 (301h) (0000011000000001)
           "769m"
1432     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
1433     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
1434     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
1435         D_DP = 0 (0h) (0000000000000000) "0m"
1436         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
1437     Q_OVERLAP = 0 (0h) (0) "No overlap information"
1438     Packet 57 - TrackToTrain - MA Request Params
1439         NID_PACKET = 57 (39h) (00111001)
1440         Q_DIR = 1 (1h) (01) "Nominal"
1441         L_PACKET = 49 (31h) (0000000110001)
1442         T_MAR = 25 (19h) (00011001)
1443         T_TIMEOURQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
1444         T_CYCRQST = 10 (Ah) (00001010)
1445     Packet 58 - TrackToTrain - Pos Report Params
1446         NID_PACKET = 58 (3Ah) (00111010)
1447         Q_DIR = 1 (1h) (01) "Nominal"
1448         L_PACKET = 88 (58h) (0000001011000)
1449         Q_SCALE = 1 (1h) (01) "1 m scale"
1450         T_CYCLOC = 10 (Ah) (00001010)
1451         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
1452         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1453     N_ITER = 2 (2h) (00010)
1454         [0] D_LOC = 10 (Ah) (000000000001010) "10m"
1455         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1456         [1] D_LOC = 131 (83h) (000000010000011) "131m"
1457         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1458     Packet 5 - TrackToTrain - Linking
1459         NID_PACKET = 5 (5h) (00000101)
1460         Q_DIR = 1 (1h) (01) "Nominal"
1461         L_PACKET = 264 (108h) (0000100001000)
1462         Q_SCALE = 1 (1h) (01) "1 m scale"
1463         D_LINK = 54 (36h) (000000000110110) "54m"
1464     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1465         NID_BG = 1025 (401h) (000100000000001)
1466         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"

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1467         Q_LINKREACTION = 2 (2h) (10) "No reaction"
1468         Q_LOCACC = 1 (1h) (000001)
1469     N_ITER = 5 (5h) (00101)
1470         [0] D_LINK = 40 (28h) (000000000101000) "40m"
1471     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1472         [0] NID_BG = 1001 (3E9h) (00001111101001)
1473         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1474         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1475         [0] Q_LOCACC = 1 (1h) (000001)
1476         [1] D_LINK = 36 (24h) (000000000100100) "36m"
1477     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1478         [1] NID_BG = 1023 (3FFh) (00001111111111)
1479         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1480         [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1481         [1] Q_LOCACC = 1 (1h) (000001)
1482         [2] D_LINK = 52 (34h) (000000000110100) "52m"
1483     [2] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1484         [2] NID_BG = 1027 (403h) (00010000000011)
1485         [2] Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
1486         [2] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1487         [2] Q_LOCACC = 1 (1h) (000001)
1488         [3] D_LINK = 148 (94h) (000000010010100) "148m"
1489     [3] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1490         [3] NID_BG = 1031 (407h) (00010000000111)
1491         [3] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1492         [3] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1493         [3] Q_LOCACC = 1 (1h) (000001)
1494         [4] D_LINK = 419 (1A3h) (000000110100011) "419m
        "
1495     [4] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1496         [4] NID_BG = 1009 (3F1h) (00001111110001)
1497         [4] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1498         [4] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1499         [4] Q_LOCACC = 1 (1h) (000001)
```

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1500 Packet 27 - TrackToTrain - International SSP
1501 NID_PACKET = 27 (1Bh) (00011011)
1502 Q_DIR = 1 (1h) (01) "Nominal"
1503 L_PACKET = 86 (56h) (0000001010110)
1504 Q_SCALE = 1 (1h) (01) "1 m scale"
1505 D_STATIC = 0 (0h) (0000000000000000) "0m"
1506 V_STATIC = 10 (Ah) (0001010) "50 km/h"
1507 Q_FRONT = 1 (1h) (1) "No train length delay on
      validity end point of profile element"
1508 N_ITER = 0 (0h) (00000)
1509 N_ITER = 1 (1h) (00001)
1510 [0] D_STATIC = 769 (301h) (000001100000001)
      "769m"
1511 [0] V_STATIC = 127 (7Fh) (1111111) "Non
      numerical value telling that the static
      speed profile description ends at D_STATIC(n
      )"
1512 [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
1513 [0] N_ITER = 0 (0h) (00000)
1514 Packet 21 - TrackToTrain - Gradient Profile
1515 NID_PACKET = 21 (15h) (00010101)
1516 Q_DIR = 1 (1h) (01) "Nominal"
1517 L_PACKET = 102 (66h) (0000001100110)
1518 Q_SCALE = 1 (1h) (01) "1 m scale"
1519 D_GRADIENT = 0 (0h) (0000000000000000) "0m"
1520 Q_GDIR = 1 (1h) (1) "Uphill"
1521 G_A = 0 (0h) (00000000) "0 o/oo"
1522 N_ITER = 2 (2h) (00010)
1523 [0] D_GRADIENT = 178 (B2h) (000000010110010)
      "178m"
1524 [0] Q_GDIR = 1 (1h) (1) "Uphill"
1525 [0] G_A = 5 (5h) (00000101) "5 o/oo"
1526 [1] D_GRADIENT = 591 (24Fh) (000001001001111)
      "591m"
1527 [1] Q_GDIR = 0 (0h) (0) "Downhill"
1528 [1] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"
1529 12:08:27.218570 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062545 - Dest:192.168.0.134
1530 00000011 00010011 10000010 11010101 00001010 11111100
      01000000 00010000 10000000 01100001 11100000 00010110
      00010000 00000000 00000000 00000001 01110001
      00010000 00000000 00011111 10000111 00100000 00001100
      01000110 01111111 11110000 10100011 10100000
      00001001 00001000 01010111 11111111 11110010 00010000
      01001100 11010000 01010000 00010010 01101000
      00001001 01000000 10000000 11111000 00010001 00000001

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10100011 00000111 11100011 10000001 00000001
00100000 00001111 11001111 00000010 00110110 00000001
01011001 00000000 00000000 00101010 00000000
10000010 11100010 11111110 00000000 10101000 00000110
01100100 00000000 00000100 00010100 01000000
10010100 01100000 00000000 00100100 01011111 11100000
1531 NID_MESSAGE = 3 (3h) (00000011)
1532 L_MESSAGE = 78 (4Eh) (0001001110)
1533 T_TRAIN = 190065649 (B542BF1h)
      (000010110101010000010101111110001)
1534 M_ACK = 0 (0h) (0) "No acknowledgement required"
1535 NID_LRBG = 33795 (8403h) (0000000010000100000000011)
1536 NID_C = 2 (2h) (0000000010)
1537 NID_BG = 1027 (403h) (000100000000011)
1538 Packet 15 - TrackToTrain - Level 2/3 MA
1539 NID_PACKET = 15 (Fh) (00001111)
1540 Q_DIR = 0 (0h) (00) "Reverse"
1541 L_PACKET = 88 (58h) (0000001011000)
1542 Q_SCALE = 1 (1h) (01) "1 m scale"
1543 V_EMA = 0 (0h) (00000000) "0 km/h"
1544 T_EMA = 0 (0h) (0000000000)
1545 N_ITER = 0 (0h) (00000)
1546 L_ENDSECTION = 738 (2E2h) (000001011100010)
      "738m"
1547 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
1548 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
1549 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
1550 D_DP = 0 (0h) (0000000000000000) "0m"
1551 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
1552 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1553 Packet 57 - TrackToTrain - MA Request Params
1554 NID_PACKET = 57 (39h) (00111001)
1555 Q_DIR = 0 (0h) (00) "Reverse"
1556 L_PACKET = 49 (31h) (0000000110001)
1557 T_MAR = 25 (19h) (00011001)
1558 T_TIMEOUSRQST = 1023 (3FFh) (111111111) "No MA
      request triggering with regards to this
      function"
1559 T_CYCRQST = 10 (Ah) (00001010)
1560 Packet 58 - TrackToTrain - Pos Report Params
1561 NID_PACKET = 58 (3Ah) (00111010)
1562 Q_DIR = 0 (0h) (00) "Reverse"
1563 L_PACKET = 72 (48h) (0000001001000)
1564 Q_SCALE = 1 (1h) (01) "1 m scale"
1565 T_CYCLOC = 10 (Ah) (00001010)
```

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1566         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
1567         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1568     N_ITER = 1 (1h) (00001)
1569         [0] D_LOC = 614 (266h) (000001001100110) "614m"
1570         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1571     Packet 5 - TrackToTrain - Linking
1572         NID_PACKET = 5 (5h) (00000101)
1573         Q_DIR = 0 (0h) (00) "Reverse"
1574         L_PACKET = 147 (93h) (0000010010011)
1575         Q_SCALE = 1 (1h) (01) "1 m scale"
1576         D_LINK = 148 (94h) (000000010010100) "148m"
1577     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1578         NID_BG = 1031 (407h) (000100000000111)
1579         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1580         Q_LINKREACTION = 2 (2h) (10) "No reaction"
1581         Q_LOCACC = 1 (1h) (000001)
1582     N_ITER = 2 (2h) (00010)
1583         [0] D_LINK = 419 (1A3h) (000000110100011) "419m
           "
1584     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1585         [0] NID_BG = 1009 (3F1h) (00001111110001)
1586         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1587         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1588         [0] Q_LOCACC = 1 (1h) (000001)
1589         [1] D_LINK = 144 (90h) (000000010010000) "144m"
1590     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1591         [1] NID_BG = 1011 (3F3h) (00001111110011)
1592         [1] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1593         [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1594         [1] Q_LOCACC = 1 (1h) (000001)
1595     Packet 27 - TrackToTrain - International SSP
1596         NID_PACKET = 27 (1Bh) (00011011)
1597         Q_DIR = 0 (0h) (00) "Reverse"
1598         L_PACKET = 86 (56h) (0000001010110)
1599         Q_SCALE = 1 (1h) (01) "1 m scale"
1600         D_STATIC = 0 (0h) (000000000000000) "0m"
1601         V_STATIC = 10 (Ah) (0001010) "50 km/h"

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1602          Q_FRONT = 1 (1h) (1) "No train length delay on
          validity end point of profile element"
1603      N_ITER = 0 (0h) (00000)
1604      N_ITER = 1 (1h) (00001)
1605          [0] D_STATIC = 738 (2E2h) (000001011100010)
          "738m"
1606          [0] V_STATIC = 127 (7Fh) (1111111) "Non
          numerical value telling that the static
          speed profile description ends at D_STATIC(n
          )"
1607          [0] Q_FRONT = 0 (0h) (0) "Train length delay on
          validity end point of profile element"
1608      [0] N_ITER = 0 (0h) (00000)
1609      Packet 21 - TrackToTrain - Gradient Profile
1610          NID_PACKET = 21 (15h) (00010101)
1611          Q_DIR = 0 (0h) (00) "Reverse"
1612          L_PACKET = 102 (66h) (0000001100110)
1613          Q_SCALE = 1 (1h) (01) "1 m scale"
1614          D_GRADIENT = 0 (0h) (000000000000000) "0m"
1615          Q_GDIR = 1 (1h) (1) "Uphill"
1616          G_A = 5 (5h) (00000101) "5 o/oo"
1617      N_ITER = 2 (2h) (00010)
1618          [0] D_GRADIENT = 593 (251h) (000001001010001)
          "593m"
1619          [0] Q_GDIR = 1 (1h) (1) "Uphill"
1620          [0] G_A = 0 (0h) (00000000) "0 o/oo"
1621          [1] D_GRADIENT = 145 (91h) (000000010010001)
          "145m"
1622          [1] Q_GDIR = 0 (0h) (0) "Downhill"
1623          [1] G_A = 255 (FFh) (11111111) "Non numerical
          value telling that the current gradient
          description ends at D_GRADIENT(n)"
1624 12:08:38.704017 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
          :192.168.0.132
1625      10000100 00000110 10000010 11010101 00001100 00011111
          10010111 00100000 01110100 01000100 00000000 00001000
          00010000 00000010 00010000 00011100 00010011
          00000010 10000000 00110010 00000000 01100100 10000000
          11111000 00010100 10000011
1626      NID_MESSAGE = 132 (84h) (10000100)
1627      L_MESSAGE = 26 (1Ah) (0000011010)
1628      T_TRAIN = 190066814 (B54307Eh)
          (00001011010101010000011000001111110)
1629      NID_ENGINE = 6062545 (5C81D1h)
          (010111001000000111010001)
1630      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
1631      Packet 0 - TrainToTrack - Pos Report
1632          NID_PACKET = 0 (0h) (00000000)

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1633         L_PACKET = 129 (81h) (00000100000001)
1634         Q_SCALE = 0 (0h) (00) "10 cm scale"
1635     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
1636         NID_C = 2 (2h) (0000000010)
1637         NID_BG = 1031 (407h) (000100000000111)
1638         D_LRBG = 608 (260h) (000001001100000) "60.8m"
1639         Q_DIRLRBG = 1 (1h) (01) "Nominal"
1640         Q_DLRBG = 1 (1h) (01) "Nominal"
1641         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1642         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
1643         "
1643     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
1644         integrity monitoring device"
1644         L_TRAININT = 248 (F8h) (000000011111000)
1645         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1646         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
1647         M_MODE = 0 (0h) (0000) "Full Supervision"
1648     M_LEVEL = 3 (3h) (011) "Level 2"
1649 12:08:38.725010 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
1649     (PK21) - Train 6062545 - Dest:192.168.0.134
1650     00000011 00010010 01000010 11010101 00001100 00011111
1650         10000000 00010000 10000000 11100001 11101000 00010110
1650         00010000 00000000 00000000 00000001 00100111
1650         00010000 00000000 00011111 10000111 00101000 00001100
1650         01000110 01111111 11110000 10100011 10100100
1650         00001001 00001000 01010111 11111111 11110010 00010000
1650         00111010 01010000 01010100 00001101 10001000
1650         00011010 00110000 01111110 00111000 00010000 10000000
1650         10010000 00000111 11100111 10000001 00011011
1650         01000000 10101100 10000000 00000000 00010101 00000000
1650         01000001 00100111 01111111 00000000 01010101
1650         00000011 00110010 00000000 00000010 00001010 00100000
1650         00110111 10110000 00000000 00010010 00101111
1650         11110000
1651     NID_MESSAGE = 3 (3h) (00000011)
1652     L_MESSAGE = 73 (49h) (0001001001)
1653     T_TRAIN = 190066814 (B54307Eh)
1653         (000010110101010000011000001111110)
1654     M_ACK = 0 (0h) (0) "No acknowledgement required"
1655     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
1656         NID_C = 2 (2h) (0000000010)
1657         NID_BG = 1031 (407h) (000100000000111)
1658     Packet 15 - TrackToTrain - Level 2/3 MA
1659         NID_PACKET = 15 (Fh) (00001111)
1660         Q_DIR = 1 (1h) (01) "Nominal"
1661         L_PACKET = 88 (58h) (0000001011000)
1662         Q_SCALE = 1 (1h) (01) "1 m scale"
1663         V_EMA = 0 (0h) (00000000) "0 km/h"
1664         T_EMA = 0 (0h) (0000000000)

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1665     N_ITER = 0 (0h) (000000)
1666         L_ENDSECTION = 590 (24Eh) (000001001001110)
           "590m"
1667     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
1668     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
1669     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
1670         D_DP = 0 (0h) (0000000000000000) "0m"
1671         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
1672     Q_OVERLAP = 0 (0h) (0) "No overlap information"
1673     Packet 57 - TrackToTrain - MA Request Params
1674         NID_PACKET = 57 (39h) (00111001)
1675         Q_DIR = 1 (1h) (01) "Nominal"
1676         L_PACKET = 49 (31h) (0000000110001)
1677         T_MAR = 25 (19h) (00011001)
1678         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
1679         T_CYCRQST = 10 (Ah) (00001010)
1680     Packet 58 - TrackToTrain - Pos Report Params
1681         NID_PACKET = 58 (3Ah) (00111010)
1682         Q_DIR = 1 (1h) (01) "Nominal"
1683         L_PACKET = 72 (48h) (0000001001000)
1684         Q_SCALE = 1 (1h) (01) "1 m scale"
1685         T_CYCLOC = 10 (Ah) (00001010)
1686         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
1687         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1688     N_ITER = 1 (1h) (00001)
1689         [0] D_LOC = 466 (1D2h) (000000111010010) "466m"
1690         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1691     Packet 5 - TrackToTrain - Linking
1692         NID_PACKET = 5 (5h) (00000101)
1693         Q_DIR = 1 (1h) (01) "Nominal"
1694         L_PACKET = 108 (6Ch) (0000001101100)
1695         Q_SCALE = 1 (1h) (01) "1 m scale"
1696         D_LINK = 419 (1A3h) (000000110100011) "419m"
1697     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1698         NID_BG = 1009 (3F1h) (00001111110001)
1699         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1700         Q_LINKREACTION = 2 (2h) (10) "No reaction"

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1701         Q_LOCACC = 1 (1h) (000001)
1702     N_ITER = 1 (1h) (00001)
1703         [0] D_LINK = 144 (90h) (000000010010000) "144m"
1704     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1705         [0] NID_BG = 1011 (3F3h) (00001111110011)
1706     [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1707         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1708     [0] Q_LOCACC = 1 (1h) (000001)
1709     Packet 27 - TrackToTrain - International SSP
1710         NID_PACKET = 27 (1Bh) (00011011)
1711         Q_DIR = 1 (1h) (01) "Nominal"
1712         L_PACKET = 86 (56h) (0000001010110)
1713         Q_SCALE = 1 (1h) (01) "1 m scale"
1714         D_STATIC = 0 (0h) (000000000000000) "0m"
1715         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1716         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
1717     N_ITER = 0 (0h) (00000)
1718     N_ITER = 1 (1h) (00001)
1719         [0] D_STATIC = 590 (24Eh) (000001001001110)
        "590m"
1720         [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
1721         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
1722     [0] N_ITER = 0 (0h) (00000)
1723     Packet 21 - TrackToTrain - Gradient Profile
1724         NID_PACKET = 21 (15h) (00010101)
1725         Q_DIR = 1 (1h) (01) "Nominal"
1726         L_PACKET = 102 (66h) (0000001100110)
1727         Q_SCALE = 1 (1h) (01) "1 m scale"
1728         D_GRADIENT = 0 (0h) (000000000000000) "0m"
1729         Q_GDIR = 1 (1h) (1) "Uphill"
1730         G_A = 5 (5h) (00000101) "5 o/oo"
1731     N_ITER = 2 (2h) (00010)
1732         [0] D_GRADIENT = 445 (1BDh) (000000110111101)
        "445m"
1733         [0] Q_GDIR = 1 (1h) (1) "Uphill"
1734         [0] G_A = 0 (0h) (00000000) "0 o/oo"
1735         [1] D_GRADIENT = 145 (91h) (000000010010001)
        "145m"
1736         [1] Q_GDIR = 0 (0h) (0) "Downhill"
1737         [1] G_A = 255 (FFh) (11111111) "Non numerical
        value telling that the current gradient

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C. Simulation Traces

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description ends at D_GRADIENT(n)"
1738 12:08:39.474188 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
      :192.168.0.132
1739      10000100 00000110 10000010 11010101 00001100 00101100
          00010111 00100000 01110100 01000100 00000000 00001000
          00010000 00000010 00010000 00011100 00010101
          01000010 10000000 00110010 00000000 01100100 10000000
          11111000 00010100 10000011
1740      NID_MESSAGE = 132 (84h) (10000100)
1741      L_MESSAGE = 26 (1Ah) (0000011010)
1742      T_TRAIN = 190066864 (B5430B0h)
          (000010110101010000011000010110000)
1743      NID_ENGINE = 6062545 (5C81D1h)
          (010111001000000111010001)
1744      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
1745      Packet 0 - TrainToTrack - Pos Report
1746      NID_PACKET = 0 (0h) (00000000)
1747      L_PACKET = 129 (81h) (00000100000001)
1748      Q_SCALE = 0 (0h) (00) "10 cm scale"
1749      NID_LRBG = 33799 (8407h) (0000000010000100000000111)
1750      NID_C = 2 (2h) (0000000010)
1751      NID_BG = 1031 (407h) (000100000000111)
1752      D_LRBG = 680 (2A8h) (000001010101000) "68.0m"
1753      Q_DIRLRBG = 1 (1h) (01) "Nominal"
1754      Q_DLRBG = 1 (1h) (01) "Nominal"
1755      L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1756      L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
          "
1757      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
1758      L_TRAININT = 248 (F8h) (000000011111000)
1759      V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1760      Q_DIRTRAIN = 1 (1h) (01) "Nominal"
1761      M_MODE = 0 (0h) (0000) "Full Supervision"
1762      M_LEVEL = 3 (3h) (011) "Level 2"
1763 12:08:49.255395 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
      :192.168.0.132
1764      10000100 00000110 10000010 11010101 00001101 00100110
          01010111 00100000 01110100 01000100 00000000 00001000
          00010000 00000010 00010000 00011100 01000000
          10101010 10000000 00110010 00000000 01100100 10000000
          11111000 00010100 10000011
1765      NID_MESSAGE = 132 (84h) (10000100)
1766      L_MESSAGE = 26 (1Ah) (0000011010)
1767      T_TRAIN = 190067865 (B543499h)
          (000010110101010000011010010011001)
1768      NID_ENGINE = 6062545 (5C81D1h)
          (010111001000000111010001)

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1769     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
        the perturbation location reached"
1770     Packet 0 - TrainToTrack - Pos Report
1771         NID_PACKET = 0 (0h) (00000000)
1772         L_PACKET = 129 (81h) (0000010000001)
1773         Q_SCALE = 0 (0h) (00) "10 cm scale"
1774     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
1775         NID_C = 2 (2h) (0000000010)
1776         NID_BG = 1031 (407h) (00010000000111)
1777         D_LRBG = 2069 (815h) (000100000010101) "206.9m"
1778         Q_DIRLRBG = 1 (1h) (01) "Nominal"
1779         Q_DLRBG = 1 (1h) (01) "Nominal"
1780         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1781         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
        "
1782     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
        integrity monitoring device"
1783         L_TRAININT = 248 (F8h) (000000011111000)
1784         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1785         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
1786         M_MODE = 0 (0h) (0000) "Full Supervision"
1787     M_LEVEL = 3 (3h) (011) "Level 2"
1788 12:08:49.279557 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
        (PK21) - Train 6062545 - Dest:192.168.0.134
1789     00000011 00010010 01000010 11010101 00001101 00100110
        01000000 00010000 10000000 11100001 11101000 00010110
        00010000 00000000 00000000 00000001 00100111
        00010000 00000000 00011111 10000111 00101000 00001100
        01000110 01111111 11110000 10100011 10100100
        00001001 00001000 01010111 11111111 11110010 00010000
        00111010 01010000 01010100 00001101 10001000
        00011010 00110000 01111110 00111000 00010000 10000000
        10010000 00000111 11100111 10000001 00011011
        01000000 10101100 10000000 00000000 00010101 00000000
        01000001 00100111 01111111 00000000 01010101
        00000011 00110010 00000000 00000010 00001010 00100000
        00110111 10110000 00000000 00010010 00101111
        11110000
1790     NID_MESSAGE = 3 (3h) (00000011)
1791     L_MESSAGE = 73 (49h) (0001001001)
1792     T_TRAIN = 190067865 (B543499h)
        (000010110101010000011010010011001)
1793     M_ACK = 0 (0h) (0) "No acknowledgement required"
1794     NID_LRBG = 33799 (8407h) (0000000010000100000000111)
1795         NID_C = 2 (2h) (0000000010)
1796         NID_BG = 1031 (407h) (00010000000111)
1797     Packet 15 - TrackToTrain - Level 2/3 MA
1798         NID_PACKET = 15 (Fh) (00001111)
1799         Q_DIR = 1 (1h) (01) "Nominal"

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C. Simulation Traces

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1800         L_PACKET = 88 (58h) (0000001011000)
1801         Q_SCALE = 1 (1h) (01) "1 m scale"
1802         V_EMA = 0 (0h) (0000000) "0 km/h"
1803         T_EMA = 0 (0h) (00000000000)
1804     N_ITER = 0 (0h) (000000)
1805         L_ENDSECTION = 590 (24Eh) (000001001001110)
           "590m"
1806     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
1807     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
1808     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
1809         D_DP = 0 (0h) (0000000000000000) "0m"
1810         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
1811     Q_OVERLAP = 0 (0h) (0) "No overlap information"
1812     Packet 57 - TrackToTrain - MA Request Params
1813         NID_PACKET = 57 (39h) (00111001)
1814         Q_DIR = 1 (1h) (01) "Nominal"
1815         L_PACKET = 49 (31h) (0000000110001)
1816         T_MAR = 25 (19h) (00011001)
1817         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
1818         T_CYCRQST = 10 (Ah) (00001010)
1819     Packet 58 - TrackToTrain - Pos Report Params
1820         NID_PACKET = 58 (3Ah) (00111010)
1821         Q_DIR = 1 (1h) (01) "Nominal"
1822         L_PACKET = 72 (48h) (0000001001000)
1823         Q_SCALE = 1 (1h) (01) "1 m scale"
1824         T_CYCLOC = 10 (Ah) (00001010)
1825         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
1826         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1827     N_ITER = 1 (1h) (00001)
1828         [0] D_LOC = 466 (1D2h) (000000111010010) "466m"
1829         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1830     Packet 5 - TrackToTrain - Linking
1831         NID_PACKET = 5 (5h) (00000101)
1832         Q_DIR = 1 (1h) (01) "Nominal"
1833         L_PACKET = 108 (6Ch) (0000001101100)
1834         Q_SCALE = 1 (1h) (01) "1 m scale"
1835         D_LINK = 419 (1A3h) (000000110100011) "419m"
1836     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1837         NID_BG = 1009 (3F1h) (00001111110001)

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1838         Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1839         Q_LINKREACTION = 2 (2h) (10) "No reaction"
1840         Q_LOCACCC = 1 (1h) (000001)
1841     N_ITER = 1 (1h) (00001)
1842         [0] D_LINK = 144 (90h) (000000010010000) "144m"
1843     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
1844         [0] NID_BG = 1011 (3F3h) (00001111110011)
1845         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
           group is seen by the train in nominal
           direction"
1846         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1847         [0] Q_LOCACCC = 1 (1h) (000001)
1848     Packet 27 - TrackToTrain - International SSP
1849         NID_PACKET = 27 (1Bh) (00011011)
1850         Q_DIR = 1 (1h) (01) "Nominal"
1851         L_PACKET = 86 (56h) (0000001010110)
1852         Q_SCALE = 1 (1h) (01) "1 m scale"
1853         D_STATIC = 0 (0h) (000000000000000) "0m"
1854         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1855         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
1856     N_ITER = 0 (0h) (00000)
1857     N_ITER = 1 (1h) (00001)
1858         [0] D_STATIC = 590 (24Eh) (000001001001110)
           "590m"
1859         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
1860         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
1861     [0] N_ITER = 0 (0h) (00000)
1862     Packet 21 - TrackToTrain - Gradient Profile
1863         NID_PACKET = 21 (15h) (00010101)
1864         Q_DIR = 1 (1h) (01) "Nominal"
1865         L_PACKET = 102 (66h) (0000001100110)
1866         Q_SCALE = 1 (1h) (01) "1 m scale"
1867         D_GRADIENT = 0 (0h) (000000000000000) "0m"
1868         Q_GDIR = 1 (1h) (1) "Uphill"
1869         G_A = 5 (5h) (00000101) "5 o/oo"
1870     N_ITER = 2 (2h) (00010)
1871         [0] D_GRADIENT = 445 (1BDh) (000000110111101)
           "445m"
1872         [0] Q_GDIR = 1 (1h) (1) "Uphill"
1873         [0] G_A = 0 (0h) (00000000) "0 o/oo"
1874         [1] D_GRADIENT = 145 (91h) (000000010010001)

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1875         "145m"
1876         [1] Q_GDIR = 0 (0h) (0) "Downhill"
1877         [1] G_A = 255 (FFh) (11111111) "Non numerical
1878         value telling that the current gradient
1879         description ends at D_GRADIENT(n)"
1880 12:08:50.068864 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
1881         :192.168.0.132
1882         10000100 00000110 10000010 11010101 00001101 00110010
1883         01010111 00100000 01110100 01000100 00000000 00001000
1884         00010000 00000010 00010000 00011100 01000010
1885         11010010 10000000 00110010 00000000 01100100 10000000
1886         11111000 00010100 10000011
1887         NID_MESSAGE = 132 (84h) (10000100)
1888         L_MESSAGE = 26 (1Ah) (0000011010)
1889         T_TRAIN = 190067913 (B5434C9h)
1890         (000010110101010000011010011001001)
1891         NID_ENGINE = 6062545 (5C81D1h)
1892         (010111001000000111010001)
1893         Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
1894         the perturbation location reached"
1895         Packet 0 - TrainToTrack - Pos Report
1896         NID_PACKET = 0 (0h) (00000000)
1897         L_PACKET = 129 (81h) (00000100000001)
1898         Q_SCALE = 0 (0h) (00) "10 cm scale"
1899         NID_LRBG = 33799 (8407h) (000000001000010000000111)
1900         NID_C = 2 (2h) (0000000010)
1901         NID_BG = 1031 (407h) (00010000000111)
1902         D_LRBG = 2138 (85Ah) (000100001011010) "213.8m"
1903         Q_DIRLRBG = 1 (1h) (01) "Nominal"
1904         Q_DLRBG = 1 (1h) (01) "Nominal"
1905         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1906         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
1907         "
1908         Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
1909         integrity monitoring device"
1910         L_TRAININT = 248 (F8h) (000000011111000)
1911         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1912         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
1913         M_MODE = 0 (0h) (0000) "Full Supervision"
1914         M_LEVEL = 3 (3h) (011) "Level 2"
1915 12:08:59.856421 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
1916         :192.168.0.132
1917         10000100 00000110 10000010 11010101 00001110 00101100
1918         11010111 00100000 01110100 01000100 00000000 00001000
1919         00010000 00000010 00010000 00011100 01101110
1920         00111010 10000000 00110010 00000000 01100100 10000000
1921         11111000 00010100 10000011
1922         NID_MESSAGE = 132 (84h) (10000100)
1923         L_MESSAGE = 26 (1Ah) (0000011010)

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1906 T_TRAIN = 190068915 (B5438B3h)
      (00001011010101000011100010110011)
1907 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
1908 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
1909 Packet 0 - TrainToTrack - Pos Report
1910 NID_PACKET = 0 (0h) (00000000)
1911 L_PACKET = 129 (81h) (0000010000001)
1912 Q_SCALE = 0 (0h) (00) "10 cm scale"
1913 NID_LRBG = 33799 (8407h) (0000000010000100000000111)
1914 NID_C = 2 (2h) (0000000010)
1915 NID_BG = 1031 (407h) (00010000000111)
1916 D_LRBG = 3527 (DC7h) (000110111000111) "352.7m"
1917 Q_DIRLRBG = 1 (1h) (01) "Nominal"
1918 Q_DLRBG = 1 (1h) (01) "Nominal"
1919 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
1920 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
1921 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
1922 L_TRAININT = 248 (F8h) (000000011111000)
1923 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
1924 Q_DIRTRAIN = 1 (1h) (01) "Nominal"
1925 M_MODE = 0 (0h) (0000) "Full Supervision"
1926 M_LEVEL = 3 (3h) (011) "Level 2"
1927 12:08:59.884693 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062545 - Dest:192.168.0.134
1928 00000011 00010010 01000010 11010101 00001110 00101100
      11000000 00010000 10000000 11100001 11101000 00010110
      00010000 00000000 00000000 00000001 00100111
      00010000 00000000 00011111 10000111 00101000 00001100
      01000110 01111111 11110000 10100011 10100100
      00001001 00001000 01010111 11111111 11110010 00010000
      00111010 01010000 01010100 00001101 10001000
      00011010 00110000 01111110 00111000 00010000 10000000
      10010000 00000111 11100111 10000001 00011011
      01000000 10101100 10000000 00000000 00010101 00000000
      01000001 00100111 01111111 00000000 01010101
      00000011 00110010 00000000 00000010 00001010 00100000
      00110111 10110000 00000000 00010010 00101111
      11110000
1929 NID_MESSAGE = 3 (3h) (00000011)
1930 L_MESSAGE = 73 (49h) (0001001001)
1931 T_TRAIN = 190068915 (B5438B3h)
      (00001011010101000011100010110011)
1932 M_ACK = 0 (0h) (0) "No acknowledgement required"
1933 NID_LRBG = 33799 (8407h) (0000000010000100000000111)
1934 NID_C = 2 (2h) (0000000010)

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1935         NID_BG = 1031 (407h) (00010000000111)
1936 Packet 15 - TrackToTrain - Level 2/3 MA
1937         NID_PACKET = 15 (Fh) (00001111)
1938         Q_DIR = 1 (1h) (01) "Nominal"
1939         L_PACKET = 88 (58h) (0000001011000)
1940         Q_SCALE = 1 (1h) (01) "1 m scale"
1941         V_EMA = 0 (0h) (0000000) "0 km/h"
1942         T_EMA = 0 (0h) (0000000000)
1943 N_ITER = 0 (0h) (00000)
1944         L_ENDSECTION = 590 (24Eh) (000001001001110)
           "590m"
1945 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
1946 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
1947 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
1948         D_DP = 0 (0h) (000000000000000) "0m"
1949         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
1950 Q_OVERLAP = 0 (0h) (0) "No overlap information"
1951 Packet 57 - TrackToTrain - MA Request Params
1952         NID_PACKET = 57 (39h) (00111001)
1953         Q_DIR = 1 (1h) (01) "Nominal"
1954         L_PACKET = 49 (31h) (0000000110001)
1955         T_MAR = 25 (19h) (00011001)
1956         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
1957         T_CYCRQST = 10 (Ah) (00001010)
1958 Packet 58 - TrackToTrain - Pos Report Params
1959         NID_PACKET = 58 (3Ah) (00111010)
1960         Q_DIR = 1 (1h) (01) "Nominal"
1961         L_PACKET = 72 (48h) (0000001001000)
1962         Q_SCALE = 1 (1h) (01) "1 m scale"
1963         T_CYCLOC = 10 (Ah) (00001010)
1964         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
1965         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
1966 N_ITER = 1 (1h) (00001)
1967         [0] D_LOC = 466 (1D2h) (000000111010010) "466m"
1968         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
1969 Packet 5 - TrackToTrain - Linking
1970         NID_PACKET = 5 (5h) (00000101)
1971         Q_DIR = 1 (1h) (01) "Nominal"
1972         L_PACKET = 108 (6Ch) (0000001101100)
1973         Q_SCALE = 1 (1h) (01) "1 m scale"

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1974         D_LINK = 419 (1A3h) (000000110100011) "419m"
1975 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1976         NID_BG = 1009 (3F1h) (00001111110001)
1977         Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1978         Q_LINKREACTION = 2 (2h) (10) "No reaction"
1979         Q_LOCACCC = 1 (1h) (000001)
1980 N_ITER = 1 (1h) (00001)
1981         [0] D_LINK = 144 (90h) (000000010010000) "144m"
1982 [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
1983         [0] NID_BG = 1011 (3F3h) (00001111110011)
1984         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
1985         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
1986         [0] Q_LOCACCC = 1 (1h) (000001)
1987 Packet 27 - TrackToTrain - International SSP
1988         NID_PACKET = 27 (1Bh) (00011011)
1989         Q_DIR = 1 (1h) (01) "Nominal"
1990         L_PACKET = 86 (56h) (0000001010110)
1991         Q_SCALE = 1 (1h) (01) "1 m scale"
1992         D_STATIC = 0 (0h) (000000000000000) "0m"
1993         V_STATIC = 10 (Ah) (0001010) "50 km/h"
1994         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
1995 N_ITER = 0 (0h) (00000)
1996 N_ITER = 1 (1h) (00001)
1997         [0] D_STATIC = 590 (24Eh) (000001001001110)
        "590m"
1998         [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
1999         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
2000 [0] N_ITER = 0 (0h) (00000)
2001 Packet 21 - TrackToTrain - Gradient Profile
2002         NID_PACKET = 21 (15h) (00010101)
2003         Q_DIR = 1 (1h) (01) "Nominal"
2004         L_PACKET = 102 (66h) (0000001100110)
2005         Q_SCALE = 1 (1h) (01) "1 m scale"
2006         D_GRADIENT = 0 (0h) (000000000000000) "0m"
2007         Q_GDIR = 1 (1h) (1) "Uphill"
2008         G_A = 5 (5h) (00000101) "5 o/oo"
2009 N_ITER = 2 (2h) (00010)
2010         [0] D_GRADIENT = 445 (1BDh) (000000110111101)

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2011         "445m"
2012         [0] Q_GDIR = 1 (1h) (1) "Uphill"
2013         [0] G_A = 0 (0h) (00000000) "0 o/oo"
2014         [1] D_GRADIENT = 145 (91h) (000000010010001)
2015         "145m"
2016         [1] Q_GDIR = 0 (0h) (0) "Downhill"
2017         [1] G_A = 255 (FFh) (11111111) "Non numerical
value telling that the current gradient
description ends at D_GRADIENT(n)"
2018 12:09:00.696259 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
:192.168.0.132
2019 10000100 00000110 10000010 11010101 00001110 01000101
2020 01010111 00100000 01110100 01000100 00000000 00001000
2021 00010000 00000010 00010000 00011100 01110010
2022 10001010 10000000 00110010 00000000 01100100 10000000
2023 11111000 00010100 10000011
2024 NID_MESSAGE = 132 (84h) (10000100)
2025 L_MESSAGE = 26 (1Ah) (0000011010)
2026 T_TRAIN = 190069013 (B543915h)
(0000101101010101000011100100010101)
2027 NID_ENGINE = 6062545 (5C81D1h)
(010111001000000111010001)
2028 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
the perturbation location reached"
2029 Packet 0 - TrainToTrack - Pos Report
2030 NID_PACKET = 0 (0h) (00000000)
2031 L_PACKET = 129 (81h) (00000100000001)
2032 Q_SCALE = 0 (0h) (00) "10 cm scale"
2033 NID_LRBG = 33799 (8407h) (0000000010000100000000111)
2034 NID_C = 2 (2h) (0000000010)
2035 NID_BG = 1031 (407h) (000100000000111)
2036 D_LRBG = 3665 (E51h) (000111001010001) "366.5m"
2037 Q_DIRLRBG = 1 (1h) (01) "Nominal"
2038 Q_DLRBG = 1 (1h) (01) "Nominal"
2039 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2040 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
"
2041 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
2042 L_TRAININT = 248 (F8h) (000000011111000)
2043 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
2044 Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2045 M_MODE = 0 (0h) (0000) "Full Supervision"
2046 M_LEVEL = 3 (3h) (011) "Level 2"
2047 12:09:10.712819 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
:192.168.0.132
2048 10000100 00000110 10000010 11010101 00001111 00111111
2049 11010111 00100000 01110100 01000100 00000000 00001000
2050 00010000 00000010 00001111 11000100 00011010

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10101010 10000000 00110010 00000000 01100100 10000000
11111000 00010010 10000011
2043 NID_MESSAGE = 132 (84h) (10000100)
2044 L_MESSAGE = 26 (1Ah) (0000011010)
2045 T_TRAIN = 190070015 (B543CFFh)
(00001011010101000011110011111111)
2046 NID_ENGINE = 6062545 (5C81D1h)
(010111001000000111010001)
2047 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
the perturbation location reached"
2048 Packet 0 - TrainToTrack - Pos Report
2049 NID_PACKET = 0 (0h) (00000000)
2050 L_PACKET = 129 (81h) (0000010000001)
2051 Q_SCALE = 0 (0h) (00) "10 cm scale"
2052 NID_LRBG = 33777 (83F1h) (000000001000001111110001)
2053 NID_C = 2 (2h) (0000000010)
2054 NID_BG = 1009 (3F1h) (00001111110001)
2055 D_LRBG = 853 (355h) (000001101010101) "85.3m"
2056 Q_DIRLRBG = 1 (1h) (01) "Nominal"
2057 Q_DLRBG = 1 (1h) (01) "Nominal"
2058 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2059 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
"
2060 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
2061 L_TRAININT = 248 (F8h) (000000011111000)
2062 V_TRAIN = 9 (9h) (0001001) "45 km/h"
2063 Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2064 M_MODE = 0 (0h) (0000) "Full Supervision"
2065 M_LEVEL = 3 (3h) (011) "Level 2"
2066 12:09:10.744333 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
(PK21) - Train 6062545 - Dest:192.168.0.134
2067 00000011 00010001 00000010 11010101 00001111 00111111
11000000 00010000 01111110 00100001 11101000 00010110
00010000 00000000 00000000 00000000 01010101
10010000 00000000 00011111 10000111 00101000 00001100
01000110 01111111 11110000 10100011 10100100
00001001 00001000 01010111 11111111 11110010 00010000
00000101 11110000 01010100 00001000 10101000
00001001 00000000 01111110 01111000 00010000 00001101
10100000 01010110 01000000 00000000 00001010
10000000 00100000 00101010 11111111 10000000 00101010
10000001 10011001 00000000 00000001 00000101
00010000 00000001 10101000 00000000 00001001 00010111
11111000
2068 NID_MESSAGE = 3 (3h) (00000011)
2069 L_MESSAGE = 68 (44h) (0001000100)
2070 T_TRAIN = 190070015 (B543CFFh)
(00001011010101000011110011111111)

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2071     M_ACK = 0 (0h) (0) "No acknowledgement required"
2072     NID_LRBG = 33777 (83F1h) (0000000010000011111110001)
2073         NID_C = 2 (2h) (0000000010)
2074         NID_BG = 1009 (3F1h) (00001111110001)
2075     Packet 15 - TrackToTrain - Level 2/3 MA
2076         NID_PACKET = 15 (Fh) (00001111)
2077         Q_DIR = 1 (1h) (01) "Nominal"
2078         L_PACKET = 88 (58h) (0000001011000)
2079         Q_SCALE = 1 (1h) (01) "1 m scale"
2080         V_EMA = 0 (0h) (00000000) "0 km/h"
2081         T_EMA = 0 (0h) (00000000000)
2082     N_ITER = 0 (0h) (000000)
2083         L_ENDSECTION = 171 (ABh) (000000010101011) "171
2084             m"
2085     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
2086         information"
2087     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
2088         information"
2089     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
2090         follow"
2091         D_DP = 0 (0h) (0000000000000000) "0m"
2092         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
2093             calculated release speed"
2094     Q_OVERLAP = 0 (0h) (0) "No overlap information"
2095     Packet 57 - TrackToTrain - MA Request Params
2096         NID_PACKET = 57 (39h) (00111001)
2097         Q_DIR = 1 (1h) (01) "Nominal"
2098         L_PACKET = 49 (31h) (0000000110001)
2099         T_MAR = 25 (19h) (00011001)
2100         T_TIMEOUSRQST = 1023 (3FFh) (111111111) "No MA
2101             request triggering with regards to this
2102             function"
2103         T_CYCRQST = 10 (Ah) (00001010)
2104     Packet 58 - TrackToTrain - Pos Report Params
2105         NID_PACKET = 58 (3Ah) (00111010)
2106         Q_DIR = 1 (1h) (01) "Nominal"
2107         L_PACKET = 72 (48h) (0000001001000)
2108         Q_SCALE = 1 (1h) (01) "1 m scale"
2109         T_CYCLOC = 10 (Ah) (00001010)
2110         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
2111             train has not to report cyclically its
2112             position"
2113         M_LOC = 1 (1h) (001) "Every LRBG compliant
2114             balise group"
2115     N_ITER = 1 (1h) (00001)
2116         [0] D_LOC = 47 (2Fh) (000000000101111) "47m"
2117         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2118     Packet 5 - TrackToTrain - Linking
2119         NID_PACKET = 5 (5h) (00000101)

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2110         Q_DIR = 1 (1h) (01) "Nominal"
2111         L_PACKET = 69 (45h) (0000001000101)
2112         Q_SCALE = 1 (1h) (01) "1 m scale"
2113         D_LINK = 144 (90h) (000000010010000) "144m"
2114     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
2115         NID_BG = 1011 (3F3h) (00001111110011)
2116         Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
2117         Q_LINKREACTION = 2 (2h) (10) "No reaction"
2118         Q_LOCACCC = 1 (1h) (000001)
2119     N_ITER = 0 (0h) (00000)
2120     Packet 27 - TrackToTrain - International SSP
2121         NID_PACKET = 27 (1Bh) (00011011)
2122         Q_DIR = 1 (1h) (01) "Nominal"
2123         L_PACKET = 86 (56h) (0000001010110)
2124         Q_SCALE = 1 (1h) (01) "1 m scale"
2125         D_STATIC = 0 (0h) (000000000000000) "0m"
2126         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2127         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
2128     N_ITER = 0 (0h) (00000)
2129     N_ITER = 1 (1h) (00001)
2130     [0] D_STATIC = 171 (ABh) (000000010101011) "171
        m"
2131     [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
2132     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
2133     [0] N_ITER = 0 (0h) (00000)
2134     Packet 21 - TrackToTrain - Gradient Profile
2135         NID_PACKET = 21 (15h) (00010101)
2136         Q_DIR = 1 (1h) (01) "Nominal"
2137         L_PACKET = 102 (66h) (0000001100110)
2138         Q_SCALE = 1 (1h) (01) "1 m scale"
2139         D_GRADIENT = 0 (0h) (000000000000000) "0m"
2140         Q_GDIR = 1 (1h) (1) "Uphill"
2141         G_A = 5 (5h) (00000101) "5 o/oo"
2142     N_ITER = 2 (2h) (00010)
2143     [0] D_GRADIENT = 26 (1Ah) (000000000011010) "26
        m"
2144     [0] Q_GDIR = 1 (1h) (1) "Uphill"
2145     [0] G_A = 0 (0h) (00000000) "0 o/oo"
2146     [1] D_GRADIENT = 145 (91h) (000000010010001)
        "145m"
2147     [1] Q_GDIR = 0 (0h) (0) "Downhill"

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2148         [1] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
2149 12:09:11.691032 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
2150     10000100 00000110 10000010 11010101 00001111 01011000
           01010111 00100000 01110100 01000100 00000000 00001000
           00010000 00000010 00001111 11000100 00011110
           01100010 10000000 00110010 00000000 01100100 10000000
           11111000 00010010 10000011
2151     NID_MESSAGE = 132 (84h) (10000100)
2152     L_MESSAGE = 26 (1Ah) (0000011010)
2153     T_TRAIN = 190070113 (B543D61h)
           (00001011010101000011110101100001)
2154     NID_ENGINE = 6062545 (5C81D1h)
           (010111001000000111010001)
2155     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
           the perturbation location reached"
2156     Packet 0 - TrainToTrack - Pos Report
2157         NID_PACKET = 0 (0h) (00000000)
2158         L_PACKET = 129 (81h) (00000100000001)
2159         Q_SCALE = 0 (0h) (00) "10 cm scale"
2160     NID_LRBG = 33777 (83F1h) (000000001000001111110001)
2161     NID_C = 2 (2h) (0000000010)
2162     NID_BG = 1009 (3F1h) (00001111110001)
2163     D_LRBG = 972 (3CCh) (000001111001100) "97.2m"
2164     Q_DIRLRBG = 1 (1h) (01) "Nominal"
2165     Q_DLRBG = 1 (1h) (01) "Nominal"
2166     L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2167     L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
2168     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
2169         L_TRAININT = 248 (F8h) (000000011111000)
2170         V_TRAIN = 9 (9h) (0001001) "45 km/h"
2171         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2172         M_MODE = 0 (0h) (0000) "Full Supervision"
2173     M_LEVEL = 3 (3h) (011) "Level 2"
2174 12:09:21.706735 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
2175     10000100 00000110 10000010 11010101 00010000 01010010
           10010111 00100000 01110100 01000100 00000000 00001000
           00010000 00000010 00001111 11001100 00000110
           00010010 10000000 00110010 00000000 01100100 10000000
           11111000 00000100 10000011
2176     NID_MESSAGE = 132 (84h) (10000100)
2177     L_MESSAGE = 26 (1Ah) (0000011010)
2178     T_TRAIN = 190071114 (B54414Ah)
           (00001011010101000100000101001010)

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2179     NID_ENGINE = 6062545 (5C81D1h)
          (010111001000000111010001)
2180     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
2181     Packet 0 - TrainToTrack - Pos Report
2182         NID_PACKET = 0 (0h) (00000000)
2183         L_PACKET = 129 (81h) (00000100000001)
2184         Q_SCALE = 0 (0h) (00) "10 cm scale"
2185     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2186         NID_C = 2 (2h) (0000000010)
2187         NID_BG = 1011 (3F3h) (00001111110011)
2188         D_LRBG = 194 (C2h) (000000011000010) "19.4m"
2189         Q_DIRLRBG = 1 (1h) (01) "Nominal"
2190         Q_DLRBG = 1 (1h) (01) "Nominal"
2191         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2192         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
          "
2193     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
2194         L_TRAININT = 248 (F8h) (000000011111000)
2195         V_TRAIN = 2 (2h) (0000010) "10 km/h"
2196         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2197         M_MODE = 0 (0h) (0000) "Full Supervision"
2198     M_LEVEL = 3 (3h) (011) "Level 2"
2199 12:09:21.736003 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
          - Train 6062545 - Dest:192.168.0.134
2200     00000011 00001101 10000010 11010101 00010000 01010010
          10000000 00010000 01111110 01100001 11101000 00010110
          00010000 00000000 00000000 00000000 00001101
          10010000 00000000 00011111 10000111 00101000 00001100
          01000110 01111111 11110000 10100011 10100100
          00000111 00001000 01010111 11111111 11110010 00000001
          10110100 00001010 11001000 00000000 00000001
          01010000 00000100 00000000 11011111 11110000 00000101
          01010000 00100111 00100000 00000000 00100000
          00000001 00000000 00110110 11111111
2201     NID_MESSAGE = 3 (3h) (00000011)
2202     L_MESSAGE = 54 (36h) (0000110110)
2203     T_TRAIN = 190071114 (B54414Ah)
          (00001011010101000100000101001010)
2204     M_ACK = 0 (0h) (0) "No acknowledgement required"
2205     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2206         NID_C = 2 (2h) (0000000010)
2207         NID_BG = 1011 (3F3h) (00001111110011)
2208     Packet 15 - TrackToTrain - Level 2/3 MA
2209         NID_PACKET = 15 (Fh) (00001111)
2210         Q_DIR = 1 (1h) (01) "Nominal"
2211         L_PACKET = 88 (58h) (0000001011000)
2212         Q_SCALE = 1 (1h) (01) "1 m scale"

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2213         V_EMA = 0 (0h) (0000000) "0 km/h"
2214         T_EMA = 0 (0h) (0000000000)
2215     N_ITER = 0 (0h) (00000)
2216         L_ENDSECTION = 27 (1Bh) (000000000011011) "27m"
2217     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
        information"
2218     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
        information"
2219     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
        follow"
2220         D_DP = 0 (0h) (000000000000000) "0m"
2221         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
        calculated release speed"
2222     Q_OVERLAP = 0 (0h) (0) "No overlap information"
2223     Packet 57 - TrackToTrain - MA Request Params
2224         NID_PACKET = 57 (39h) (00111001)
2225         Q_DIR = 1 (1h) (01) "Nominal"
2226         L_PACKET = 49 (31h) (0000000110001)
2227         T_MAR = 25 (19h) (00011001)
2228         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
        request triggering with regards to this
        function"
2229         T_CYCRQST = 10 (Ah) (00001010)
2230     Packet 58 - TrackToTrain - Pos Report Params
2231         NID_PACKET = 58 (3Ah) (00111010)
2232         Q_DIR = 1 (1h) (01) "Nominal"
2233         L_PACKET = 56 (38h) (0000000111000)
2234         Q_SCALE = 1 (1h) (01) "1 m scale"
2235         T_CYCLOC = 10 (Ah) (00001010)
2236         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
        train has not to report cyclically its
        position"
2237         M_LOC = 1 (1h) (001) "Every LRBG compliant
        balise group"
2238     N_ITER = 0 (0h) (00000)
2239     Packet 27 - TrackToTrain - International SSP
2240         NID_PACKET = 27 (1Bh) (00011011)
2241         Q_DIR = 1 (1h) (01) "Nominal"
2242         L_PACKET = 86 (56h) (0000001010110)
2243         Q_SCALE = 1 (1h) (01) "1 m scale"
2244         D_STATIC = 0 (0h) (000000000000000) "0m"
2245         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2246         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
2247     N_ITER = 0 (0h) (00000)
2248     N_ITER = 1 (1h) (00001)
2249         [0] D_STATIC = 27 (1Bh) (000000000011011) "27m"
2250         [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static

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                speed profile description ends at D_STATIC(n
                )"
2251         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
2252     [0] N_ITER = 0 (0h) (00000)
2253     Packet 21 - TrackToTrain - Gradient Profile
2254         NID_PACKET = 21 (15h) (00010101)
2255         Q_DIR = 1 (1h) (01) "Nominal"
2256         L_PACKET = 78 (4Eh) (0000001001110)
2257         Q_SCALE = 1 (1h) (01) "1 m scale"
2258         D_GRADIENT = 0 (0h) (000000000000000) "0m"
2259         Q_GDIR = 1 (1h) (1) "Uphill"
2260         G_A = 0 (0h) (00000000) "0 o/oo"
2261     N_ITER = 1 (1h) (00001)
2262     [0] D_GRADIENT = 27 (1Bh) (000000000011011) "27
                m"
2263     [0] Q_GDIR = 0 (0h) (0) "Downhill"
2264     [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2265 12:09:22.486899 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
                :192.168.0.132
2266     10000100 00000110 10000010 11010101 00010000 01011110
                11010111 00100000 01110100 01000100 00000000 00001000
                00010000 00000010 00001111 11001100 00000110
                01001010 10000000 00110010 00000000 01100100 10000000
                11111000 00000010 10000011
2267     NID_MESSAGE = 132 (84h) (10000100)
2268     L_MESSAGE = 26 (1Ah) (0000011010)
2269     T_TRAIN = 190071163 (B54417Bh)
                (00001011010101000100000101111011)
2270     NID_ENGINE = 6062545 (5C81D1h)
                (010111001000000111010001)
2271     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2272     Packet 0 - TrainToTrack - Pos Report
2273         NID_PACKET = 0 (0h) (00000000)
2274         L_PACKET = 129 (81h) (00000100000001)
2275         Q_SCALE = 0 (0h) (00) "10 cm scale"
2276     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2277         NID_C = 2 (2h) (0000000010)
2278         NID_BG = 1011 (3F3h) (00001111110011)
2279         D_LRBG = 201 (C9h) (000000011001001) "20.1m"
2280         Q_DIRLRBG = 1 (1h) (01) "Nominal"
2281         Q_DLRBG = 1 (1h) (01) "Nominal"
2282         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2283         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
                "
2284     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by

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                integrity monitoring device"
2285             L_TRAININT = 248 (F8h) (000000011111000)
2286             V_TRAIN = 1 (1h) (0000001) "5 km/h"
2287             Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2288             M_MODE = 0 (0h) (0000) "Full Supervision"
2289             M_LEVEL = 3 (3h) (011) "Level 2"
2290 12:09:25.533100 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
                :192.168.0.132
2291             10000100 00000110 10000010 11010101 00010000 10110010
                01010111 00100000 01110100 00000100 00000000 00001000
                00010000 00000010 00001111 11001101 10101101
                10111010 10000000 00110010 00000000 01100100 10000000
                11111000 00010100 10000011
2292             NID_MESSAGE = 132 (84h) (10000100)
2293             L_MESSAGE = 26 (1Ah) (0000011010)
2294             T_TRAIN = 190071497 (B5442C9h)
                (000010110101010000100001011001001)
2295             NID_ENGINE = 6062544 (5C81D0h)
                (010111001000000111010000)
2296             Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2297             Packet 0 - TrainToTrack - Pos Report
2298             NID_PACKET = 0 (0h) (00000000)
2299             L_PACKET = 129 (81h) (00000100000001)
2300             Q_SCALE = 0 (0h) (00) "10 cm scale"
2301             NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2302             NID_C = 2 (2h) (0000000010)
2303             NID_BG = 1011 (3F3h) (00001111110011)
2304             D_LRBG = 13751 (35B7h) (011010110110111)
                "1375.1m"
2305             Q_DIRLRBG = 1 (1h) (01) "Nominal"
2306             Q_DLRBG = 1 (1h) (01) "Nominal"
2307             L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2308             L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
                "
2309             Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"
2310             L_TRAININT = 248 (F8h) (000000011111000)
2311             V_TRAIN = 10 (Ah) (0001010) "50 km/h"
2312             Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2313             M_MODE = 0 (0h) (0000) "Full Supervision"
2314             M_LEVEL = 3 (3h) (011) "Level 2"
2315 12:09:25.561550 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
                (PK21) - Train 6062544 - Dest:192.168.0.134
2316             00000011 00010100 00000010 11010101 00010000 10110010
                01000000 00010000 01111110 01100001 11101000 00010110
                00010000 00000000 00000000 00000011 10110101
                00010000 00000000 00011111 10000111 00101000 00001100
                01000110 01111111 11110000 10100011 10100100

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00001001 00001000 01010111 11111111 11110010 00010000
00000110 11010000 01010100 00001000 10101000
01100101 10110000 01111111 00101000 00010000 00001101
10100000 01010110 01000000 00000000 00001010
10000000 00100001 11011010 10111111 10000000 00101010
10000011 00011001 00000000 00000001 00000000
00110000 00011001 11000000 00010000 00010000 00101000
00000000 00011001 00101000 00110000 00010011
00101000 00100000 00011111 00111000 01111000 00000001
01010111 11111000
2317 NID_MESSAGE = 3 (3h) (00000011)
2318 L_MESSAGE = 80 (50h) (0001010000)
2319 T_TRAIN = 190071497 (B5442C9h)
(00001011010101000100001011001001)
2320 M_ACK = 0 (0h) (0) "No acknowledgement required"
2321 NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2322 NID_C = 2 (2h) (0000000010)
2323 NID_BG = 1011 (3F3h) (00001111110011)
2324 Packet 15 - TrackToTrain - Level 2/3 MA
2325 NID_PACKET = 15 (Fh) (00001111)
2326 Q_DIR = 1 (1h) (01) "Nominal"
2327 L_PACKET = 88 (58h) (0000001011000)
2328 Q_SCALE = 1 (1h) (01) "1 m scale"
2329 V_EMA = 0 (0h) (00000000) "0 km/h"
2330 T_EMA = 0 (0h) (0000000000)
2331 N_ITER = 0 (0h) (000000)
2332 L_ENDSECTION = 1898 (76Ah) (000011101101010)
"1898m"
2333 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
2334 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
2335 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
2336 D_DP = 0 (0h) (0000000000000000) "0m"
2337 V_RELEASEDP = 126 (7Eh) (11111110) "Use onboard
calculated release speed"
2338 Q_OVERLAP = 0 (0h) (0) "No overlap information"
2339 Packet 57 - TrackToTrain - MA Request Params
2340 NID_PACKET = 57 (39h) (00111001)
2341 Q_DIR = 1 (1h) (01) "Nominal"
2342 L_PACKET = 49 (31h) (0000000110001)
2343 T_MAR = 25 (19h) (00011001)
2344 T_TIMEOUIRQST = 1023 (3FFh) (1111111111) "No MA
request triggering with regards to this
function"
2345 T_CYCRQST = 10 (Ah) (00001010)
2346 Packet 58 - TrackToTrain - Pos Report Params
2347 NID_PACKET = 58 (3Ah) (00111010)

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2348         Q_DIR = 1 (1h) (01) "Nominal"
2349         L_PACKET = 72 (48h) (0000001001000)
2350         Q_SCALE = 1 (1h) (01) "1 m scale"
2351         T_CYCLOC = 10 (Ah) (00001010)
2352         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
           train has not to report cyclically its
           position"
2353         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
2354     N_ITER = 1 (1h) (00001)
2355         [0] D_LOC = 54 (36h) (000000000110110) "54m"
2356         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2357     Packet 5 - TrackToTrain - Linking
2358         NID_PACKET = 5 (5h) (00000101)
2359         Q_DIR = 1 (1h) (01) "Nominal"
2360         L_PACKET = 69 (45h) (0000001000101)
2361         Q_SCALE = 1 (1h) (01) "1 m scale"
2362         D_LINK = 1627 (65Bh) (000011001011011) "1627m"
2363     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
2364         NID_BG = 1017 (3F9h) (00001111111001)
2365         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
2366         Q_LINKREACTION = 2 (2h) (10) "No reaction"
2367         Q_LOCACCC = 1 (1h) (000001)
2368     N_ITER = 0 (0h) (00000)
2369     Packet 27 - TrackToTrain - International SSP
2370         NID_PACKET = 27 (1Bh) (00011011)
2371         Q_DIR = 1 (1h) (01) "Nominal"
2372         L_PACKET = 86 (56h) (0000001010110)
2373         Q_SCALE = 1 (1h) (01) "1 m scale"
2374         D_STATIC = 0 (0h) (000000000000000) "0m"
2375         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2376         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
2377     N_ITER = 0 (0h) (00000)
2378     N_ITER = 1 (1h) (00001)
2379         [0] D_STATIC = 1898 (76Ah) (000011101101010)
           "1898m"
2380         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
2381         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
2382     [0] N_ITER = 0 (0h) (00000)
2383     Packet 21 - TrackToTrain - Gradient Profile
2384         NID_PACKET = 21 (15h) (00010101)

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2385 Q_DIR = 1 (1h) (01) "Nominal"
2386 L_PACKET = 198 (C6h) (0000011000110)
2387 Q_SCALE = 1 (1h) (01) "1 m scale"
2388 D_GRADIENT = 0 (0h) (000000000000000) "0m"
2389 Q_GDIR = 1 (1h) (1) "Uphill"
2390 G_A = 0 (0h) (00000000) "0 o/oo"
2391 N_ITER = 6 (6h) (00110)
2392 [0] D_GRADIENT = 412 (19Ch) (000000110011100)
      "412m"
2393 [0] Q_GDIR = 0 (0h) (0) "Downhill"
2394 [0] G_A = 2 (2h) (00000010) "2 o/oo"
2395 [1] D_GRADIENT = 258 (102h) (000000100000010)
      "258m"
2396 [1] Q_GDIR = 1 (1h) (1) "Uphill"
2397 [1] G_A = 0 (0h) (00000000) "0 o/oo"
2398 [2] D_GRADIENT = 402 (192h) (000000110010010)
      "402m"
2399 [2] Q_GDIR = 1 (1h) (1) "Uphill"
2400 [2] G_A = 6 (6h) (00000110) "6 o/oo"
2401 [3] D_GRADIENT = 306 (132h) (000000100110010)
      "306m"
2402 [3] Q_GDIR = 1 (1h) (1) "Uphill"
2403 [3] G_A = 4 (4h) (00000100) "4 o/oo"
2404 [4] D_GRADIENT = 499 (1F3h) (000000111110011)
      "499m"
2405 [4] Q_GDIR = 1 (1h) (1) "Uphill"
2406 [4] G_A = 15 (Fh) (00001111) "15 o/oo"
2407 [5] D_GRADIENT = 21 (15h) (00000000010101) "21
      m"
2408 [5] Q_GDIR = 0 (0h) (0) "Downhill"
2409 [5] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"
2410 12:09:26.528959 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
2411 10000100 00000110 10000010 11010101 00010000 11001011
      00010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00001111 11001101 10110010
      00100010 10000000 00110010 00000000 01100100 10000000
      11111000 00010100 10000011
2412 NID_MESSAGE = 132 (84h) (10000100)
2413 L_MESSAGE = 26 (1Ah) (0000011010)
2414 T_TRAIN = 190071596 (B54432Ch)
      (00001011010101000100001100101100)
2415 NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
2416 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
2417 Packet 0 - TrainToTrack - Pos Report

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2418         NID_PACKET = 0 (0h) (00000000)
2419         L_PACKET = 129 (81h) (00000100000001)
2420         Q_SCALE = 0 (0h) (00) "10 cm scale"
2421     NID_LRBG = 33779 (83F3h) (0000000010000011111110011)
2422         NID_C = 2 (2h) (0000000010)
2423         NID_BG = 1011 (3F3h) (00001111110011)
2424         D_LRBG = 13892 (3644h) (011011001000100)
                "1389.2m"
2425         Q_DIRLRBG = 1 (1h) (01) "Nominal"
2426         Q_DLRBG = 1 (1h) (01) "Nominal"
2427         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2428         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
                "
2429     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"
2430         L_TRAININT = 248 (F8h) (000000011111000)
2431         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
2432         Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2433         M_MODE = 0 (0h) (0000) "Full Supervision"
2434     M_LEVEL = 3 (3h) (011) "Level 2"
2435 12:09:32.258118 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
                :192.168.0.132
2436     10000100 00000110 10000010 11010101 00010001 01011001
                00010111 00100000 01110100 01000100 00000000 00001000
                00010000 00000010 00001111 11001100 00000110
                10010010 10000000 00110010 00000000 01100100 10000000
                11111000 00000001 00000011
2437     NID_MESSAGE = 132 (84h) (10000100)
2438     L_MESSAGE = 26 (1Ah) (0000011010)
2439     T_TRAIN = 190072164 (B544564h)
                (000010110101010000100010101100100)
2440     NID_ENGINE = 6062545 (5C81D1h)
                (010111001000000111010001)
2441     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2442     Packet 0 - TrainToTrack - Pos Report
2443         NID_PACKET = 0 (0h) (00000000)
2444         L_PACKET = 129 (81h) (00000100000001)
2445         Q_SCALE = 0 (0h) (00) "10 cm scale"
2446     NID_LRBG = 33779 (83F3h) (0000000010000011111110011)
2447         NID_C = 2 (2h) (0000000010)
2448         NID_BG = 1011 (3F3h) (00001111110011)
2449         D_LRBG = 210 (D2h) (000000011010010) "21.0m"
2450         Q_DIRLRBG = 1 (1h) (01) "Nominal"
2451         Q_DLRBG = 1 (1h) (01) "Nominal"
2452         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2453         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
                "
2454     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by

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                integrity monitoring device"
2455                L_TRAININT = 248 (F8h) (000000011111000)
2456                V_TRAIN = 0 (0h) (0000000) "0 km/h"
2457                Q_DIRTRAIN = 2 (2h) (10) "Unknown"
2458                M_MODE = 0 (0h) (0000) "Full Supervision"
2459                M_LEVEL = 3 (3h) (011) "Level 2"
2460 12:09:32.281822 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
        - Train 6062545 - Dest:192.168.0.134
2461                00000011 00001101 10000010 11010101 00010001 01011001
                00000000 00010000 01111110 01100001 11101000 00010110
                00010000 00000000 00000000 00000000 00001101
                10010000 00000000 00011111 10000111 00101000 00001100
                01000110 01111111 11110000 10100011 10100100
                00000111 00001000 01010111 11111111 11110010 00000001
                10110100 00001010 11001000 00000000 00000001
                01010000 00000100 00000000 11011111 11110000 00000101
                01010000 00100111 00100000 00000000 00100000
                00000001 00000000 00110110 11111111
2462                NID_MESSAGE = 3 (3h) (00000011)
2463                L_MESSAGE = 54 (36h) (0000110110)
2464                T_TRAIN = 190072164 (B544564h)
                (00001011010101000100010101100100)
2465                M_ACK = 0 (0h) (0) "No acknowledgement required"
2466                NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2467                NID_C = 2 (2h) (0000000010)
2468                NID_BG = 1011 (3F3h) (00001111110011)
2469                Packet 15 - TrackToTrain - Level 2/3 MA
2470                NID_PACKET = 15 (Fh) (00001111)
2471                Q_DIR = 1 (1h) (01) "Nominal"
2472                L_PACKET = 88 (58h) (0000001011000)
2473                Q_SCALE = 1 (1h) (01) "1 m scale"
2474                V_EMA = 0 (0h) (0000000) "0 km/h"
2475                T_EMA = 0 (0h) (0000000000)
2476                N_ITER = 0 (0h) (00000)
2477                L_ENDSECTION = 27 (1Bh) (000000000011011) "27m"
2478                Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
                information"
2479                Q_ENDTIMER = 0 (0h) (0) "No End Section timer
                information"
2480                Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
                follow"
2481                D_DP = 0 (0h) (000000000000000) "0m"
2482                V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
                calculated release speed"
2483                Q_OVERLAP = 0 (0h) (0) "No overlap information"
2484                Packet 57 - TrackToTrain - MA Request Params
2485                NID_PACKET = 57 (39h) (00111001)
2486                Q_DIR = 1 (1h) (01) "Nominal"
2487                L_PACKET = 49 (31h) (0000000110001)

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2488         T_MAR = 25 (19h) (00011001)
2489         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
2490         T_CYCRQST = 10 (Ah) (00001010)
2491 Packet 58 - TrackToTrain - Pos Report Params
2492         NID_PACKET = 58 (3Ah) (00111010)
2493         Q_DIR = 1 (1h) (01) "Nominal"
2494         L_PACKET = 56 (38h) (0000000111000)
2495         Q_SCALE = 1 (1h) (01) "1 m scale"
2496         T_CYCLOC = 10 (Ah) (00001010)
2497         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
2498         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
2499         N_ITER = 0 (0h) (00000)
2500 Packet 27 - TrackToTrain - International SSP
2501         NID_PACKET = 27 (1Bh) (00011011)
2502         Q_DIR = 1 (1h) (01) "Nominal"
2503         L_PACKET = 86 (56h) (0000001010110)
2504         Q_SCALE = 1 (1h) (01) "1 m scale"
2505         D_STATIC = 0 (0h) (000000000000000) "0m"
2506         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2507         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
2508         N_ITER = 0 (0h) (00000)
2509         N_ITER = 1 (1h) (00001)
2510         [0] D_STATIC = 27 (1Bh) (000000000011011) "27m"
2511         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
2512         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
2513         [0] N_ITER = 0 (0h) (00000)
2514 Packet 21 - TrackToTrain - Gradient Profile
2515         NID_PACKET = 21 (15h) (00010101)
2516         Q_DIR = 1 (1h) (01) "Nominal"
2517         L_PACKET = 78 (4Eh) (0000001001110)
2518         Q_SCALE = 1 (1h) (01) "1 m scale"
2519         D_GRADIENT = 0 (0h) (000000000000000) "0m"
2520         Q_GDIR = 1 (1h) (1) "Uphill"
2521         G_A = 0 (0h) (00000000) "0 o/oo"
2522         N_ITER = 1 (1h) (00001)
2523         [0] D_GRADIENT = 27 (1Bh) (000000000011011) "27
           m"
2524         [0] Q_GDIR = 0 (0h) (0) "Downhill"
2525         [0] G_A = 255 (FFh) (11111111) "Non numerical

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value telling that the current gradient
description ends at D_GRADIENT(n)"
2526 12:09:33.191869 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
      :192.168.0.132
2527      10000100 00000110 10000010 11010101 00010001 01110001
          11010111 00100000 01110100 01000100 00000000 00001000
          00010000 00000010 00001111 11001100 00000110
          10010010 10000000 00110010 00000000 01100100 10000000
          11111000 00000001 00000011
2528      NID_MESSAGE = 132 (84h) (10000100)
2529      L_MESSAGE = 26 (1Ah) (0000011010)
2530      T_TRAIN = 190072263 (B5445C7h)
          (00001011010101000100010111000111)
2531      NID_ENGINE = 6062545 (5C81D1h)
          (010111001000000111010001)
2532      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
2533      Packet 0 - TrainToTrack - Pos Report
2534          NID_PACKET = 0 (0h) (00000000)
2535          L_PACKET = 129 (81h) (00000100000001)
2536          Q_SCALE = 0 (0h) (00) "10 cm scale"
2537      NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2538          NID_C = 2 (2h) (0000000010)
2539          NID_BG = 1011 (3F3h) (00001111110011)
2540          D_LRBG = 210 (D2h) (000000011010010) "21.0m"
2541          Q_DIRLRBG = 1 (1h) (01) "Nominal"
2542          Q_DLRBG = 1 (1h) (01) "Nominal"
2543          L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2544          L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
          "
2545          Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
2546          L_TRAININT = 248 (F8h) (000000011111000)
2547          V_TRAIN = 0 (0h) (0000000) "0 km/h"
2548          Q_DIRTRAIN = 2 (2h) (10) "Unknown"
2549          M_MODE = 0 (0h) (0000) "Full Supervision"
2550      M_LEVEL = 3 (3h) (011) "Level 2"
2551 12:09:36.545016 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
2552      10000100 00000110 10000010 11010101 00010001 11000101
          10010111 00100000 01110100 00000100 00000000 00001000
          00010000 00000010 00001111 11001101 11011101
          10001010 10000000 00110010 00000000 01100100 10000000
          11111000 00010100 10000011
2553      NID_MESSAGE = 132 (84h) (10000100)
2554      L_MESSAGE = 26 (1Ah) (0000011010)
2555      T_TRAIN = 190072598 (B544716h)
          (00001011010101000100011100010110)
2556      NID_ENGINE = 6062544 (5C81D0h)

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                (010111001000000111010000)
2557    Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2558    Packet 0 - TrainToTrack - Pos Report
2559                NID_PACKET = 0 (0h) (00000000)
2560                L_PACKET = 129 (81h) (00000100000001)
2561                Q_SCALE = 0 (0h) (00) "10 cm scale"
2562    NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2563                NID_C = 2 (2h) (0000000010)
2564                NID_BG = 1011 (3F3h) (00001111110011)
2565                D_LRBG = 15281 (3BB1h) (011101110110001)
                "1528.1m"
2566                Q_DIRLRBG = 1 (1h) (01) "Nominal"
2567                Q_DLRBG = 1 (1h) (01) "Nominal"
2568                L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2569                L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
                "
2570    Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"
2571                L_TRAININT = 248 (F8h) (000000011111000)
2572                V_TRAIN = 10 (Ah) (0001010) "50 km/h"
2573                Q_DIRTRAIN = 1 (1h) (01) "Nominal"
2574                M_MODE = 0 (0h) (0000) "Full Supervision"
2575    M_LEVEL = 3 (3h) (011) "Level 2"
2576    12:09:36.572832 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
                (PK21) - Train 6062544 - Dest:192.168.0.134
2577    00000011 00010100 00000010 11010101 00010001 11000101
                10000000 00010000 01111110 01100001 11101000 00010110
                00010000 00000000 00000000 00000011 10110101
                00010000 00000000 00011111 10000111 00101000 00001100
                01000110 01111111 11110000 10100011 10100100
                00001001 00001000 01010111 11111111 11110010 00010000
                00000110 11010000 01010100 00001000 10101000
                01100101 10110000 01111111 00101000 00010000 00001101
                10100000 01010110 01000000 00000000 00001010
                10000000 00100001 11011010 10111111 10000000 00101010
                10000011 00011001 00000000 00000001 00000000
                00110000 00011001 11000000 00010000 00010000 00101000
                00000000 00011001 00101000 00110000 00010011
                00101000 00100000 00011111 00111000 01111000 00000001
                01010111 11111000
2578    NID_MESSAGE = 3 (3h) (00000011)
2579    L_MESSAGE = 80 (50h) (0001010000)
2580    T_TRAIN = 190072598 (B544716h)
                (00001011010101000100011100010110)
2581    M_ACK = 0 (0h) (0) "No acknowledgement required"
2582    NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2583                NID_C = 2 (2h) (0000000010)
2584                NID_BG = 1011 (3F3h) (00001111110011)

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2585 Packet 15 - TrackToTrain - Level 2/3 MA
2586 NID_PACKET = 15 (Fh) (00001111)
2587 Q_DIR = 1 (1h) (01) "Nominal"
2588 L_PACKET = 88 (58h) (0000001011000)
2589 Q_SCALE = 1 (1h) (01) "1 m scale"
2590 V_EMA = 0 (0h) (0000000) "0 km/h"
2591 T_EMA = 0 (0h) (0000000000)
2592 N_ITER = 0 (0h) (00000)
2593 L_ENDSECTION = 1898 (76Ah) (000011101101010)
      "1898m"
2594 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"
2595 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
2596 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
      follow"
2597 D_DP = 0 (0h) (000000000000000) "0m"
2598 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
      calculated release speed"
2599 Q_OVERLAP = 0 (0h) (0) "No overlap information"
2600 Packet 57 - TrackToTrain - MA Request Params
2601 NID_PACKET = 57 (39h) (00111001)
2602 Q_DIR = 1 (1h) (01) "Nominal"
2603 L_PACKET = 49 (31h) (0000000110001)
2604 T_MAR = 25 (19h) (00011001)
2605 T_TIMEOURQST = 1023 (3FFh) (1111111111) "No MA
      request triggering with regards to this
      function"
2606 T_CYCRQST = 10 (Ah) (00001010)
2607 Packet 58 - TrackToTrain - Pos Report Params
2608 NID_PACKET = 58 (3Ah) (00111010)
2609 Q_DIR = 1 (1h) (01) "Nominal"
2610 L_PACKET = 72 (48h) (0000001001000)
2611 Q_SCALE = 1 (1h) (01) "1 m scale"
2612 T_CYCLOC = 10 (Ah) (00001010)
2613 D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
      train has not to report cyclically its
      position"
2614 M_LOC = 1 (1h) (001) "Every LRBG compliant
      balise group"
2615 N_ITER = 1 (1h) (00001)
2616 [0] D_LOC = 54 (36h) (000000000110110) "54m"
2617 [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
2618 Packet 5 - TrackToTrain - Linking
2619 NID_PACKET = 5 (5h) (00000101)
2620 Q_DIR = 1 (1h) (01) "Nominal"
2621 L_PACKET = 69 (45h) (0000001000101)
2622 Q_SCALE = 1 (1h) (01) "1 m scale"
2623 D_LINK = 1627 (65Bh) (000011001011011) "1627m"

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C. Simulation Traces

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2624     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
          administration, no NID_C follows"
2625     NID_BG = 1017 (3F9h) (00001111111001)
2626     Q_LINKORIENTATION = 0 (0h) (0) "The balise
          group is seen by the train in reverse
          direction"
2627     Q_LINKREACTION = 2 (2h) (10) "No reaction"
2628     Q_LOCACC = 1 (1h) (000001)
2629     N_ITER = 0 (0h) (00000)
2630     Packet 27 - TrackToTrain - International SSP
2631     NID_PACKET = 27 (1Bh) (00011011)
2632     Q_DIR = 1 (1h) (01) "Nominal"
2633     L_PACKET = 86 (56h) (0000001010110)
2634     Q_SCALE = 1 (1h) (01) "1 m scale"
2635     D_STATIC = 0 (0h) (0000000000000000) "0m"
2636     V_STATIC = 10 (Ah) (0001010) "50 km/h"
2637     Q_FRONT = 1 (1h) (1) "No train length delay on
          validity end point of profile element"
2638     N_ITER = 0 (0h) (00000)
2639     N_ITER = 1 (1h) (00001)
2640     [0] D_STATIC = 1898 (76Ah) (000011101101010)
          "1898m"
2641     [0] V_STATIC = 127 (7Fh) (1111111) "Non
          numerical value telling that the static
          speed profile description ends at D_STATIC(n
          )"
2642     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
          validity end point of profile element"
2643     [0] N_ITER = 0 (0h) (00000)
2644     Packet 21 - TrackToTrain - Gradient Profile
2645     NID_PACKET = 21 (15h) (00010101)
2646     Q_DIR = 1 (1h) (01) "Nominal"
2647     L_PACKET = 198 (C6h) (0000011000110)
2648     Q_SCALE = 1 (1h) (01) "1 m scale"
2649     D_GRADIENT = 0 (0h) (0000000000000000) "0m"
2650     Q_GDIR = 1 (1h) (1) "Uphill"
2651     G_A = 0 (0h) (00000000) "0 o/oo"
2652     N_ITER = 6 (6h) (00110)
2653     [0] D_GRADIENT = 412 (19Ch) (000000110011100)
          "412m"
2654     [0] Q_GDIR = 0 (0h) (0) "Downhill"
2655     [0] G_A = 2 (2h) (00000010) "2 o/oo"
2656     [1] D_GRADIENT = 258 (102h) (000000100000010)
          "258m"
2657     [1] Q_GDIR = 1 (1h) (1) "Uphill"
2658     [1] G_A = 0 (0h) (00000000) "0 o/oo"
2659     [2] D_GRADIENT = 402 (192h) (000000110010010)
          "402m"
2660     [2] Q_GDIR = 1 (1h) (1) "Uphill"

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2661 [2] G_A = 6 (6h) (00000110) "6 o/oo"
2662 [3] D_GRADIENT = 306 (132h) (000000100110010)
      "306m"
2663 [3] Q_GDIR = 1 (1h) (1) "Uphill"
2664 [3] G_A = 4 (4h) (00000100) "4 o/oo"
2665 [4] D_GRADIENT = 499 (1F3h) (000000111110011)
      "499m"
2666 [4] Q_GDIR = 1 (1h) (1) "Uphill"
2667 [4] G_A = 15 (Fh) (00001111) "15 o/oo"
2668 [5] D_GRADIENT = 21 (15h) (000000000010101) "21
      m"
2669 [5] Q_GDIR = 0 (0h) (0) "Downhill"
2670 [5] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"
2671 12:09:37.523569 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
2672 10000100 00000110 10000010 11010101 00010001 11011110
      00010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00001111 11001101 11100001
      11011010 10000000 00110010 00000000 01100100 10000000
      11111000 00010100 10000011
2673 NID_MESSAGE = 132 (84h) (10000100)
2674 L_MESSAGE = 26 (1Ah) (0000011010)
2675 T_TRAIN = 190072696 (B544778h)
      (00001011010101000100011101111000)
2676 NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
2677 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
2678 Packet 0 - TrainToTrack - Pos Report
2679 NID_PACKET = 0 (0h) (00000000)
2680 L_PACKET = 129 (81h) (0000010000001)
2681 Q_SCALE = 0 (0h) (00) "10 cm scale"
2682 NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2683 NID_C = 2 (2h) (0000000010)
2684 NID_BG = 1011 (3F3h) (00001111110011)
2685 D_LRBG = 15419 (3C3Bh) (011110000111011)
      "1541.9m"
2686 Q_DIRLRBG = 1 (1h) (01) "Nominal"
2687 Q_DLRBG = 1 (1h) (01) "Nominal"
2688 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2689 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
      "
2690 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
2691 L_TRAININT = 248 (F8h) (000000011111000)
2692 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
2693 Q_DIRTRAIN = 1 (1h) (01) "Nominal"

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2694             M_MODE = 0 (0h) (0000) "Full Supervision"
2695             M_LEVEL = 3 (3h) (011) "Level 2"
2696 12:09:43.203483 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
2697             10000100 00000110 10000010 11010101 00010010 01101100
                00010111 00100000 01110100 01000100 00000000 00001000
                00010000 00000010 00001111 11001100 00000110
                10010010 10000000 00110010 00000000 01100100 10000000
                11111000 00000001 00000011
2698             NID_MESSAGE = 132 (84h) (10000100)
2699             L_MESSAGE = 26 (1Ah) (0000011010)
2700             T_TRAIN = 190073264 (B5449B0h)
                (000010110101010000100100110110000)
2701             NID_ENGINE = 6062545 (5C81D1h)
                (010111001000000111010001)
2702             Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2703             Packet 0 - TrainToTrack - Pos Report
2704             NID_PACKET = 0 (0h) (00000000)
2705             L_PACKET = 129 (81h) (00000100000001)
2706             Q_SCALE = 0 (0h) (00) "10 cm scale"
2707             NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2708             NID_C = 2 (2h) (0000000010)
2709             NID_BG = 1011 (3F3h) (00001111110011)
2710             D_LRBG = 210 (D2h) (000000011010010) "21.0m"
2711             Q_DIRLRBG = 1 (1h) (01) "Nominal"
2712             Q_DLRBG = 1 (1h) (01) "Nominal"
2713             L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2714             L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
                "
2715             Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"
2716             L_TRAININT = 248 (F8h) (000000011111000)
2717             V_TRAIN = 0 (0h) (0000000) "0 km/h"
2718             Q_DIRTRAIN = 2 (2h) (10) "Unknown"
2719             M_MODE = 0 (0h) (0000) "Full Supervision"
2720             M_LEVEL = 3 (3h) (011) "Level 2"
2721 12:09:43.232908 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
           - Train 6062545 - Dest:192.168.0.134
2722             00000011 00001101 10000010 11010101 00010010 01101100
                00000000 00010000 01111110 01100001 11101000 00010110
                00010000 00000000 00000000 00000000 00001101
                10010000 00000000 00011111 10000111 00101000 00001100
                01000110 01111111 11110000 10100011 10100100
                00000111 00001000 01010111 11111111 11110010 00000001
                10110100 00001010 11001000 00000000 00000001
                01010000 00000100 00000000 11011111 11110000 00000101
                01010000 00100111 00100000 00000000 00100000
                00000001 00000000 00110110 11111111

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2723     NID_MESSAGE = 3 (3h) (00000011)
2724     L_MESSAGE = 54 (36h) (0000110110)
2725     T_TRAIN = 190073264 (B5449B0h)
           (00001011010101000100100110110000)
2726     M_ACK = 0 (0h) (0) "No acknowledgement required"
2727     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2728         NID_C = 2 (2h) (0000000010)
2729         NID_BG = 1011 (3F3h) (00001111110011)
2730     Packet 15 - TrackToTrain - Level 2/3 MA
2731         NID_PACKET = 15 (Fh) (00001111)
2732         Q_DIR = 1 (1h) (01) "Nominal"
2733         L_PACKET = 88 (58h) (0000001011000)
2734         Q_SCALE = 1 (1h) (01) "1 m scale"
2735         V_EMA = 0 (0h) (00000000) "0 km/h"
2736         T_EMA = 0 (0h) (0000000000)
2737     N_ITER = 0 (0h) (00000)
2738         L_ENDSECTION = 27 (1Bh) (000000000011011) "27m"
2739     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
2740     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
2741     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
2742         D_DP = 0 (0h) (0000000000000000) "0m"
2743         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
2744     Q_OVERLAP = 0 (0h) (0) "No overlap information"
2745     Packet 57 - TrackToTrain - MA Request Params
2746         NID_PACKET = 57 (39h) (00111001)
2747         Q_DIR = 1 (1h) (01) "Nominal"
2748         L_PACKET = 49 (31h) (0000000110001)
2749         T_MAR = 25 (19h) (00011001)
2750         T_TIMEOURQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
2751         T_CYCRQST = 10 (Ah) (00001010)
2752     Packet 58 - TrackToTrain - Pos Report Params
2753         NID_PACKET = 58 (3Ah) (00111010)
2754         Q_DIR = 1 (1h) (01) "Nominal"
2755         L_PACKET = 56 (38h) (0000000111000)
2756         Q_SCALE = 1 (1h) (01) "1 m scale"
2757         T_CYCLOC = 10 (Ah) (00001010)
2758         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
2759         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
2760     N_ITER = 0 (0h) (00000)
2761     Packet 27 - TrackToTrain - International SSP

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2762         NID_PACKET = 27 (1Bh) (00011011)
2763         Q_DIR = 1 (1h) (01) "Nominal"
2764         L_PACKET = 86 (56h) (0000001010110)
2765         Q_SCALE = 1 (1h) (01) "1 m scale"
2766         D_STATIC = 0 (0h) (0000000000000000) "0m"
2767         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2768         Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
2769     N_ITER = 0 (0h) (00000)
2770     N_ITER = 1 (1h) (00001)
2771         [0] D_STATIC = 27 (1Bh) (000000000011011) "27m"
2772         [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
2773         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
2774     [0] N_ITER = 0 (0h) (00000)
2775     Packet 21 - TrackToTrain - Gradient Profile
2776         NID_PACKET = 21 (15h) (00010101)
2777         Q_DIR = 1 (1h) (01) "Nominal"
2778         L_PACKET = 78 (4Eh) (0000001001110)
2779         Q_SCALE = 1 (1h) (01) "1 m scale"
2780         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
2781         Q_GDIR = 1 (1h) (1) "Uphill"
2782         G_A = 0 (0h) (00000000) "0 o/oo"
2783     N_ITER = 1 (1h) (00001)
2784         [0] D_GRADIENT = 27 (1Bh) (000000000011011) "27
                m"
2785         [0] Q_GDIR = 0 (0h) (0) "Downhill"
2786         [0] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2787 12:09:44.189365 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
                :192.168.0.132
2788     10000100 00000110 10000010 11010101 00010010 10000100
                10010111 00100000 01110100 01000100 00000000 00001000
                00010000 00000010 00001111 11001100 00000110
                10010010 10000000 00110010 00000000 01100100 10000000
                11111000 00000001 00000011
2789     NID_MESSAGE = 132 (84h) (10000100)
2790     L_MESSAGE = 26 (1Ah) (0000011010)
2791     T_TRAIN = 190073362 (B544A12h)
                (000010110101010000100101000010010)
2792     NID_ENGINE = 6062545 (5C81D1h)
                (010111001000000111010001)
2793     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2794     Packet 0 - TrainToTrack - Pos Report

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2795         NID_PACKET = 0 (0h) (00000000)
2796         L_PACKET = 129 (81h) (00000100000001)
2797         Q_SCALE = 0 (0h) (00) "10 cm scale"
2798     NID_LRBG = 33779 (83F3h) (0000000010000011111110011)
2799         NID_C = 2 (2h) (0000000010)
2800         NID_BG = 1011 (3F3h) (00001111110011)
2801         D_LRBG = 210 (D2h) (000000011010010) "21.0m"
2802         Q_DIRLRBG = 1 (1h) (01) "Nominal"
2803         Q_DLRBG = 1 (1h) (01) "Nominal"
2804         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2805         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
                "
2806     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"
2807         L_TRAININT = 248 (F8h) (000000011111000)
2808         V_TRAIN = 0 (0h) (0000000) "0 km/h"
2809         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
2810         M_MODE = 0 (0h) (0000) "Full Supervision"
2811     M_LEVEL = 3 (3h) (011) "Level 2"
2812 12:09:47.545569 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
                :192.168.0.132
2813     10000100 00000110 10000010 11010101 00010010 11011000
                10010111 00100000 01110100 00000100 00000000 00001000
                00010000 00000010 00001111 11100100 00010000
                11010000 00000000 00110010 00000000 01100100 10000000
                11111000 00010100 00000011
2814     NID_MESSAGE = 132 (84h) (10000100)
2815     L_MESSAGE = 26 (1Ah) (0000011010)
2816     T_TRAIN = 190073698 (B544B62h)
                (00001011010101000100101101100010)
2817     NID_ENGINE = 6062544 (5C81D0h)
                (010111001000000111010000)
2818     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2819     Packet 0 - TrainToTrack - Pos Report
2820         NID_PACKET = 0 (0h) (00000000)
2821         L_PACKET = 129 (81h) (00000100000001)
2822         Q_SCALE = 0 (0h) (00) "10 cm scale"
2823     NID_LRBG = 33785 (83F9h) (000000001000001111111001)
2824         NID_C = 2 (2h) (0000000010)
2825         NID_BG = 1017 (3F9h) (00001111111001)
2826         D_LRBG = 538 (21Ah) (000001000011010) "53.8m"
2827         Q_DIRLRBG = 0 (0h) (00) "Reverse"
2828         Q_DLRBG = 0 (0h) (00) "Reverse"
2829         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2830         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
                "
2831     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"

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2832         L_TRAININT = 248 (F8h) (000000011111000)
2833         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
2834         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
2835         M_MODE = 0 (0h) (0000) "Full Supervision"
2836         M_LEVEL = 3 (3h) (011) "Level 2"
2837 12:09:47.574409 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
      - Train 6062544 - Dest:192.168.0.134
2838         00000011 00001110 01000010 11010101 00010010 11011000
          10000000 00010000 01111111 00100001 11100000 00010110
          00010000 00000000 00000000 00000000 10000111
          10010000 00000000 00011111 10000111 00100000 00001100
          01000110 01111111 11110000 10100011 10100000
          00000111 00001000 01010111 11111111 11110010 00000001
          10110000 00001010 11001000 00000000 00000001
          01010000 00000100 00001000 01111111 11110000 00000101
          01000000 00110011 00100000 00000000 00100000
          10000010 00000001 11110101 00001111 00000000 00101010
          11111111
2839         NID_MESSAGE = 3 (3h) (00000011)
2840         L_MESSAGE = 57 (39h) (0000111001)
2841         T_TRAIN = 190073698 (B544B62h)
          (000010110101010000100101101100010)
2842         M_ACK = 0 (0h) (0) "No acknowledgement required"
2843         NID_LRBG = 33785 (83F9h) (000000001000001111111001)
2844         NID_C = 2 (2h) (0000000010)
2845         NID_BG = 1017 (3F9h) (00001111111001)
2846 Packet 15 - TrackToTrain - Level 2/3 MA
2847         NID_PACKET = 15 (Fh) (00001111)
2848         Q_DIR = 0 (0h) (00) "Reverse"
2849         L_PACKET = 88 (58h) (0000001011000)
2850         Q_SCALE = 1 (1h) (01) "1 m scale"
2851         V_EMA = 0 (0h) (0000000) "0 km/h"
2852         T_EMA = 0 (0h) (0000000000)
2853         N_ITER = 0 (0h) (00000)
2854         L_ENDSECTION = 271 (10Fh) (000000100001111)
          "271m"
2855         Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
          information"
2856         Q_ENDTIMER = 0 (0h) (0) "No End Section timer
          information"
2857         Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
          follow"
2858         D_DP = 0 (0h) (000000000000000) "0m"
2859         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
          calculated release speed"
2860         Q_OVERLAP = 0 (0h) (0) "No overlap information"
2861 Packet 57 - TrackToTrain - MA Request Params
2862         NID_PACKET = 57 (39h) (00111001)
2863         Q_DIR = 0 (0h) (00) "Reverse"

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2864         L_PACKET = 49 (31h) (0000000110001)
2865         T_MAR = 25 (19h) (00011001)
2866         T_TIMEOUIRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
2867         T_CYCRQST = 10 (Ah) (00001010)
2868     Packet 58 - TrackToTrain - Pos Report Params
2869         NID_PACKET = 58 (3Ah) (00111010)
2870         Q_DIR = 0 (0h) (00) "Reverse"
2871         L_PACKET = 56 (38h) (0000000111000)
2872         Q_SCALE = 1 (1h) (01) "1 m scale"
2873         T_CYCLOC = 10 (Ah) (00001010)
2874         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
           train has not to report cyclically its
           position"
2875         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
2876     N_ITER = 0 (0h) (00000)
2877     Packet 27 - TrackToTrain - International SSP
2878         NID_PACKET = 27 (1Bh) (00011011)
2879         Q_DIR = 0 (0h) (00) "Reverse"
2880         L_PACKET = 86 (56h) (0000001010110)
2881         Q_SCALE = 1 (1h) (01) "1 m scale"
2882         D_STATIC = 0 (0h) (000000000000000) "0m"
2883         V_STATIC = 10 (Ah) (0001010) "50 km/h"
2884         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
2885     N_ITER = 0 (0h) (00000)
2886     N_ITER = 1 (1h) (00001)
2887         [0] D_STATIC = 271 (10Fh) (000000100001111)
           "271m"
2888         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
2889         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
2890     [0] N_ITER = 0 (0h) (00000)
2891     Packet 21 - TrackToTrain - Gradient Profile
2892         NID_PACKET = 21 (15h) (00010101)
2893         Q_DIR = 0 (0h) (00) "Reverse"
2894         L_PACKET = 102 (66h) (0000001100110)
2895         Q_SCALE = 1 (1h) (01) "1 m scale"
2896         D_GRADIENT = 0 (0h) (000000000000000) "0m"
2897         Q_GDIR = 1 (1h) (1) "Uphill"
2898         G_A = 4 (4h) (00000100) "4 o/oo"
2899     N_ITER = 2 (2h) (00010)
2900         [0] D_GRADIENT = 250 (FAh) (000000011111010)
           "250m"

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2901          [0] Q_GDIR = 1 (1h) (1) "Uphill"
2902          [0] G_A = 15 (Fh) (00001111) "15 o/oo"
2903          [1] D_GRADIENT = 21 (15h) (000000000010101) "21
                m"
2904          [1] Q_GDIR = 0 (0h) (0) "Downhill"
2905          [1] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
2906 12:09:48.525263 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
                :192.168.0.132
2907          10000100 00000110 10000010 11010101 00010010 11110001
                00010111 00100000 01110100 00000100 00000000 00001000
                00010000 00000010 00001111 11100100 00010101
                00101000 00000000 00110010 00000000 01100100 10000000
                11111000 00010100 00000011
2908          NID_MESSAGE = 132 (84h) (10000100)
2909          L_MESSAGE = 26 (1Ah) (0000011010)
2910          T_TRAIN = 190073796 (B544BC4h)
                (000010110101010000100101111000100)
2911          NID_ENGINE = 6062544 (5C81D0h)
                (010111001000000111010000)
2912          Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
2913          Packet 0 - TrainToTrack - Pos Report
2914          NID_PACKET = 0 (0h) (00000000)
2915          L_PACKET = 129 (81h) (00000100000001)
2916          Q_SCALE = 0 (0h) (00) "10 cm scale"
2917          NID_LRBG = 33785 (83F9h) (000000001000001111111001)
2918          NID_C = 2 (2h) (0000000010)
2919          NID_BG = 1017 (3F9h) (00001111111001)
2920          D_LRBG = 677 (2A5h) (000001010100101) "67.7m"
2921          Q_DIRLRBG = 0 (0h) (00) "Reverse"
2922          Q_DLRBG = 0 (0h) (00) "Reverse"
2923          L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2924          L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
                "
2925          Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"
2926          L_TRAININT = 248 (F8h) (000000011111000)
2927          V_TRAIN = 10 (Ah) (0001010) "50 km/h"
2928          Q_DIRTRAIN = 0 (0h) (00) "Reverse"
2929          M_MODE = 0 (0h) (0000) "Full Supervision"
2930          M_LEVEL = 3 (3h) (011) "Level 2"
2931 12:09:54.209437 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
                :192.168.0.132
2932          10000100 00000110 10000010 11010101 00010011 01111111
                00010111 00100000 01110100 01000100 00000000 00001000
                00010000 00000010 00001111 11001100 00000110
                10010010 10000000 00110010 00000000 01100100 10000000

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11111000 00000001 00000011
2933 NID_MESSAGE = 132 (84h) (10000100)
2934 L_MESSAGE = 26 (1Ah) (0000011010)
2935 T_TRAIN = 190074364 (B544DFCh)
      (00001011010101000100110111111100)
2936 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
2937 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
2938 Packet 0 - TrainToTrack - Pos Report
2939 NID_PACKET = 0 (0h) (00000000)
2940 L_PACKET = 129 (81h) (0000010000001)
2941 Q_SCALE = 0 (0h) (00) "10 cm scale"
2942 NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2943 NID_C = 2 (2h) (0000000010)
2944 NID_BG = 1011 (3F3h) (00001111110011)
2945 D_LRBG = 210 (D2h) (000000011010010) "21.0m"
2946 Q_DIRLRBG = 1 (1h) (01) "Nominal"
2947 Q_DLRBG = 1 (1h) (01) "Nominal"
2948 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
2949 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
2950 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
2951 L_TRAININT = 248 (F8h) (000000011111000)
2952 V_TRAIN = 0 (0h) (0000000) "0 km/h"
2953 Q_DIRTRAIN = 2 (2h) (10) "Unknown"
2954 M_MODE = 0 (0h) (0000) "Full Supervision"
2955 M_LEVEL = 3 (3h) (011) "Level 2"
2956 12:09:54.232934 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
      - Train 6062545 - Dest:192.168.0.134
2957 00000011 00001101 10000010 11010101 00010011 01111111
      00000000 00010000 01111110 01100001 11101000 00010110
      00010000 00000000 00000000 00000000 00001101
      10010000 00000000 00011111 10000111 00101000 00001100
      01000110 01111111 11110000 10100011 10100100
      00000111 00001000 01010111 11111111 11110010 00000001
      10110100 00001010 11001000 00000000 00000001
      01010000 00000100 00000000 11011111 11110000 00000101
      01010000 00100111 00100000 00000000 00100000
      00000001 00000000 00110110 11111111
2958 NID_MESSAGE = 3 (3h) (00000011)
2959 L_MESSAGE = 54 (36h) (0000110110)
2960 T_TRAIN = 190074364 (B544DFCh)
      (00001011010101000100110111111100)
2961 M_ACK = 0 (0h) (0) "No acknowledgement required"
2962 NID_LRBG = 33779 (83F3h) (000000001000001111110011)
2963 NID_C = 2 (2h) (0000000010)
2964 NID_BG = 1011 (3F3h) (00001111110011)

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C. Simulation Traces

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2965 Packet 15 - TrackToTrain - Level 2/3 MA
2966     NID_PACKET = 15 (Fh) (00001111)
2967     Q_DIR = 1 (1h) (01) "Nominal"
2968     L_PACKET = 88 (58h) (0000001011000)
2969     Q_SCALE = 1 (1h) (01) "1 m scale"
2970     V_EMA = 0 (0h) (0000000) "0 km/h"
2971     T_EMA = 0 (0h) (0000000000)
2972     N_ITER = 0 (0h) (00000)
2973     L_ENDSECTION = 27 (1Bh) (000000000011011) "27m"
2974     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
        information"
2975     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
        information"
2976     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
        follow"
2977     D_DP = 0 (0h) (000000000000000) "0m"
2978     V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
        calculated release speed"
2979     Q_OVERLAP = 0 (0h) (0) "No overlap information"
2980 Packet 57 - TrackToTrain - MA Request Params
2981     NID_PACKET = 57 (39h) (00111001)
2982     Q_DIR = 1 (1h) (01) "Nominal"
2983     L_PACKET = 49 (31h) (0000000110001)
2984     T_MAR = 25 (19h) (00011001)
2985     T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
        request triggering with regards to this
        function"
2986     T_CYCRQST = 10 (Ah) (00001010)
2987 Packet 58 - TrackToTrain - Pos Report Params
2988     NID_PACKET = 58 (3Ah) (00111010)
2989     Q_DIR = 1 (1h) (01) "Nominal"
2990     L_PACKET = 56 (38h) (0000000111000)
2991     Q_SCALE = 1 (1h) (01) "1 m scale"
2992     T_CYCLOC = 10 (Ah) (00001010)
2993     D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
        train has not to report cyclically its
        position"
2994     M_LOC = 1 (1h) (001) "Every LRBG compliant
        balise group"
2995     N_ITER = 0 (0h) (00000)
2996 Packet 27 - TrackToTrain - International SSP
2997     NID_PACKET = 27 (1Bh) (00011011)
2998     Q_DIR = 1 (1h) (01) "Nominal"
2999     L_PACKET = 86 (56h) (0000001010110)
3000     Q_SCALE = 1 (1h) (01) "1 m scale"
3001     D_STATIC = 0 (0h) (000000000000000) "0m"
3002     V_STATIC = 10 (Ah) (0001010) "50 km/h"
3003     Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
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3004     N_ITER = 0 (0h) (00000)
3005     N_ITER = 1 (1h) (00001)
3006         [0] D_STATIC = 27 (1Bh) (000000000011011) "27m"
3007         [0] V_STATIC = 127 (7Fh) (1111111) "Non
            numerical value telling that the static
            speed profile description ends at D_STATIC(n
            )"
3008         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
            validity end point of profile element"
3009     [0] N_ITER = 0 (0h) (00000)
3010     Packet 21 - TrackToTrain - Gradient Profile
3011         NID_PACKET = 21 (15h) (00010101)
3012         Q_DIR = 1 (1h) (01) "Nominal"
3013         L_PACKET = 78 (4Eh) (0000001001110)
3014         Q_SCALE = 1 (1h) (01) "1 m scale"
3015         D_GRADIENT = 0 (0h) (000000000000000) "0m"
3016         Q_GDIR = 1 (1h) (1) "Uphill"
3017         G_A = 0 (0h) (00000000) "0 o/oo"
3018     N_ITER = 1 (1h) (00001)
3019         [0] D_GRADIENT = 27 (1Bh) (000000000011011) "27
            m"
3020         [0] Q_GDIR = 0 (0h) (0) "Downhill"
3021         [0] G_A = 255 (FFh) (11111111) "Non numerical
            value telling that the current gradient
            description ends at D_GRADIENT(n)"
3022 12:09:55.203837 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
            :192.168.0.132
3023     10000100 00000110 10000010 11010101 00010011 10011000
            00010111 00100000 01110100 01000100 00000000 00001000
            00010000 00000010 00001111 11001100 00000110
            10010010 10000000 00110010 00000000 01100100 10000000
            11111000 00000001 00000011
3024     NID_MESSAGE = 132 (84h) (10000100)
3025     L_MESSAGE = 26 (1Ah) (0000011010)
3026     T_TRAIN = 190074464 (B544E60h)
            (00001011010101000100111001100000)
3027     NID_ENGINE = 6062545 (5C81D1h)
            (010111001000000111010001)
3028     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
            the perturbation location reached"
3029     Packet 0 - TrainToTrack - Pos Report
3030         NID_PACKET = 0 (0h) (00000000)
3031         L_PACKET = 129 (81h) (00000100000001)
3032         Q_SCALE = 0 (0h) (00) "10 cm scale"
3033     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
3034         NID_C = 2 (2h) (0000000010)
3035         NID_BG = 1011 (3F3h) (00001111110011)
3036         D_LRBG = 210 (D2h) (000000011010010) "21.0m"
3037         Q_DIRLRBG = 1 (1h) (01) "Nominal"

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C. Simulation Traces

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3038         Q_DLRBG = 1 (1h) (01) "Nominal"
3039         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3040         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
           "
3041     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
           integrity monitoring device"
3042         L_TRAININT = 248 (F8h) (000000011111000)
3043         V_TRAIN = 0 (0h) (0000000) "0 km/h"
3044         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
3045         M_MODE = 0 (0h) (0000) "Full Supervision"
3046     M_LEVEL = 3 (3h) (011) "Level 2"
3047 12:09:55.397024 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
           (PK21) - Train 6062544 - Dest:192.168.0.134
3048     00000011 00010011 00000010 11010101 00010011 10011011
           00000000 00010000 01111111 00100001 11100000 00010110
           00010000 00000000 00000000 00000010 00111010
           00010000 00000000 00011111 10000111 00100000 00001100
           01000110 01111111 11110000 10100011 10100000
           00001001 00001000 01010111 11111111 11110010 00010000
           00100101 01010000 01010000 00001101 10001000
           00011010 01100000 01111110 11101000 00010000 10000010
           01111010 00000111 11101010 10000001 00011011
           00000000 10101100 10000000 00000000 00010101 00000000
           01000010 00111010 01111111 00000000 01010100
           00000011 11110010 00000000 00000010 00001000 00110000
           00011111 01010000 11110000 01100000 10110000
           01010000 00001110 10101111 11110000
3049     NID_MESSAGE = 3 (3h) (00000011)
3050     L_MESSAGE = 76 (4Ch) (0001001100)
3051     T_TRAIN = 190074476 (B544E6Ch)
           (000010110101010000100111001101100)
3052     M_ACK = 0 (0h) (0) "No acknowledgement required"
3053     NID_LRBG = 33785 (83F9h) (000000001000001111111001)
3054         NID_C = 2 (2h) (0000000010)
3055         NID_BG = 1017 (3F9h) (00001111111001)
3056     Packet 15 - TrackToTrain - Level 2/3 MA
3057         NID_PACKET = 15 (Fh) (00001111)
3058         Q_DIR = 0 (0h) (00) "Reverse"
3059         L_PACKET = 88 (58h) (0000001011000)
3060         Q_SCALE = 1 (1h) (01) "1 m scale"
3061         V_EMA = 0 (0h) (0000000) "0 km/h"
3062         T_EMA = 0 (0h) (0000000000)
3063     N_ITER = 0 (0h) (00000)
3064         L_ENDSECTION = 1140 (474h) (000010001110100)
           "1140m"
3065     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
3066     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"

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3067     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
        follow"
3068         D_DP = 0 (0h) (0000000000000000) "0m"
3069         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
        calculated release speed"
3070     Q_OVERLAP = 0 (0h) (0) "No overlap information"
3071     Packet 57 - TrackToTrain - MA Request Params
3072         NID_PACKET = 57 (39h) (00111001)
3073         Q_DIR = 0 (0h) (00) "Reverse"
3074         L_PACKET = 49 (31h) (0000000110001)
3075         T_MAR = 25 (19h) (00011001)
3076         T_TIMEOUSRQST = 1023 (3FFh) (1111111111) "No MA
        request triggering with regards to this
        function"
3077         T_CYCRQST = 10 (Ah) (00001010)
3078     Packet 58 - TrackToTrain - Pos Report Params
3079         NID_PACKET = 58 (3Ah) (00111010)
3080         Q_DIR = 0 (0h) (00) "Reverse"
3081         L_PACKET = 72 (48h) (0000001001000)
3082         Q_SCALE = 1 (1h) (01) "1 m scale"
3083         T_CYCLOC = 10 (Ah) (00001010)
3084         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
        train has not to report cyclically its
        position"
3085         M_LOC = 1 (1h) (001) "Every LRBG compliant
        balise group"
3086     N_ITER = 1 (1h) (00001)
3087         [0] D_LOC = 298 (12Ah) (000000100101010) "298m"
3088         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
3089     Packet 5 - TrackToTrain - Linking
3090         NID_PACKET = 5 (5h) (00000101)
3091         Q_DIR = 0 (0h) (00) "Reverse"
3092         L_PACKET = 108 (6Ch) (0000001101100)
3093         Q_SCALE = 1 (1h) (01) "1 m scale"
3094         D_LINK = 422 (1A6h) (000000110100110) "422m"
3095     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
3096         NID_BG = 1015 (3F7h) (00001111110111)
3097         Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
3098         Q_LINKREACTION = 2 (2h) (10) "No reaction"
3099         Q_LOCAC = 1 (1h) (000001)
3100     N_ITER = 1 (1h) (00001)
3101         [0] D_LINK = 634 (27Ah) (000001001111010) "634m
        "
3102     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
3103         [0] NID_BG = 1013 (3F5h) (00001111110101)

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C. Simulation Traces

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3104         [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
3105         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
3106         [0] Q_LOCACC = 1 (1h) (000001)
3107     Packet 27 - TrackToTrain - International SSP
3108         NID_PACKET = 27 (1Bh) (00011011)
3109         Q_DIR = 0 (0h) (00) "Reverse"
3110         L_PACKET = 86 (56h) (0000001010110)
3111         Q_SCALE = 1 (1h) (01) "1 m scale"
3112         D_STATIC = 0 (0h) (0000000000000000) "0m"
3113         V_STATIC = 10 (Ah) (0001010) "50 km/h"
3114         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
3115     N_ITER = 0 (0h) (00000)
3116     N_ITER = 1 (1h) (00001)
3117         [0] D_STATIC = 1140 (474h) (000010001110100)
           "1140m"
3118         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
3119         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
3120     [0] N_ITER = 0 (0h) (00000)
3121     Packet 21 - TrackToTrain - Gradient Profile
3122         NID_PACKET = 21 (15h) (00010101)
3123         Q_DIR = 0 (0h) (00) "Reverse"
3124         L_PACKET = 126 (7Eh) (0000001111110)
3125         Q_SCALE = 1 (1h) (01) "1 m scale"
3126         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
3127         Q_GDIR = 1 (1h) (1) "Uphill"
3128         G_A = 4 (4h) (00000100) "4 o/oo"
3129     N_ITER = 3 (3h) (00011)
3130         [0] D_GRADIENT = 250 (FAh) (000000011111010)
           "250m"
3131         [0] Q_GDIR = 1 (1h) (1) "Uphill"
3132         [0] G_A = 15 (Fh) (00001111) "15 o/oo"
3133         [1] D_GRADIENT = 773 (305h) (000001100000101)
           "773m"
3134         [1] Q_GDIR = 1 (1h) (1) "Uphill"
3135         [1] G_A = 5 (5h) (00000101) "5 o/oo"
3136         [2] D_GRADIENT = 117 (75h) (000000001110101)
           "117m"
3137         [2] Q_GDIR = 0 (0h) (0) "Downhill"
3138         [2] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
3139 12:10:05.253162 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest

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:192.168.0.132
3140      10000100 00000110 10000010 11010101 00010100 10010010
          01010111 00100000 01110100 01000100 00000000 00001000
          00010000 00000010 00001111 11001100 00000110
          10010010 10000000 00110010 00000000 01100100 10000000
          11111000 00000001 00000011
3141      NID_MESSAGE = 132 (84h) (10000100)
3142      L_MESSAGE = 26 (1Ah) (0000011010)
3143      T_TRAIN = 190075465 (B545249h)
          (00001011010101000101001001001001)
3144      NID_ENGINE = 6062545 (5C81D1h)
          (010111001000000111010001)
3145      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
3146      Packet 0 - TrainToTrack - Pos Report
3147          NID_PACKET = 0 (0h) (00000000)
3148          L_PACKET = 129 (81h) (0000010000001)
3149          Q_SCALE = 0 (0h) (00) "10 cm scale"
3150      NID_LRBG = 33779 (83F3h) (000000001000001111110011)
3151          NID_C = 2 (2h) (0000000010)
3152          NID_BG = 1011 (3F3h) (00001111110011)
3153          D_LRBG = 210 (D2h) (000000011010010) "21.0m"
3154          Q_DIRLRBG = 1 (1h) (01) "Nominal"
3155          Q_DLRBG = 1 (1h) (01) "Nominal"
3156          L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3157          L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
          "
3158      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
3159          L_TRAININT = 248 (F8h) (000000011111000)
3160          V_TRAIN = 0 (0h) (0000000) "0 km/h"
3161          Q_DIRTRAIN = 2 (2h) (10) "Unknown"
3162          M_MODE = 0 (0h) (0000) "Full Supervision"
3163      M_LEVEL = 3 (3h) (011) "Level 2"
3164      12:10:05.274024 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
          - Train 6062545 - Dest:192.168.0.134
3165      00000011 00001101 10000010 11010101 00010100 10010010
          01000000 00010000 01111110 01100001 11101000 00010110
          00010000 00000000 00000000 00000000 00001101
          10010000 00000000 00011111 10000111 00101000 00001100
          01000110 01111111 11110000 10100011 10100100
          00000111 00001000 01010111 11111111 11110010 00000001
          10110100 00001010 11001000 00000000 00000001
          01010000 00000100 00000000 11011111 11110000 00000101
          01010000 00100111 00100000 00000000 00100000
          00000001 00000000 00110110 11111111
3166      NID_MESSAGE = 3 (3h) (00000011)
3167      L_MESSAGE = 54 (36h) (0000110110)
3168      T_TRAIN = 190075465 (B545249h)

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C. Simulation Traces

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(00001011010101000101001001001001)
3169 M_ACK = 0 (0h) (0) "No acknowledgement required"
3170 NID_LRBG = 33779 (83F3h) (0000000010000011111110011)
3171 NID_C = 2 (2h) (0000000010)
3172 NID_BG = 1011 (3F3h) (00001111110011)
3173 Packet 15 - TrackToTrain - Level 2/3 MA
3174 NID_PACKET = 15 (Fh) (00001111)
3175 Q_DIR = 1 (1h) (01) "Nominal"
3176 L_PACKET = 88 (58h) (0000001011000)
3177 Q_SCALE = 1 (1h) (01) "1 m scale"
3178 V_EMA = 0 (0h) (00000000) "0 km/h"
3179 T_EMA = 0 (0h) (0000000000)
3180 N_ITER = 0 (0h) (00000)
3181 L_ENDSECTION = 27 (1Bh) (000000000011011) "27m"
3182 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
3183 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
3184 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
3185 D_DP = 0 (0h) (0000000000000000) "0m"
3186 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
3187 Q_OVERLAP = 0 (0h) (0) "No overlap information"
3188 Packet 57 - TrackToTrain - MA Request Params
3189 NID_PACKET = 57 (39h) (00111001)
3190 Q_DIR = 1 (1h) (01) "Nominal"
3191 L_PACKET = 49 (31h) (0000000110001)
3192 T_MAR = 25 (19h) (00011001)
3193 T_TIMEOUSRQST = 1023 (3FFh) (1111111111) "No MA
request triggering with regards to this
function"
3194 T_CYCRQST = 10 (Ah) (00001010)
3195 Packet 58 - TrackToTrain - Pos Report Params
3196 NID_PACKET = 58 (3Ah) (00111010)
3197 Q_DIR = 1 (1h) (01) "Nominal"
3198 L_PACKET = 56 (38h) (0000000111000)
3199 Q_SCALE = 1 (1h) (01) "1 m scale"
3200 T_CYCLOC = 10 (Ah) (00001010)
3201 D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
train has not to report cyclically its
position"
3202 M_LOC = 1 (1h) (001) "Every LRBG compliant
balise group"
3203 N_ITER = 0 (0h) (00000)
3204 Packet 27 - TrackToTrain - International SSP
3205 NID_PACKET = 27 (1Bh) (00011011)
3206 Q_DIR = 1 (1h) (01) "Nominal"
3207 L_PACKET = 86 (56h) (0000001010110)
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3208         Q_SCALE = 1 (1h) (01) "1 m scale"
3209         D_STATIC = 0 (0h) (0000000000000000) "0m"
3210         V_STATIC = 10 (Ah) (0001010) "50 km/h"
3211         Q_FRONT = 1 (1h) (1) "No train length delay on
          validity end point of profile element"
3212     N_ITER = 0 (0h) (00000)
3213     N_ITER = 1 (1h) (00001)
3214         [0] D_STATIC = 27 (1Bh) (000000000011011) "27m"
3215         [0] V_STATIC = 127 (7Fh) (1111111) "Non
          numerical value telling that the static
          speed profile description ends at D_STATIC(n
          )"
3216         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
          validity end point of profile element"
3217     [0] N_ITER = 0 (0h) (00000)
3218     Packet 21 - TrackToTrain - Gradient Profile
3219         NID_PACKET = 21 (15h) (00010101)
3220         Q_DIR = 1 (1h) (01) "Nominal"
3221         L_PACKET = 78 (4Eh) (0000001001110)
3222         Q_SCALE = 1 (1h) (01) "1 m scale"
3223         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
3224         Q_GDIR = 1 (1h) (1) "Uphill"
3225         G_A = 0 (0h) (00000000) "0 o/oo"
3226     N_ITER = 1 (1h) (00001)
3227         [0] D_GRADIENT = 27 (1Bh) (000000000011011) "27
          m"
3228         [0] Q_GDIR = 0 (0h) (0) "Downhill"
3229         [0] G_A = 255 (FFh) (11111111) "Non numerical
          value telling that the current gradient
          description ends at D_GRADIENT(n)"
3230 12:10:06.199288 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
          :192.168.0.132
3231     10000100 00000110 10000010 11010101 00010100 10101010
          11010111 00100000 01110100 01000100 00000000 00001000
          00010000 00000010 00001111 11001100 00000110
          10010010 10000000 00110010 00000000 01100100 10000000
          11111000 00000001 00000011
3232     NID_MESSAGE = 132 (84h) (10000100)
3233     L_MESSAGE = 26 (1Ah) (0000011010)
3234     T_TRAIN = 190075563 (B5452ABh)
          (00001011010101000101001010101011)
3235     NID_ENGINE = 6062545 (5C81D1h)
          (010111001000000111010001)
3236     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
3237     Packet 0 - TrainToTrack - Pos Report
3238         NID_PACKET = 0 (0h) (00000000)
3239         L_PACKET = 129 (81h) (00000100000001)
3240         Q_SCALE = 0 (0h) (00) "10 cm scale"

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3241     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
3242     NID_C = 2 (2h) (0000000010)
3243     NID_BG = 1011 (3F3h) (00001111110011)
3244     D_LRBG = 210 (D2h) (0000000011010010) "21.0m"
3245     Q_DIRLRBG = 1 (1h) (01) "Nominal"
3246     Q_DLRBG = 1 (1h) (01) "Nominal"
3247     L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3248     L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
3249     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
3250     L_TRAININT = 248 (F8h) (000000011111000)
3251     V_TRAIN = 0 (0h) (0000000) "0 km/h"
3252     Q_DIRTRAIN = 2 (2h) (10) "Unknown"
3253     M_MODE = 0 (0h) (0000) "Full Supervision"
3254     M_LEVEL = 3 (3h) (011) "Level 2"
3255 12:10:09.241040 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
      - Train 6062545 - Dest:192.168.0.134
3256     00000011 00001111 00000010 11010101 00010100 11110101
      11000000 00010000 01111110 01100001 11101000 00010000
      10010000 00000000 00000000 00000001 10111110
      10000001 11001010 00000011 00010001 10011111 11111100
      00101000 11101001 00000010 01000010 00010101
      11111111 11111100 10000100 00000001 10110100 01101101
      00000010 10110010 00000000 00000000 01010100
      00000001 00000110 11111011 11111100 00000001 01010100
      00001111 11001000 00000000 00001000 00000000
      11000000 11001110 00000000 10000000 10000001 01000000
      00000000 01101111 10111111 11000000
3257     NID_MESSAGE = 3 (3h) (00000011)
3258     L_MESSAGE = 60 (3Ch) (0000111100)
3259     T_TRAIN = 190075863 (B5453D7h)
      (000010110101010000101001111010111)
3260     M_ACK = 0 (0h) (0) "No acknowledgement required"
3261     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
3262     NID_C = 2 (2h) (0000000010)
3263     NID_BG = 1011 (3F3h) (00001111110011)
3264     Packet 15 - TrackToTrain - Level 2/3 MA
3265     NID_PACKET = 15 (Fh) (00001111)
3266     Q_DIR = 1 (1h) (01) "Nominal"
3267     L_PACKET = 66 (42h) (0000001000010)
3268     Q_SCALE = 1 (1h) (01) "1 m scale"
3269     V_EMA = 0 (0h) (0000000) "0 km/h"
3270     T_EMA = 0 (0h) (0000000000)
3271     N_ITER = 0 (0h) (00000)
3272     L_ENDSECTION = 893 (37Dh) (000001101111101)
      "893m"
3273     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
      information"

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3274 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
      information"
3275 Q_DANGERPOINT = 0 (0h) (0) "No danger point information"
3276 Q_OVERLAP = 0 (0h) (0) "No overlap information"
3277 Packet 57 - TrackToTrain - MA Request Params
3278 NID_PACKET = 57 (39h) (00111001)
3279 Q_DIR = 1 (1h) (01) "Nominal"
3280 L_PACKET = 49 (31h) (0000000110001)
3281 T_MAR = 25 (19h) (00011001)
3282 T_TIMEOUSRQST = 1023 (3FFh) (1111111111) "No MA
      request triggering with regards to this
      function"
3283 T_CYCRQST = 10 (Ah) (00001010)
3284 Packet 58 - TrackToTrain - Pos Report Params
3285 NID_PACKET = 58 (3Ah) (00111010)
3286 Q_DIR = 1 (1h) (01) "Nominal"
3287 L_PACKET = 72 (48h) (0000001001000)
3288 Q_SCALE = 1 (1h) (01) "1 m scale"
3289 T_CYCLOC = 10 (Ah) (00001010)
3290 D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
      train has not to report cyclically its
      position"
3291 M_LOC = 1 (1h) (001) "Every LRBG compliant
      balise group"
3292 N_ITER = 1 (1h) (00001)
3293 [0] D_LOC = 54 (36h) (000000000110110) "54m"
3294 [0] Q_LGTLLOC = 1 (1h) (1) "Max safe front end"
3295 Packet 27 - TrackToTrain - International SSP
3296 NID_PACKET = 27 (1Bh) (00011011)
3297 Q_DIR = 1 (1h) (01) "Nominal"
3298 L_PACKET = 86 (56h) (0000001010110)
3299 Q_SCALE = 1 (1h) (01) "1 m scale"
3300 D_STATIC = 0 (0h) (000000000000000) "0m"
3301 V_STATIC = 10 (Ah) (0001010) "50 km/h"
3302 Q_FRONT = 1 (1h) (1) "No train length delay on
      validity end point of profile element"
3303 N_ITER = 0 (0h) (00000)
3304 N_ITER = 1 (1h) (00001)
3305 [0] D_STATIC = 893 (37Dh) (000001101111101)
      "893m"
3306 [0] V_STATIC = 127 (7Fh) (1111111) "Non
      numerical value telling that the static
      speed profile description ends at D_STATIC(n
      )"
3307 [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
3308 [0] N_ITER = 0 (0h) (00000)
3309 Packet 21 - TrackToTrain - Gradient Profile
3310 NID_PACKET = 21 (15h) (00010101)

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3311         Q_DIR = 1 (1h) (01) "Nominal"
3312         L_PACKET = 126 (7Eh) (0000001111110)
3313         Q_SCALE = 1 (1h) (01) "1 m scale"
3314         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
3315         Q_GDIR = 1 (1h) (1) "Uphill"
3316         G_A = 0 (0h) (00000000) "0 o/oo"
3317     N_ITER = 3 (3h) (00011)
3318         [0] D_GRADIENT = 412 (19Ch) (000000110011100)
3319             "412m"
3320         [0] Q_GDIR = 0 (0h) (0) "Downhill"
3321         [0] G_A = 2 (2h) (00000010) "2 o/oo"
3322         [1] D_GRADIENT = 258 (102h) (000000100000010)
3323             "258m"
3324         [1] Q_GDIR = 1 (1h) (1) "Uphill"
3325         [1] G_A = 0 (0h) (00000000) "0 o/oo"
3326         [2] D_GRADIENT = 223 (DFh) (000000011011111)
3327             "223m"
3328         [2] Q_GDIR = 0 (0h) (0) "Downhill"
3329         [2] G_A = 255 (FFh) (11111111) "Non numerical
3330             value telling that the current gradient
3331             description ends at D_GRADIENT(n)"
3332 12:10:12.317571 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
3333     (PK21) - Train 6062545 - Dest:192.168.0.134
3334     00000011 00010010 10000010 11010101 00010101 01000101
3335         11000000 00010000 01111110 01100001 11101000 00010000
3336         10010000 00000000 00000000 00000011 01101011
3337         00000001 11001010 00000011 00010001 10011111 11111100
3338         00101000 11101001 00000010 01000010 00010101
3339         11111111 11111100 10000100 00000001 10110100 00010101
3340         00000010 00101010 00011001 01101100 00011111
3341         11001010 00000100 00000011 01101000 00010101 10010000
3342         00000000 00000010 10100000 00001000 01101101
3343         01101111 11100000 00001010 10100000 10101110 01000000
3344         00000000 01000000 00001010 00000110 01110000
3345         00000100 00000100 00001010 00000000 00000110 01001010
3346         00001100 00000100 11001010 00001000 00000101
3347         11010001 11111110
3348     NID_MESSAGE = 3 (3h) (00000011)
3349     L_MESSAGE = 74 (4Ah) (0001001010)
3350     T_TRAIN = 190076183 (B545517h)
3351         (000010110101010000101010100010111)
3352     M_ACK = 0 (0h) (0) "No acknowledgement required"
3353     NID_LRBG = 33779 (83F3h) (000000001000001111110011)
3354         NID_C = 2 (2h) (0000000010)
3355         NID_BG = 1011 (3F3h) (00001111110011)
3356     Packet 15 - TrackToTrain - Level 2/3 MA
3357         NID_PACKET = 15 (Fh) (00001111)
3358         Q_DIR = 1 (1h) (01) "Nominal"
3359         L_PACKET = 66 (42h) (0000001000010)

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3340         Q_SCALE = 1 (1h) (01) "1 m scale"
3341         V_EMA = 0 (0h) (0000000) "0 km/h"
3342         T_EMA = 0 (0h) (0000000000)
3343     N_ITER = 0 (0h) (00000)
3344         L_ENDSECTION = 1750 (6D6h) (000011011010110)
           "1750m"
3345     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
3346     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
3347     Q_DANGERPOINT = 0 (0h) (0) "No danger point information"
3348     Q_OVERLAP = 0 (0h) (0) "No overlap information"
3349     Packet 57 - TrackToTrain - MA Request Params
3350         NID_PACKET = 57 (39h) (00111001)
3351         Q_DIR = 1 (1h) (01) "Nominal"
3352         L_PACKET = 49 (31h) (0000000110001)
3353         T_MAR = 25 (19h) (00011001)
3354         T_TIMEOUSRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
3355         T_CYCRQST = 10 (Ah) (00001010)
3356     Packet 58 - TrackToTrain - Pos Report Params
3357         NID_PACKET = 58 (3Ah) (00111010)
3358         Q_DIR = 1 (1h) (01) "Nominal"
3359         L_PACKET = 72 (48h) (0000001001000)
3360         Q_SCALE = 1 (1h) (01) "1 m scale"
3361         T_CYCLOC = 10 (Ah) (00001010)
3362         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
3363         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
3364     N_ITER = 1 (1h) (00001)
3365         [0] D_LOC = 54 (36h) (000000000110110) "54m"
3366         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
3367     Packet 5 - TrackToTrain - Linking
3368         NID_PACKET = 5 (5h) (00000101)
3369         Q_DIR = 1 (1h) (01) "Nominal"
3370         L_PACKET = 69 (45h) (0000001000101)
3371         Q_SCALE = 1 (1h) (01) "1 m scale"
3372         D_LINK = 1627 (65Bh) (000011001011011) "1627m"
3373     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
3374         NID_BG = 1017 (3F9h) (000011111111001)
3375         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
3376         Q_LINKREACTION = 2 (2h) (10) "No reaction"
3377         Q_LOCACCC = 1 (1h) (000001)

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3378     N_ITER = 0 (0h) (000000)
3379     Packet 27 - TrackToTrain - International SSP
3380         NID_PACKET = 27 (1Bh) (00011011)
3381         Q_DIR = 1 (1h) (01) "Nominal"
3382         L_PACKET = 86 (56h) (0000001010110)
3383         Q_SCALE = 1 (1h) (01) "1 m scale"
3384         D_STATIC = 0 (0h) (0000000000000000) "0m"
3385         V_STATIC = 10 (Ah) (0001010) "50 km/h"
3386         Q_FRONT = 1 (1h) (1) "No train length delay on
            validity end point of profile element"
3387     N_ITER = 0 (0h) (000000)
3388     N_ITER = 1 (1h) (000001)
3389         [0] D_STATIC = 1750 (6D6h) (000011011010110)
            "1750m"
3390         [0] V_STATIC = 127 (7Fh) (1111111) "Non
            numerical value telling that the static
            speed profile description ends at D_STATIC(n
            )"
3391         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
            validity end point of profile element"
3392     [0] N_ITER = 0 (0h) (000000)
3393     Packet 21 - TrackToTrain - Gradient Profile
3394         NID_PACKET = 21 (15h) (00010101)
3395         Q_DIR = 1 (1h) (01) "Nominal"
3396         L_PACKET = 174 (AEh) (0000010101110)
3397         Q_SCALE = 1 (1h) (01) "1 m scale"
3398         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
3399         Q_GDIR = 1 (1h) (1) "Uphill"
3400         G_A = 0 (0h) (00000000) "0 o/oo"
3401     N_ITER = 5 (5h) (00101)
3402         [0] D_GRADIENT = 412 (19Ch) (000000110011100)
            "412m"
3403         [0] Q_GDIR = 0 (0h) (0) "Downhill"
3404         [0] G_A = 2 (2h) (00000010) "2 o/oo"
3405         [1] D_GRADIENT = 258 (102h) (000000100000010)
            "258m"
3406         [1] Q_GDIR = 1 (1h) (1) "Uphill"
3407         [1] G_A = 0 (0h) (00000000) "0 o/oo"
3408         [2] D_GRADIENT = 402 (192h) (000000110010010)
            "402m"
3409         [2] Q_GDIR = 1 (1h) (1) "Uphill"
3410         [2] G_A = 6 (6h) (00000110) "6 o/oo"
3411         [3] D_GRADIENT = 306 (132h) (000000100110010)
            "306m"
3412         [3] Q_GDIR = 1 (1h) (1) "Uphill"
3413         [3] G_A = 4 (4h) (00000100) "4 o/oo"
3414         [4] D_GRADIENT = 372 (174h) (000000101110100)
            "372m"
3415         [4] Q_GDIR = 0 (0h) (0) "Downhill"
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3416             [4] G_A = 255 (FFh) (11111111) "Non numerical
                value telling that the current gradient
                description ends at D_GRADIENT(n)"
3417 12:10:28.043693 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
                :192.168.0.132
3418     10000100 00000110 10000010 11010101 00010110 11001100
                10010111 00100000 01110100 00000100 00000000 00001000
                00010000 00000010 00001111 11011100 00111100
                10001000 00000000 00110010 00000000 01100100 10000000
                11111000 00010100 00000011
3419     NID_MESSAGE = 132 (84h) (10000100)
3420     L_MESSAGE = 26 (1Ah) (0000011010)
3421     T_TRAIN = 190077746 (B545B32h)
                (00001011010101000101101100110010)
3422     NID_ENGINE = 6062544 (5C81D0h)
                (010111001000000111010000)
3423     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                the perturbation location reached"
3424     Packet 0 - TrainToTrack - Pos Report
3425     NID_PACKET = 0 (0h) (00000000)
3426     L_PACKET = 129 (81h) (0000010000001)
3427     Q_SCALE = 0 (0h) (00) "10 cm scale"
3428     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3429     NID_C = 2 (2h) (0000000010)
3430     NID_BG = 1015 (3F7h) (00001111110111)
3431     D_LRBG = 1937 (791h) (000011110010001) "193.7m"
3432     Q_DIRLRBG = 0 (0h) (00) "Reverse"
3433     Q_DLRBG = 0 (0h) (00) "Reverse"
3434     L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3435     L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
                "
3436     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
                integrity monitoring device"
3437     L_TRAININT = 248 (F8h) (000000011111000)
3438     V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3439     Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3440     M_MODE = 0 (0h) (0000) "Full Supervision"
3441     M_LEVEL = 3 (3h) (011) "Level 2"
3442 12:10:28.073205 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
                (PK21) - Train 6062544 - Dest:192.168.0.134
3443     00000011 00010000 10000010 11010101 00010110 11001100
                10000000 00010000 01111110 11100001 11100000 00010110
                00010000 00000000 00000000 00000001 01100111
                00010000 00000000 00011111 10000111 00100000 00001100
                01000110 01111111 11110000 10100011 10100000
                00000111 00001000 01010111 11111111 11110010 00000000
                01010000 00001000 10101000 00100111 10100000
                01111110 10101000 00010000 00001101 10000000 01010110
                01000000 00000000 00001010 10000000 00100000

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10110011 10111111 10000000 00101010 00000001 10011001
00000000 00000001 00001111 00010000 00100101
10011000 00101000 00000111 01010111 11111000
3444 NID_MESSAGE = 3 (3h) (00000011)
3445 L_MESSAGE = 66 (42h) (0001000010)
3446 T_TRAIN = 190077746 (B545B32h)
(00001011010101000101101100110010)
3447 M_ACK = 0 (0h) (0) "No acknowledgement required"
3448 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3449 NID_C = 2 (2h) (0000000010)
3450 NID_BG = 1015 (3F7h) (00001111110111)
3451 Packet 15 - TrackToTrain - Level 2/3 MA
3452 NID_PACKET = 15 (Fh) (00001111)
3453 Q_DIR = 0 (0h) (00) "Reverse"
3454 L_PACKET = 88 (58h) (0000001011000)
3455 Q_SCALE = 1 (1h) (01) "1 m scale"
3456 V_EMA = 0 (0h) (00000000) "0 km/h"
3457 T_EMA = 0 (0h) (0000000000)
3458 N_ITER = 0 (0h) (00000)
3459 L_ENDSECTION = 718 (2CEh) (000001011001110)
"718m"
3460 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
3461 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
3462 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
3463 D_DP = 0 (0h) (0000000000000000) "0m"
3464 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
3465 Q_OVERLAP = 0 (0h) (0) "No overlap information"
3466 Packet 57 - TrackToTrain - MA Request Params
3467 NID_PACKET = 57 (39h) (00111001)
3468 Q_DIR = 0 (0h) (00) "Reverse"
3469 L_PACKET = 49 (31h) (0000000110001)
3470 T_MAR = 25 (19h) (00011001)
3471 T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
request triggering with regards to this
function"
3472 T_CYCRQST = 10 (Ah) (00001010)
3473 Packet 58 - TrackToTrain - Pos Report Params
3474 NID_PACKET = 58 (3Ah) (00111010)
3475 Q_DIR = 0 (0h) (00) "Reverse"
3476 L_PACKET = 56 (38h) (0000000111000)
3477 Q_SCALE = 1 (1h) (01) "1 m scale"
3478 T_CYCLOC = 10 (Ah) (00001010)
3479 D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
train has not to report cyclically its
position"
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3480             M_LOC = 1 (1h) (001) "Every LRBG compliant
                balise group"
3481 N_ITER = 0 (0h) (00000)
3482 Packet 5 - TrackToTrain - Linking
3483             NID_PACKET = 5 (5h) (00000101)
3484             Q_DIR = 0 (0h) (00) "Reverse"
3485             L_PACKET = 69 (45h) (0000001000101)
3486             Q_SCALE = 1 (1h) (01) "1 m scale"
3487             D_LINK = 634 (27Ah) (000001001111010) "634m"
3488 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                administration, no NID_C follows"
3489             NID_BG = 1013 (3F5h) (00001111110101)
3490             Q_LINKORIENTATION = 0 (0h) (0) "The balise
                group is seen by the train in reverse
                direction"
3491             Q_LINKREACTION = 2 (2h) (10) "No reaction"
3492             Q_LOACC = 1 (1h) (000001)
3493 N_ITER = 0 (0h) (00000)
3494 Packet 27 - TrackToTrain - International SSP
3495             NID_PACKET = 27 (1Bh) (00011011)
3496             Q_DIR = 0 (0h) (00) "Reverse"
3497             L_PACKET = 86 (56h) (0000001010110)
3498             Q_SCALE = 1 (1h) (01) "1 m scale"
3499             D_STATIC = 0 (0h) (000000000000000) "0m"
3500             V_STATIC = 10 (Ah) (0001010) "50 km/h"
3501             Q_FRONT = 1 (1h) (1) "No train length delay on
                validity end point of profile element"
3502 N_ITER = 0 (0h) (00000)
3503 N_ITER = 1 (1h) (00001)
3504             [0] D_STATIC = 718 (2CEh) (000001011001110)
                "718m"
3505             [0] V_STATIC = 127 (7Fh) (1111111) "Non
                numerical value telling that the static
                speed profile description ends at D_STATIC(n
                )"
3506             [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                validity end point of profile element"
3507 [0] N_ITER = 0 (0h) (00000)
3508 Packet 21 - TrackToTrain - Gradient Profile
3509             NID_PACKET = 21 (15h) (00010101)
3510             Q_DIR = 0 (0h) (00) "Reverse"
3511             L_PACKET = 102 (66h) (0000001100110)
3512             Q_SCALE = 1 (1h) (01) "1 m scale"
3513             D_GRADIENT = 0 (0h) (000000000000000) "0m"
3514             Q_GDIR = 1 (1h) (1) "Uphill"
3515             G_A = 15 (Fh) (00001111) "15 o/oo"
3516 N_ITER = 2 (2h) (00010)
3517             [0] D_GRADIENT = 601 (259h) (000001001011001)
                "601m"

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3518          [0] Q_GDIR = 1 (1h) (1) "Uphill"
3519          [0] G_A = 5 (5h) (00000101) "5 o/oo"
3520          [1] D_GRADIENT = 117 (75h) (000000001110101)
              "117m"
3521          [1] Q_GDIR = 0 (0h) (0) "Downhill"
3522          [1] G_A = 255 (FFh) (11111111) "Non numerical
              value telling that the current gradient
              description ends at D_GRADIENT(n)"
3523 12:10:28.854071 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
              :192.168.0.132
3524          10000100 00000110 10000010 11010101 00010110 11011001
              00010111 00100000 01110100 00000100 00000000 00001000
              00010000 00000010 00001111 11011100 00111110
              10110000 00000000 00110010 00000000 01100100 10000000
              11111000 00010100 00000011
3525          NID_MESSAGE = 132 (84h) (10000100)
3526          L_MESSAGE = 26 (1Ah) (0000011010)
3527          T_TRAIN = 190077796 (B545B64h)
              (000010110101010000101101101100100)
3528          NID_ENGINE = 6062544 (5C81D0h)
              (010111001000000111010000)
3529          Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
              the perturbation location reached"
3530          Packet 0 - TrainToTrack - Pos Report
3531          NID_PACKET = 0 (0h) (00000000)
3532          L_PACKET = 129 (81h) (00000100000001)
3533          Q_SCALE = 0 (0h) (00) "10 cm scale"
3534          NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3535          NID_C = 2 (2h) (0000000010)
3536          NID_BG = 1015 (3F7h) (00001111110111)
3537          D_LRBG = 2006 (7D6h) (000011111010110) "200.6m"
3538          Q_DIRLRBG = 0 (0h) (00) "Reverse"
3539          Q_DLRBG = 0 (0h) (00) "Reverse"
3540          L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3541          L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
              "
3542          Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
              integrity monitoring device"
3543          L_TRAININT = 248 (F8h) (000000011111000)
3544          V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3545          Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3546          M_MODE = 0 (0h) (0000) "Full Supervision"
3547          M_LEVEL = 3 (3h) (011) "Level 2"
3548 12:10:38.653801 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
              :192.168.0.132
3549          10000100 00000110 10000010 11010101 00010111 11010011
              01010111 00100000 01110100 00000100 00000000 00001000
              00010000 00000010 00001111 11011100 01101010
              00011000 00000000 00110010 00000000 01100100 10000000

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11111000 00010100 00000011
3550 NID_MESSAGE = 132 (84h) (10000100)
3551 L_MESSAGE = 26 (1Ah) (0000011010)
3552 T_TRAIN = 190078797 (B545F4Dh)
      (00001011010101000101111101001101)
3553 NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
3554 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
3555 Packet 0 - TrainToTrack - Pos Report
3556 NID_PACKET = 0 (0h) (00000000)
3557 L_PACKET = 129 (81h) (0000010000001)
3558 Q_SCALE = 0 (0h) (00) "10 cm scale"
3559 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3560 NID_C = 2 (2h) (0000000010)
3561 NID_BG = 1015 (3F7h) (00001111110111)
3562 D_LRBG = 3395 (D43h) (000110101000011) "339.5m"
3563 Q_DIRLRBG = 0 (0h) (00) "Reverse"
3564 Q_DLRBG = 0 (0h) (00) "Reverse"
3565 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3566 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
3567 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
3568 L_TRAININT = 248 (F8h) (000000011111000)
3569 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3570 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3571 M_MODE = 0 (0h) (0000) "Full Supervision"
3572 M_LEVEL = 3 (3h) (011) "Level 2"
3573 12:10:38.677416 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062544 - Dest:192.168.0.134
3574 00000011 00010000 10000010 11010101 00010111 11010011
      01000000 00010000 01111110 11100001 11100000 00010110
      00010000 00000000 00000000 00000001 01100111
      00010000 00000000 00011111 10000111 00100000 00001100
      01000110 01111111 11110000 10100011 10100000
      00000111 00001000 01010111 11111111 11110010 00000000
      01010000 00001000 10101000 00100111 10100000
      01111110 10101000 00010000 00001101 10000000 01010110
      01000000 00000000 00001010 10000000 00100000
      10110011 10111111 10000000 00101010 00000001 10011001
      00000000 00000001 00001111 00010000 00100101
      10011000 00101000 00000111 01010111 11111000
3575 NID_MESSAGE = 3 (3h) (00000011)
3576 L_MESSAGE = 66 (42h) (0001000010)
3577 T_TRAIN = 190078797 (B545F4Dh)
      (00001011010101000101111101001101)
3578 M_ACK = 0 (0h) (0) "No acknowledgement required"
3579 NID_LRBG = 33783 (83F7h) (000000001000001111110111)

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C. Simulation Traces

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3580         NID_C = 2 (2h) (0000000010)
3581         NID_BG = 1015 (3F7h) (00001111110111)
3582     Packet 15 - TrackToTrain - Level 2/3 MA
3583         NID_PACKET = 15 (Fh) (00001111)
3584         Q_DIR = 0 (0h) (00) "Reverse"
3585         L_PACKET = 88 (58h) (0000001011000)
3586         Q_SCALE = 1 (1h) (01) "1 m scale"
3587         V_EMA = 0 (0h) (00000000) "0 km/h"
3588         T_EMA = 0 (0h) (00000000000)
3589     N_ITER = 0 (0h) (000000)
3590         L_ENDSECTION = 718 (2CEh) (000001011001110)
3591             "718m"
3592     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
3593         information"
3594     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
3595         information"
3596     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
3597         follow"
3598         D_DP = 0 (0h) (0000000000000000) "0m"
3599         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
3600             calculated release speed"
3601     Q_OVERLAP = 0 (0h) (0) "No overlap information"
3602     Packet 57 - TrackToTrain - MA Request Params
3603         NID_PACKET = 57 (39h) (00111001)
3604         Q_DIR = 0 (0h) (00) "Reverse"
3605         L_PACKET = 49 (31h) (0000000110001)
3606         T_MAR = 25 (19h) (00011001)
3607         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
3608             request triggering with regards to this
3609             function"
3610         T_CYCRQST = 10 (Ah) (00001010)
3611     Packet 58 - TrackToTrain - Pos Report Params
3612         NID_PACKET = 58 (3Ah) (00111010)
3613         Q_DIR = 0 (0h) (00) "Reverse"
3614         L_PACKET = 56 (38h) (0000000111000)
3615         Q_SCALE = 1 (1h) (01) "1 m scale"
3616         T_CYCLOC = 10 (Ah) (00001010)
3617         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
3618             train has not to report cyclically its
3619             position"
3620         M_LOC = 1 (1h) (001) "Every LRBG compliant
3621             balise group"
3622     N_ITER = 0 (0h) (000000)
3623     Packet 5 - TrackToTrain - Linking
3624         NID_PACKET = 5 (5h) (00000101)
3625         Q_DIR = 0 (0h) (00) "Reverse"
3626         L_PACKET = 69 (45h) (0000001000101)
3627         Q_SCALE = 1 (1h) (01) "1 m scale"
3628         D_LINK = 634 (27Ah) (000001001111010) "634m"
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3619     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
          administration, no NID_C follows"
3620     NID_BG = 1013 (3F5h) (00001111110101)
3621     Q_LINKORIENTATION = 0 (0h) (0) "The balise
          group is seen by the train in reverse
          direction"
3622     Q_LINKREACTION = 2 (2h) (10) "No reaction"
3623     Q_LOCACC = 1 (1h) (000001)
3624     N_ITER = 0 (0h) (00000)
3625     Packet 27 - TrackToTrain - International SSP
3626     NID_PACKET = 27 (1Bh) (00011011)
3627     Q_DIR = 0 (0h) (00) "Reverse"
3628     L_PACKET = 86 (56h) (0000001010110)
3629     Q_SCALE = 1 (1h) (01) "1 m scale"
3630     D_STATIC = 0 (0h) (0000000000000000) "0m"
3631     V_STATIC = 10 (Ah) (0001010) "50 km/h"
3632     Q_FRONT = 1 (1h) (1) "No train length delay on
          validity end point of profile element"
3633     N_ITER = 0 (0h) (00000)
3634     N_ITER = 1 (1h) (00001)
3635     [0] D_STATIC = 718 (2CEh) (000001011001110)
          "718m"
3636     [0] V_STATIC = 127 (7Fh) (1111111) "Non
          numerical value telling that the static
          speed profile description ends at D_STATIC(n
          )"
3637     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
          validity end point of profile element"
3638     [0] N_ITER = 0 (0h) (00000)
3639     Packet 21 - TrackToTrain - Gradient Profile
3640     NID_PACKET = 21 (15h) (00010101)
3641     Q_DIR = 0 (0h) (00) "Reverse"
3642     L_PACKET = 102 (66h) (0000001100110)
3643     Q_SCALE = 1 (1h) (01) "1 m scale"
3644     D_GRADIENT = 0 (0h) (0000000000000000) "0m"
3645     Q_GDIR = 1 (1h) (1) "Uphill"
3646     G_A = 15 (Fh) (00001111) "15 o/oo"
3647     N_ITER = 2 (2h) (00010)
3648     [0] D_GRADIENT = 601 (259h) (000001001011001)
          "601m"
3649     [0] Q_GDIR = 1 (1h) (1) "Uphill"
3650     [0] G_A = 5 (5h) (00000101) "5 o/oo"
3651     [1] D_GRADIENT = 117 (75h) (000000001110101)
          "117m"
3652     [1] Q_GDIR = 0 (0h) (0) "Downhill"
3653     [1] G_A = 255 (FFh) (11111111) "Non numerical
          value telling that the current gradient
          description ends at D_GRADIENT(n)"
3654 12:10:39.523839 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest

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C. Simulation Traces

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:192.168.0.132
3655 10000100 00000110 10000010 11010101 00010111 11101011
      11010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00001111 11011100 01101110
      01101000 00000000 00110010 00000000 01100100 10000000
      11111000 00010100 00000011
3656 NID_MESSAGE = 132 (84h) (10000100)
3657 L_MESSAGE = 26 (1Ah) (0000011010)
3658 T_TRAIN = 190078895 (B545FAFh)
      (00001011010101000101111110101111)
3659 NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
3660 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
3661 Packet 0 - TrainToTrack - Pos Report
3662 NID_PACKET = 0 (0h) (00000000)
3663 L_PACKET = 129 (81h) (00000100000001)
3664 Q_SCALE = 0 (0h) (00) "10 cm scale"
3665 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3666 NID_C = 2 (2h) (0000000010)
3667 NID_BG = 1015 (3F7h) (00001111110111)
3668 D_LRBG = 3533 (DCDh) (000110111001101) "353.3m"
3669 Q_DIRLRBG = 0 (0h) (00) "Reverse"
3670 Q_DLRBG = 0 (0h) (00) "Reverse"
3671 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3672 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
3673 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
3674 L_TRAININT = 248 (F8h) (000000011111000)
3675 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3676 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3677 M_MODE = 0 (0h) (0000) "Full Supervision"
3678 M_LEVEL = 3 (3h) (011) "Level 2"
3679 12:10:49.534574 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
3680 10000100 00000110 10000010 11010101 00011000 11100110
      01010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00001111 11011100 10011001
      11010000 00000000 00110010 00000000 01100100 10000000
      11111000 00010100 00000011
3681 NID_MESSAGE = 132 (84h) (10000100)
3682 L_MESSAGE = 26 (1Ah) (0000011010)
3683 T_TRAIN = 190079897 (B546399h)
      (00001011010101000110001110011001)
3684 NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
3685 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"

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3686 Packet 0 - TrainToTrack - Pos Report
3687 NID_PACKET = 0 (0h) (00000000)
3688 L_PACKET = 129 (81h) (0000010000001)
3689 Q_SCALE = 0 (0h) (00) "10 cm scale"
3690 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3691 NID_C = 2 (2h) (0000000010)
3692 NID_BG = 1015 (3F7h) (00001111110111)
3693 D_LRBG = 4922 (133Ah) (001001100111010) "492.2m
"
3694 Q_DIRLRBG = 0 (0h) (00) "Reverse"
3695 Q_DLRBG = 0 (0h) (00) "Reverse"
3696 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3697 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
"
3698 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
3699 L_TRAININT = 248 (F8h) (000000011111000)
3700 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3701 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3702 M_MODE = 0 (0h) (0000) "Full Supervision"
3703 M_LEVEL = 3 (3h) (011) "Level 2"
3704 12:10:49.556811 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
(PK21) - Train 6062544 - Dest:192.168.0.134
3705 00000011 00010000 10000010 11010101 00011000 11100110
01000000 00010000 01111110 11100001 11100000 00010110
00010000 00000000 00000000 00000001 01100111
00010000 00000000 00011111 10000111 00100000 00001100
01000110 01111111 11110000 10100011 10100000
00000111 00001000 01010111 11111111 11110010 00000000
01010000 00001000 10101000 00100111 10100000
01111110 10101000 00010000 00001101 10000000 01010110
01000000 00000000 00001010 10000000 00100000
10110011 10111111 10000000 00101010 00000001 10011001
00000000 00000001 00001111 00010000 00100101
10011000 00101000 00000111 01010111 11111000
3706 NID_MESSAGE = 3 (3h) (00000011)
3707 L_MESSAGE = 66 (42h) (0001000010)
3708 T_TRAIN = 190079897 (B546399h)
(00001011010101000110001110011001)
3709 M_ACK = 0 (0h) (0) "No acknowledgement required"
3710 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3711 NID_C = 2 (2h) (0000000010)
3712 NID_BG = 1015 (3F7h) (00001111110111)
3713 Packet 15 - TrackToTrain - Level 2/3 MA
3714 NID_PACKET = 15 (Fh) (00001111)
3715 Q_DIR = 0 (0h) (00) "Reverse"
3716 L_PACKET = 88 (58h) (0000001011000)
3717 Q_SCALE = 1 (1h) (01) "1 m scale"
3718 V_EMA = 0 (0h) (0000000) "0 km/h"

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C. Simulation Traces

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3719         T_EMA = 0 (0h) (0000000000)
3720     N_ITER = 0 (0h) (00000)
3721         L_ENDSECTION = 718 (2CEh) (000001011001110)
           "718m"
3722     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
3723     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
3724     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
3725         D_DP = 0 (0h) (0000000000000000) "0m"
3726         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
3727     Q_OVERLAP = 0 (0h) (0) "No overlap information"
3728     Packet 57 - TrackToTrain - MA Request Params
3729         NID_PACKET = 57 (39h) (00111001)
3730         Q_DIR = 0 (0h) (00) "Reverse"
3731         L_PACKET = 49 (31h) (0000000110001)
3732         T_MAR = 25 (19h) (00011001)
3733         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
3734         T_CYCRQST = 10 (Ah) (00001010)
3735     Packet 58 - TrackToTrain - Pos Report Params
3736         NID_PACKET = 58 (3Ah) (00111010)
3737         Q_DIR = 0 (0h) (00) "Reverse"
3738         L_PACKET = 56 (38h) (0000000111000)
3739         Q_SCALE = 1 (1h) (01) "1 m scale"
3740         T_CYCLOC = 10 (Ah) (00001010)
3741         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
3742         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
3743     N_ITER = 0 (0h) (00000)
3744     Packet 5 - TrackToTrain - Linking
3745         NID_PACKET = 5 (5h) (00000101)
3746         Q_DIR = 0 (0h) (00) "Reverse"
3747         L_PACKET = 69 (45h) (0000001000101)
3748         Q_SCALE = 1 (1h) (01) "1 m scale"
3749         D_LINK = 634 (27Ah) (000001001111010) "634m"
3750     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
3751         NID_BG = 1013 (3F5h) (00001111110101)
3752         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
3753         Q_LINKREACTION = 2 (2h) (10) "No reaction"
3754         Q_LOCACC = 1 (1h) (000001)
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3755     N_ITER = 0 (0h) (00000)
3756     Packet 27 - TrackToTrain - International SSP
3757         NID_PACKET = 27 (1Bh) (00011011)
3758         Q_DIR = 0 (0h) (00) "Reverse"
3759         L_PACKET = 86 (56h) (0000001010110)
3760         Q_SCALE = 1 (1h) (01) "1 m scale"
3761         D_STATIC = 0 (0h) (000000000000000) "0m"
3762         V_STATIC = 10 (Ah) (0001010) "50 km/h"
3763         Q_FRONT = 1 (1h) (1) "No train length delay on
            validity end point of profile element"
3764     N_ITER = 0 (0h) (00000)
3765     N_ITER = 1 (1h) (00001)
3766         [0] D_STATIC = 718 (2CEh) (000001011001110)
            "718m"
3767         [0] V_STATIC = 127 (7Fh) (1111111) "Non
            numerical value telling that the static
            speed profile description ends at D_STATIC(n
            )"
3768         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
            validity end point of profile element"
3769     [0] N_ITER = 0 (0h) (00000)
3770     Packet 21 - TrackToTrain - Gradient Profile
3771         NID_PACKET = 21 (15h) (00010101)
3772         Q_DIR = 0 (0h) (00) "Reverse"
3773         L_PACKET = 102 (66h) (0000001100110)
3774         Q_SCALE = 1 (1h) (01) "1 m scale"
3775         D_GRADIENT = 0 (0h) (000000000000000) "0m"
3776         Q_GDIR = 1 (1h) (1) "Uphill"
3777         G_A = 15 (Fh) (00001111) "15 o/oo"
3778     N_ITER = 2 (2h) (00010)
3779         [0] D_GRADIENT = 601 (259h) (000001001011001)
            "601m"
3780         [0] Q_GDIR = 1 (1h) (1) "Uphill"
3781         [0] G_A = 5 (5h) (00000101) "5 o/oo"
3782         [1] D_GRADIENT = 117 (75h) (000000001110101)
            "117m"
3783         [1] Q_GDIR = 0 (0h) (0) "Downhill"
3784         [1] G_A = 255 (FFh) (11111111) "Non numerical
            value telling that the current gradient
            description ends at D_GRADIENT(n)"
3785 12:10:50.515025 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
            :192.168.0.132
3786     10000100 00000110 10000010 11010101 00011000 11111110
            11010111 00100000 01110100 00000100 00000000 00001000
            00010000 00000010 00001111 11011100 10011110
            00101000 00000000 00110010 00000000 01100100 10000000
            11111000 00010100 00000011
3787     NID_MESSAGE = 132 (84h) (10000100)
3788     L_MESSAGE = 26 (1Ah) (0000011010)

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C. Simulation Traces

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3789     T_TRAIN = 190079995 (B5463FBh)
          (00001011010101000110001111111011)
3790     NID_ENGINE = 6062544 (5C81D0h)
          (010111001000000111010000)
3791     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
          the perturbation location reached"
3792     Packet 0 - TrainToTrack - Pos Report
3793         NID_PACKET = 0 (0h) (00000000)
3794         L_PACKET = 129 (81h) (00000100000001)
3795         Q_SCALE = 0 (0h) (00) "10 cm scale"
3796     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3797         NID_C = 2 (2h) (0000000010)
3798         NID_BG = 1015 (3F7h) (00001111110111)
3799         D_LRBG = 5061 (13C5h) (001001111000101) "506.1m
          "
3800         Q_DIRLRBG = 0 (0h) (00) "Reverse"
3801         Q_DLRBG = 0 (0h) (00) "Reverse"
3802         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3803         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
          "
3804     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
          integrity monitoring device"
3805         L_TRAININT = 248 (F8h) (000000011111000)
3806         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3807         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3808         M_MODE = 0 (0h) (0000) "Full Supervision"
3809     M_LEVEL = 3 (3h) (011) "Level 2"
3810 12:10:58.451976 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
          (PK21) - Train 6062544 - Dest:192.168.0.134
3811     00000011 00010011 00000010 11010101 00011001 11000001
          11000000 00010000 01111110 11100001 11100000 00010110
          00010000 00000000 00000000 00000001 11110101
          00010000 00000000 00011111 10000111 00100000 00001100
          01000110 01111111 11110000 10100011 10100000
          00001001 00001000 01010111 11111111 11110010 00010000
          01011101 00110000 01010000 00001101 10001000
          00100111 10100000 01111110 10101000 00010000 10000000
          11000011 00000111 11110111 10000001 00011011
          00000000 10101100 10000000 00000000 00010101 00000000
          01000001 11110101 01111111 00000000 01010100
          00000011 11110010 00000000 00000010 00011110 00110000
          01001011 00110000 01010000 00010000 00010000
          11110000 00100010 00101111 11110000
3812     NID_MESSAGE = 3 (3h) (00000011)
3813     L_MESSAGE = 76 (4Ch) (0001001100)
3814     T_TRAIN = 190080775 (B546707h)
          (00001011010101000110011100000111)
3815     M_ACK = 0 (0h) (0) "No acknowledgement required"
3816     NID_LRBG = 33783 (83F7h) (000000001000001111110111)

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3817         NID_C = 2 (2h) (0000000010)
3818         NID_BG = 1015 (3F7h) (0000111110111)
3819     Packet 15 - TrackToTrain - Level 2/3 MA
3820         NID_PACKET = 15 (Fh) (00001111)
3821         Q_DIR = 0 (0h) (00) "Reverse"
3822         L_PACKET = 88 (58h) (0000001011000)
3823         Q_SCALE = 1 (1h) (01) "1 m scale"
3824         V_EMA = 0 (0h) (0000000) "0 km/h"
3825         T_EMA = 0 (0h) (0000000000)
3826     N_ITER = 0 (0h) (00000)
3827         L_ENDSECTION = 1002 (3EAh) (000001111101010)
3828             "1002m"
3829     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
3830         information"
3831     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
3832         information"
3833     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
3834         follow"
3835         D_DP = 0 (0h) (000000000000000) "0m"
3836         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
3837             calculated release speed"
3838     Q_OVERLAP = 0 (0h) (0) "No overlap information"
3839     Packet 57 - TrackToTrain - MA Request Params
3840         NID_PACKET = 57 (39h) (00111001)
3841         Q_DIR = 0 (0h) (00) "Reverse"
3842         L_PACKET = 49 (31h) (0000000110001)
3843         T_MAR = 25 (19h) (00011001)
3844         T_TIMEOURQST = 1023 (3FFh) (1111111111) "No MA
3845             request triggering with regards to this
3846             function"
3847         T_CYCRQST = 10 (Ah) (00001010)
3848     Packet 58 - TrackToTrain - Pos Report Params
3849         NID_PACKET = 58 (3Ah) (00111010)
3850         Q_DIR = 0 (0h) (00) "Reverse"
3851         L_PACKET = 72 (48h) (0000001001000)
3852         Q_SCALE = 1 (1h) (01) "1 m scale"
3853         T_CYCLOC = 10 (Ah) (00001010)
3854         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
3855             train has not to report cyclically its
3856             position"
3857         M_LOC = 1 (1h) (001) "Every LRBG compliant
3858             balise group"
3859     N_ITER = 1 (1h) (00001)
3860         [0] D_LOC = 745 (2E9h) (000001011101001) "745m"
3861         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
3862     Packet 5 - TrackToTrain - Linking
3863         NID_PACKET = 5 (5h) (00000101)
3864         Q_DIR = 0 (0h) (00) "Reverse"
3865         L_PACKET = 108 (6Ch) (0000001101100)

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3856         Q_SCALE = 1 (1h) (01) "1 m scale"
3857         D_LINK = 634 (27Ah) (000001001111010) "634m"
3858     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
3859         NID_BG = 1013 (3F5h) (00001111110101)
3860         Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
3861         Q_LINKREACTION = 2 (2h) (10) "No reaction"
3862         Q_LOCACC = 1 (1h) (000001)
3863     N_ITER = 1 (1h) (00001)
3864         [0] D_LINK = 195 (C3h) (000000011000011) "195m"
3865     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
3866         [0] NID_BG = 1019 (3FBh) (00001111111011)
3867         [0] Q_LINKORIENTATION = 1 (1h) (1) "The balise
        group is seen by the train in nominal
        direction"
3868         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
3869         [0] Q_LOCACC = 1 (1h) (000001)
3870     Packet 27 - TrackToTrain - International SSP
3871         NID_PACKET = 27 (1Bh) (00011011)
3872         Q_DIR = 0 (0h) (00) "Reverse"
3873         L_PACKET = 86 (56h) (0000001010110)
3874         Q_SCALE = 1 (1h) (01) "1 m scale"
3875         D_STATIC = 0 (0h) (000000000000000) "0m"
3876         V_STATIC = 10 (Ah) (0001010) "50 km/h"
3877         Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
3878     N_ITER = 0 (0h) (00000)
3879     N_ITER = 1 (1h) (00001)
3880         [0] D_STATIC = 1002 (3EAh) (000001111101010)
        "1002m"
3881         [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
3882         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
3883     [0] N_ITER = 0 (0h) (00000)
3884     Packet 21 - TrackToTrain - Gradient Profile
3885         NID_PACKET = 21 (15h) (00010101)
3886         Q_DIR = 0 (0h) (00) "Reverse"
3887         L_PACKET = 126 (7Eh) (0000001111110)
3888         Q_SCALE = 1 (1h) (01) "1 m scale"
3889         D_GRADIENT = 0 (0h) (000000000000000) "0m"
3890         Q_GDIR = 1 (1h) (1) "Uphill"
3891         G_A = 15 (Fh) (00001111) "15 o/oo"
3892     N_ITER = 3 (3h) (00011)

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3893 [0] D_GRADIENT = 601 (259h) (000001001011001)
      "601m"
3894 [0] Q_GDIR = 1 (1h) (1) "Uphill"
3895 [0] G_A = 5 (5h) (00000101) "5 o/oo"
3896 [1] D_GRADIENT = 128 (80h) (000000010000000)
      "128m"
3897 [1] Q_GDIR = 1 (1h) (1) "Uphill"
3898 [1] G_A = 15 (Fh) (00001111) "15 o/oo"
3899 [2] D_GRADIENT = 273 (111h) (000000100010001)
      "273m"
3900 [2] Q_GDIR = 0 (0h) (0) "Downhill"
3901 [2] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"
3902 12:10:59.065165 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
3903 10000100 00000110 10000010 11010101 00011001 11010011
      01010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00001111 11011100 11000011
      00010000 00000000 00110010 00000000 01100100 10000000
      11111000 00010100 00000011
3904 NID_MESSAGE = 132 (84h) (10000100)
3905 L_MESSAGE = 26 (1Ah) (0000011010)
3906 T_TRAIN = 190080845 (B54674Dh)
      (00001011010101000110011101001101)
3907 NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
3908 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
3909 Packet 0 - TrainToTrack - Pos Report
3910 NID_PACKET = 0 (0h) (00000000)
3911 L_PACKET = 129 (81h) (0000010000001)
3912 Q_SCALE = 0 (0h) (00) "10 cm scale"
3913 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
3914 NID_C = 2 (2h) (0000000010)
3915 NID_BG = 1015 (3F7h) (00001111110111)
3916 D_LRBG = 6242 (1862h) (001100001100010) "624.2m
      "
3917 Q_DIRLRBG = 0 (0h) (00) "Reverse"
3918 Q_DLRBG = 0 (0h) (00) "Reverse"
3919 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3920 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
      "
3921 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
3922 L_TRAININT = 248 (F8h) (000000011111000)
3923 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3924 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3925 M_MODE = 0 (0h) (0000) "Full Supervision"

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3926     M_LEVEL = 3 (3h) (011) "Level 2"
3927 12:11:09.055274 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
      :192.168.0.132
3928     10000100 00000110 10000010 11010101 00011010 11001101
      11010111 00100000 01110100 00000100 00000000 00001000
      00010000 00000010 00001111 11010100 00101000
      01011000 00000000 00110010 00000000 01100100 10000000
      11111000 00010100 00000011
3929     NID_MESSAGE = 132 (84h) (10000100)
3930     L_MESSAGE = 26 (1Ah) (0000011010)
3931     T_TRAIN = 190081847 (B546B37h)
      (000010110101010000110101100110111)
3932     NID_ENGINE = 6062544 (5C81D0h)
      (010111001000000111010000)
3933     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
3934     Packet 0 - TrainToTrack - Pos Report
3935         NID_PACKET = 0 (0h) (00000000)
3936         L_PACKET = 129 (81h) (00000100000001)
3937         Q_SCALE = 0 (0h) (00) "10 cm scale"
3938     NID_LRBG = 33781 (83F5h) (000000001000001111110101)
3939         NID_C = 2 (2h) (0000000010)
3940         NID_BG = 1013 (3F5h) (00001111110101)
3941         D_LRBG = 1291 (50Bh) (000010100001011) "129.1m"
3942         Q_DIRLRBG = 0 (0h) (00) "Reverse"
3943         Q_DLRBG = 0 (0h) (00) "Reverse"
3944         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
3945         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
3946     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
3947         L_TRAININT = 248 (F8h) (000000011111000)
3948         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
3949         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
3950         M_MODE = 0 (0h) (0000) "Full Supervision"
3951     M_LEVEL = 3 (3h) (011) "Level 2"
3952 12:11:09.077944 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
      (PK21) - Train 6062544 - Dest:192.168.0.134
3953     00000011 00010001 00000010 11010101 00011010 11001101
      11000000 00010000 01111110 10100001 11100000 00010110
      00010000 00000000 00000000 00000000 10111000
      00010000 00000000 00011111 10000111 00100000 00001100
      01000110 01111111 11110000 10100011 10100000
      00001001 00001000 01010111 11111111 11110010 00010000
      00001101 11110000 01010000 00001000 10101000
      00001100 00110000 01111111 01111000 00010000 00001101
      10000000 01010110 01000000 00000000 00001010
      10000000 00100000 01011100 00111111 10000000 00101010
      00000001 10011001 00000000 00000001 00000101

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00010000 00000101 11111000 01111000 00010001 00010111
11111000
3954 NID_MESSAGE = 3 (3h) (00000011)
3955 L_MESSAGE = 68 (44h) (0001000100)
3956 T_TRAIN = 190081847 (B546B37h)
(00001011010101000110101100110111)
3957 M_ACK = 0 (0h) (0) "No acknowledgement required"
3958 NID_LRBG = 33781 (83F5h) (000000001000001111110101)
3959 NID_C = 2 (2h) (0000000010)
3960 NID_BG = 1013 (3F5h) (00001111110101)
3961 Packet 15 - TrackToTrain - Level 2/3 MA
3962 NID_PACKET = 15 (Fh) (00001111)
3963 Q_DIR = 0 (0h) (00) "Reverse"
3964 L_PACKET = 88 (58h) (0000001011000)
3965 Q_SCALE = 1 (1h) (01) "1 m scale"
3966 V_EMA = 0 (0h) (00000000) "0 km/h"
3967 T_EMA = 0 (0h) (0000000000)
3968 N_ITER = 0 (0h) (00000)
3969 L_ENDSECTION = 368 (170h) (000000101110000)
"368m"
3970 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
3971 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
3972 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
3973 D_DP = 0 (0h) (0000000000000000) "0m"
3974 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
3975 Q_OVERLAP = 0 (0h) (0) "No overlap information"
3976 Packet 57 - TrackToTrain - MA Request Params
3977 NID_PACKET = 57 (39h) (00111001)
3978 Q_DIR = 0 (0h) (00) "Reverse"
3979 L_PACKET = 49 (31h) (0000000110001)
3980 T_MAR = 25 (19h) (00011001)
3981 T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
request triggering with regards to this
function"
3982 T_CYCRQST = 10 (Ah) (00001010)
3983 Packet 58 - TrackToTrain - Pos Report Params
3984 NID_PACKET = 58 (3Ah) (00111010)
3985 Q_DIR = 0 (0h) (00) "Reverse"
3986 L_PACKET = 72 (48h) (0000001001000)
3987 Q_SCALE = 1 (1h) (01) "1 m scale"
3988 T_CYCLOC = 10 (Ah) (00001010)
3989 D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
train has not to report cyclically its
position"
3990 M_LOC = 1 (1h) (001) "Every LRBG compliant

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                                balise group"
3991      N_ITER = 1 (1h) (00001)
3992      [0] D_LOC = 111 (6Fh) (000000001101111) "111m"
3993      [0] Q_LGTLLOC = 1 (1h) (1) "Max safe front end"
3994      Packet 5 - TrackToTrain - Linking
3995      NID_PACKET = 5 (5h) (00000101)
3996      Q_DIR = 0 (0h) (00) "Reverse"
3997      L_PACKET = 69 (45h) (0000001000101)
3998      Q_SCALE = 1 (1h) (01) "1 m scale"
3999      D_LINK = 195 (C3h) (000000011000011) "195m"
4000      Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
                                administration, no NID_C follows"
4001      NID_BG = 1019 (3FBh) (00001111111011)
4002      Q_LINKORIENTATION = 1 (1h) (1) "The balise
                                group is seen by the train in nominal
                                direction"
4003      Q_LINKREACTION = 2 (2h) (10) "No reaction"
4004      Q_LOCACCC = 1 (1h) (000001)
4005      N_ITER = 0 (0h) (00000)
4006      Packet 27 - TrackToTrain - International SSP
4007      NID_PACKET = 27 (1Bh) (00011011)
4008      Q_DIR = 0 (0h) (00) "Reverse"
4009      L_PACKET = 86 (56h) (0000001010110)
4010      Q_SCALE = 1 (1h) (01) "1 m scale"
4011      D_STATIC = 0 (0h) (000000000000000) "0m"
4012      V_STATIC = 10 (Ah) (0001010) "50 km/h"
4013      Q_FRONT = 1 (1h) (1) "No train length delay on
                                validity end point of profile element"
4014      N_ITER = 0 (0h) (00000)
4015      N_ITER = 1 (1h) (00001)
4016      [0] D_STATIC = 368 (170h) (000000101110000)
                                "368m"
4017      [0] V_STATIC = 127 (7Fh) (1111111) "Non
                                numerical value telling that the static
                                speed profile description ends at D_STATIC(n
                                )"
4018      [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                                validity end point of profile element"
4019      [0] N_ITER = 0 (0h) (00000)
4020      Packet 21 - TrackToTrain - Gradient Profile
4021      NID_PACKET = 21 (15h) (00010101)
4022      Q_DIR = 0 (0h) (00) "Reverse"
4023      L_PACKET = 102 (66h) (0000001100110)
4024      Q_SCALE = 1 (1h) (01) "1 m scale"
4025      D_GRADIENT = 0 (0h) (000000000000000) "0m"
4026      Q_GDIR = 1 (1h) (1) "Uphill"
4027      G_A = 5 (5h) (00000101) "5 o/oo"
4028      N_ITER = 2 (2h) (00010)
4029      [0] D_GRADIENT = 95 (5Fh) (000000001011111) "95

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m"
4030      [0] Q_GDIR = 1 (1h) (1) "Uphill"
4031      [0] G_A = 15 (Fh) (00001111) "15 o/oo"
4032      [1] D_GRADIENT = 273 (111h) (000000100010001)
         "273m"
4033      [1] Q_GDIR = 0 (0h) (0) "Downhill"
4034      [1] G_A = 255 (FFh) (11111111) "Non numerical
         value telling that the current gradient
         description ends at D_GRADIENT(n)"
4035 12:11:09.855485 # MA Req (MsgId 132) (PK0) - Train 6062544 - Dest
         :192.168.0.132
4036      10000100 00000110 10000010 11010101 00011010 11011001
         11010111 00100000 01110100 00000100 00000000 00001000
         00010000 00000010 00001111 11010100 00101010
         10000000 00000000 00110010 00000000 01100100 10000000
         11111000 00010100 00000011
4037      NID_MESSAGE = 132 (84h) (10000100)
4038      L_MESSAGE = 26 (1Ah) (0000011010)
4039      T_TRAIN = 190081895 (B546B67h)
         (00001011010101000110101101100111)
4040      NID_ENGINE = 6062544 (5C81D0h)
         (010111001000000111010000)
4041      Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
         the perturbation location reached"
4042      Packet 0 - TrainToTrack - Pos Report
4043      NID_PACKET = 0 (0h) (00000000)
4044      L_PACKET = 129 (81h) (0000010000001)
4045      Q_SCALE = 0 (0h) (00) "10 cm scale"
4046      NID_LRBG = 33781 (83F5h) (000000001000001111110101)
4047      NID_C = 2 (2h) (0000000010)
4048      NID_BG = 1013 (3F5h) (00001111110101)
4049      D_LRBG = 1360 (550h) (000010101010000) "136.0m"
4050      Q_DIRLRBG = 0 (0h) (00) "Reverse"
4051      Q_DLRBG = 0 (0h) (00) "Reverse"
4052      L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4053      L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
         "
4054      Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4055      L_TRAININT = 248 (F8h) (000000011111000)
4056      V_TRAIN = 10 (Ah) (0001010) "50 km/h"
4057      Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4058      M_MODE = 0 (0h) (0000) "Full Supervision"
4059      M_LEVEL = 3 (3h) (011) "Level 2"
4060 12:11:15.364455 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
         (PK21) - Train 6062545 - Dest:192.168.0.134
4061      00000011 00010101 00000010 11010101 00011011 01101010
         01000000 00010000 01111110 01100001 11101000 00010000
         10010000 00000000 00000000 00000101 00011110

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10000001 11001010 00000011 00010001 10011111 11111100
00101000 11101001 00000010 11000010 00010101
11111111 11111100 10001000 00000001 10110100 00111010
01111100 00010101 00000011 01100010 00011001
01101100 00011111 11001010 00000100 00100000 01101001
10000001 11111011 10100000 01000110 11010000
00101011 00100000 00000000 00000101 01000000 00010001
01000111 10111111 11000000 00010101 01000001
10001100 10000000 00000000 10000000 00011000 00001100
11100000 00001000 00001000 00010100 00000000
00001100 10010100 00011000 00001001 10010100 00010000
00001111 10011100 00111100 00010111 01000011
11111100
4062 NID_MESSAGE = 3 (3h) (00000011)
4063 L_MESSAGE = 84 (54h) (0001010100)
4064 T_TRAIN = 190082473 (B546DA9h)
(000010110101010000110110110101001)
4065 M_ACK = 0 (0h) (0) "No acknowledgement required"
4066 NID_LRBG = 33779 (83F3h) (000000001000001111110011)
4067 NID_C = 2 (2h) (0000000010)
4068 NID_BG = 1011 (3F3h) (00001111110011)
4069 Packet 15 - TrackToTrain - Level 2/3 MA
4070 NID_PACKET = 15 (Fh) (00001111)
4071 Q_DIR = 1 (1h) (01) "Nominal"
4072 L_PACKET = 66 (42h) (0000001000010)
4073 Q_SCALE = 1 (1h) (01) "1 m scale"
4074 V_EMA = 0 (0h) (00000000) "0 km/h"
4075 T_EMA = 0 (0h) (0000000000)
4076 N_ITER = 0 (0h) (000000)
4077 L_ENDSECTION = 2621 (A3Dh) (000101000111101)
"2621m"
4078 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
4079 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
4080 Q_DANGERPOINT = 0 (0h) (0) "No danger point information"
4081 Q_OVERLAP = 0 (0h) (0) "No overlap information"
4082 Packet 57 - TrackToTrain - MA Request Params
4083 NID_PACKET = 57 (39h) (00111001)
4084 Q_DIR = 1 (1h) (01) "Nominal"
4085 L_PACKET = 49 (31h) (0000000110001)
4086 T_MAR = 25 (19h) (00011001)
4087 T_TIMEOUSRQST = 1023 (3FFh) (111111111) "No MA
request triggering with regards to this
function"
4088 T_CYCRQST = 10 (Ah) (00001010)
4089 Packet 58 - TrackToTrain - Pos Report Params
4090 NID_PACKET = 58 (3Ah) (00111010)
4091 Q_DIR = 1 (1h) (01) "Nominal"

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4092         L_PACKET = 88 (58h) (0000001011000)
4093         Q_SCALE = 1 (1h) (01) "1 m scale"
4094         T_CYCLOC = 10 (Ah) (00001010)
4095         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
4096         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
4097     N_ITER = 2 (2h) (00010)
4098         [0] D_LOC = 54 (36h) (000000000110110) "54m"
4099         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
4100         [1] D_LOC = 1871 (74Fh) (000011101001111) "1871
           m"
4101         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
4102     Packet 5 - TrackToTrain - Linking
4103         NID_PACKET = 5 (5h) (00000101)
4104         Q_DIR = 1 (1h) (01) "Nominal"
4105         L_PACKET = 108 (6Ch) (0000001101100)
4106         Q_SCALE = 1 (1h) (01) "1 m scale"
4107         D_LINK = 1627 (65Bh) (000011001011011) "1627m"
4108     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
4109         NID_BG = 1017 (3F9h) (00001111111001)
4110         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
4111         Q_LINKREACTION = 2 (2h) (10) "No reaction"
4112         Q_LOCAC = 1 (1h) (000001)
4113     N_ITER = 1 (1h) (00001)
4114         [0] D_LINK = 422 (1A6h) (000000110100110) "422m
           "
4115         [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
4116         [0] NID_BG = 1015 (3F7h) (00001111110111)
4117         [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
4118         [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
4119         [0] Q_LOCAC = 1 (1h) (000001)
4120     Packet 27 - TrackToTrain - International SSP
4121         NID_PACKET = 27 (1Bh) (00011011)
4122         Q_DIR = 1 (1h) (01) "Nominal"
4123         L_PACKET = 86 (56h) (0000001010110)
4124         Q_SCALE = 1 (1h) (01) "1 m scale"
4125         D_STATIC = 0 (0h) (000000000000000) "0m"
4126         V_STATIC = 10 (Ah) (0001010) "50 km/h"
4127         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
4128     N_ITER = 0 (0h) (00000)

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C. Simulation Traces

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4129     N_ITER = 1 (1h) (00001)
4130     [0] D_STATIC = 2621 (A3Dh) (000101000111101)
         "2621m"
4131     [0] V_STATIC = 127 (7Fh) (1111111) "Non
         numerical value telling that the static
         speed profile description ends at D_STATIC(n
         )"
4132     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
         validity end point of profile element"
4133     [0] N_ITER = 0 (0h) (00000)
4134     Packet 21 - TrackToTrain - Gradient Profile
4135     NID_PACKET = 21 (15h) (00010101)
4136     Q_DIR = 1 (1h) (01) "Nominal"
4137     L_PACKET = 198 (C6h) (0000011000110)
4138     Q_SCALE = 1 (1h) (01) "1 m scale"
4139     D_GRADIENT = 0 (0h) (000000000000000) "0m"
4140     Q_GDIR = 1 (1h) (1) "Uphill"
4141     G_A = 0 (0h) (00000000) "0 o/oo"
4142     N_ITER = 6 (6h) (00110)
4143     [0] D_GRADIENT = 412 (19Ch) (000000110011100)
         "412m"
4144     [0] Q_GDIR = 0 (0h) (0) "Downhill"
4145     [0] G_A = 2 (2h) (00000010) "2 o/oo"
4146     [1] D_GRADIENT = 258 (102h) (000000100000010)
         "258m"
4147     [1] Q_GDIR = 1 (1h) (1) "Uphill"
4148     [1] G_A = 0 (0h) (00000000) "0 o/oo"
4149     [2] D_GRADIENT = 402 (192h) (000000110010010)
         "402m"
4150     [2] Q_GDIR = 1 (1h) (1) "Uphill"
4151     [2] G_A = 6 (6h) (00000110) "6 o/oo"
4152     [3] D_GRADIENT = 306 (132h) (000000100110010)
         "306m"
4153     [3] Q_GDIR = 1 (1h) (1) "Uphill"
4154     [3] G_A = 4 (4h) (00000100) "4 o/oo"
4155     [4] D_GRADIENT = 499 (1F3h) (000000111110011)
         "499m"
4156     [4] Q_GDIR = 1 (1h) (1) "Uphill"
4157     [4] G_A = 15 (Fh) (00001111) "15 o/oo"
4158     [5] D_GRADIENT = 744 (2E8h) (000001011101000)
         "744m"
4159     [5] Q_GDIR = 0 (0h) (0) "Downhill"
4160     [5] G_A = 255 (FFh) (11111111) "Non numerical
         value telling that the current gradient
         description ends at D_GRADIENT(n)"
4161 12:11:15.628253 # VL Release Request (MsgId 3) - Dest
         :192.168.0.132
4162     Preamble = 65535 (FFFFh) (1111111111111111)
4163     Length of PDU = 14 (0Eh) (0000000000001110)

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4164         Message ID = 3 (03h) (00000011)
4165         Channel ID = 128 (80h) (10000000)
4166         DATA [0] = 2 (02h) (00000010)
4167         DATA [1] = 3 (03h) (00000011)
4168         DATA [2] = 0 (00h) (00000000)
4169         DATA [3] = 3 (03h) (00000011)
4170         DATA [4] = 16 (10h) (00010000)
4171         DATA [5] = 0 (00h) (00000000)
4172         DATA [6] = 0 (00h) (00000000)
4173         DATA [7] = 2 (02h) (00000010)
4174         DATA [8] = 5 (05h) (00000101)
4175         DATA [9] = 0 (00h) (00000000)
4176         DATA [10] = 1 (01h) (00000001)
4177         DATA [11] = 128 (80h) (10000000)
4178 12:11:26.131614 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
         (PK21) - Train 6062545 - Dest:192.168.0.134
4179         00000011 00010111 11000010 11010101 00011100 01111000
         00000000 00010000 01111110 01100001 11101000 00010110
         00010000 00000000 00000000 00000101 01100111
         10010000 00000000 00011111 10000111 00101000 00001100
         01000110 01111111 11110000 10100011 10100100
         00001011 00001000 01010111 11111111 11110010 00100000
         00000110 11010000 11101001 11110000 01010100
         00010010 01101000 01100101 10110000 01111111 00101000
         00010001 00000001 10100110 00000111 11101110
         10000001 00000100 11110100 00001111 11010101 00000010
         00110110 10000001 01011001 00000000 00000000
         00101010 00000000 10001010 11001111 11111110 00000000
         10101010 00001101 11100100 00000000 00000100
         00000000 11100000 01100111 00000000 01000000 01000000
         10100000 00000000 01100100 10100000 11000000
         01001100 10100000 10000000 01111100 11100001 11100000
         11000001 01100000 10100000 00011101 01011111
         11100000
4180         NID_MESSAGE = 3 (3h) (00000011)
4181         L_MESSAGE = 95 (5Fh) (0001011111)
4182         T_TRAIN = 190083552 (B5471E0h)
         (0000101101010101000111000111100000)
4183         M_ACK = 0 (0h) (0) "No acknowledgement required"
4184         NID_LRBG = 33779 (83F3h) (000000001000001111110011)
         NID_C = 2 (2h) (0000000010)
4185         NID_BG = 1011 (3F3h) (00001111110011)
4186         Packet 15 - TrackToTrain - Level 2/3 MA
4187         NID_PACKET = 15 (Fh) (00001111)
4188         Q_DIR = 1 (1h) (01) "Nominal"
4189         L_PACKET = 88 (58h) (0000001011000)
4190         Q_SCALE = 1 (1h) (01) "1 m scale"
4191         V_EMA = 0 (0h) (00000000) "0 km/h"
4192         T_EMA = 0 (0h) (0000000000)
4193

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4194     N_ITER = 0 (0h) (000000)
4195         L_ENDSECTION = 2767 (ACFh) (000101011001111)
           "2767m"
4196     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
4197     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
4198     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
4199         D_DP = 0 (0h) (0000000000000000) "0m"
4200         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
4201     Q_OVERLAP = 0 (0h) (0) "No overlap information"
4202     Packet 57 - TrackToTrain - MA Request Params
4203         NID_PACKET = 57 (39h) (00111001)
4204         Q_DIR = 1 (1h) (01) "Nominal"
4205         L_PACKET = 49 (31h) (0000000110001)
4206         T_MAR = 25 (19h) (00011001)
4207         T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
           request triggering with regards to this
           function"
4208         T_CYCRQST = 10 (Ah) (00001010)
4209     Packet 58 - TrackToTrain - Pos Report Params
4210         NID_PACKET = 58 (3Ah) (00111010)
4211         Q_DIR = 1 (1h) (01) "Nominal"
4212         L_PACKET = 88 (58h) (0000001011000)
4213         Q_SCALE = 1 (1h) (01) "1 m scale"
4214         T_CYCLOC = 10 (Ah) (00001010)
4215         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
           train has not to report cyclically its
           position"
4216         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
4217     N_ITER = 2 (2h) (00010)
4218         [0] D_LOC = 54 (36h) (000000000110110) "54m"
4219         [0] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
4220         [1] D_LOC = 1871 (74Fh) (000011101001111) "1871
           m"
4221         [1] Q_LGTLOC = 1 (1h) (1) "Max safe front end"
4222     Packet 5 - TrackToTrain - Linking
4223         NID_PACKET = 5 (5h) (00000101)
4224         Q_DIR = 1 (1h) (01) "Nominal"
4225         L_PACKET = 147 (93h) (0000010010011)
4226         Q_SCALE = 1 (1h) (01) "1 m scale"
4227         D_LINK = 1627 (65Bh) (000011001011011) "1627m"
4228     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
4229         NID_BG = 1017 (3F9h) (00001111111001)
4230         Q_LINKORIENTATION = 0 (0h) (0) "The balise
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        group is seen by the train in reverse
        direction"
4231     Q_LINKREACTION = 2 (2h) (10) "No reaction"
4232     Q_LOCACCC = 1 (1h) (000001)
4233     N_ITER = 2 (2h) (00010)
4234     [0] D_LINK = 422 (1A6h) (0000000110100110) "422m
        "
4235     [0] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
4236     [0] NID_BG = 1015 (3F7h) (00001111110111)
4237     [0] Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
4238     [0] Q_LINKREACTION = 2 (2h) (10) "No reaction"
4239     [0] Q_LOCACCC = 1 (1h) (000001)
4240     [1] D_LINK = 634 (27Ah) (000001001111010) "634m
        "
4241     [1] Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
        administration, no NID_C follows"
4242     [1] NID_BG = 1013 (3F5h) (00001111110101)
4243     [1] Q_LINKORIENTATION = 0 (0h) (0) "The balise
        group is seen by the train in reverse
        direction"
4244     [1] Q_LINKREACTION = 2 (2h) (10) "No reaction"
4245     [1] Q_LOCACCC = 1 (1h) (000001)
4246     Packet 27 - TrackToTrain - International SSP
4247     NID_PACKET = 27 (1Bh) (00011011)
4248     Q_DIR = 1 (1h) (01) "Nominal"
4249     L_PACKET = 86 (56h) (0000001010110)
4250     Q_SCALE = 1 (1h) (01) "1 m scale"
4251     D_STATIC = 0 (0h) (000000000000000) "0m"
4252     V_STATIC = 10 (Ah) (0001010) "50 km/h"
4253     Q_FRONT = 1 (1h) (1) "No train length delay on
        validity end point of profile element"
4254     N_ITER = 0 (0h) (00000)
4255     N_ITER = 1 (1h) (00001)
4256     [0] D_STATIC = 2767 (ACFh) (000101011001111)
        "2767m"
4257     [0] V_STATIC = 127 (7Fh) (1111111) "Non
        numerical value telling that the static
        speed profile description ends at D_STATIC(n
        )"
4258     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
        validity end point of profile element"
4259     [0] N_ITER = 0 (0h) (00000)
4260     Packet 21 - TrackToTrain - Gradient Profile
4261     NID_PACKET = 21 (15h) (00010101)
4262     Q_DIR = 1 (1h) (01) "Nominal"
4263     L_PACKET = 222 (DEh) (0000011011110)

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C. Simulation Traces

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4264         Q_SCALE = 1 (1h) (01) "1 m scale"
4265         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
4266         Q_GDIR = 1 (1h) (1) "Uphill"
4267         G_A = 0 (0h) (00000000) "0 o/oo"
4268     N_ITER = 7 (7h) (00111)
4269         [0] D_GRADIENT = 412 (19Ch) (000000110011100)
           "412m"
4270         [0] Q_GDIR = 0 (0h) (0) "Downhill"
4271         [0] G_A = 2 (2h) (00000010) "2 o/oo"
4272         [1] D_GRADIENT = 258 (102h) (000000100000010)
           "258m"
4273         [1] Q_GDIR = 1 (1h) (1) "Uphill"
4274         [1] G_A = 0 (0h) (00000000) "0 o/oo"
4275         [2] D_GRADIENT = 402 (192h) (000000110010010)
           "402m"
4276         [2] Q_GDIR = 1 (1h) (1) "Uphill"
4277         [2] G_A = 6 (6h) (00000110) "6 o/oo"
4278         [3] D_GRADIENT = 306 (132h) (000000100110010)
           "306m"
4279         [3] Q_GDIR = 1 (1h) (1) "Uphill"
4280         [3] G_A = 4 (4h) (00000100) "4 o/oo"
4281         [4] D_GRADIENT = 499 (1F3h) (000000111110011)
           "499m"
4282         [4] Q_GDIR = 1 (1h) (1) "Uphill"
4283         [4] G_A = 15 (Fh) (00001111) "15 o/oo"
4284         [5] D_GRADIENT = 773 (305h) (000001100000101)
           "773m"
4285         [5] Q_GDIR = 1 (1h) (1) "Uphill"
4286         [5] G_A = 5 (5h) (00000101) "5 o/oo"
4287         [6] D_GRADIENT = 117 (75h) (000000001110101)
           "117m"
4288         [6] Q_GDIR = 0 (0h) (0) "Downhill"
4289         [6] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
4290 12:13:00.205137 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
4291     10000100 00000110 10000010 11010101 00100101 10101000
           11010111 00100000 01110100 01000100 00000000 00001000
           00010000 00000010 00001111 11011100 00111100
           11111000 00000000 00110010 00000000 01100100 10000000
           11111000 00010100 00000011
4292     NID_MESSAGE = 132 (84h) (10000100)
4293     L_MESSAGE = 26 (1Ah) (0000011010)
4294     T_TRAIN = 190092963 (B5496A3h)
           (00001011010101001001001011010100011)
4295     NID_ENGINE = 6062545 (5C81D1h)
           (010111001000000111010001)
4296     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching

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the perturbation location reached"
4297 Packet 0 - TrainToTrack - Pos Report
4298 NID_PACKET = 0 (0h) (00000000)
4299 L_PACKET = 129 (81h) (00000100000001)
4300 Q_SCALE = 0 (0h) (00) "10 cm scale"
4301 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4302 NID_C = 2 (2h) (0000000010)
4303 NID_BG = 1015 (3F7h) (00001111110111)
4304 D_LRBG = 1951 (79Fh) (000011110011111) "195.1m"
4305 Q_DIRLRBG = 0 (0h) (00) "Reverse"
4306 Q_DLRBG = 0 (0h) (00) "Reverse"
4307 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4308 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
"
4309 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
integrity monitoring device"
4310 L_TRAININT = 248 (F8h) (000000011111000)
4311 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
4312 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4313 M_MODE = 0 (0h) (0000) "Full Supervision"
4314 M_LEVEL = 3 (3h) (011) "Level 2"
4315 12:13:00.233324 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
(PK21) - Train 6062545 - Dest:192.168.0.134
4316 00000011 00010000 10000010 11010101 00100101 10101000
11000000 00010000 01111110 11100001 11100000 00010110
00010000 00000000 00000000 00000001 01100111
00010000 00000000 00011111 10000111 00100000 00001100
01000110 01111111 11110000 10100011 10100000
00000111 00001000 01010111 11111111 11110010 00000000
01010000 00001000 10101000 00100111 10100000
01111110 10101000 00010000 00001101 10000000 01010110
01000000 00000000 00001010 10000000 00100000
10110011 10111111 10000000 00101010 00000001 10011001
00000000 00000001 00001111 00010000 00100101
10011000 00101000 00000111 01010111 11111000
4317 NID_MESSAGE = 3 (3h) (00000011)
4318 L_MESSAGE = 66 (42h) (0001000010)
4319 T_TRAIN = 190092963 (B5496A3h)
(00001011010101001001001011010100011)
4320 M_ACK = 0 (0h) (0) "No acknowledgement required"
4321 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4322 NID_C = 2 (2h) (0000000010)
4323 NID_BG = 1015 (3F7h) (00001111110111)
4324 Packet 15 - TrackToTrain - Level 2/3 MA
4325 NID_PACKET = 15 (Fh) (00001111)
4326 Q_DIR = 0 (0h) (00) "Reverse"
4327 L_PACKET = 88 (58h) (0000001011000)
4328 Q_SCALE = 1 (1h) (01) "1 m scale"
4329 V_EMA = 0 (0h) (0000000) "0 km/h"

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4330         T_EMA = 0 (0h) (0000000000)
4331 N_ITER = 0 (0h) (00000)
4332         L_ENDSECTION = 718 (2CEh) (000001011001110)
           "718m"
4333 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
           information"
4334 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
           information"
4335 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
           follow"
4336         D_DP = 0 (0h) (0000000000000000) "0m"
4337         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
           calculated release speed"
4338 Q_OVERLAP = 0 (0h) (0) "No overlap information"
4339 Packet 57 - TrackToTrain - MA Request Params
4340         NID_PACKET = 57 (39h) (00111001)
4341         Q_DIR = 0 (0h) (00) "Reverse"
4342         L_PACKET = 49 (31h) (0000000110001)
4343         T_MAR = 25 (19h) (00011001)
4344         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
4345         T_CYCRQST = 10 (Ah) (00001010)
4346 Packet 58 - TrackToTrain - Pos Report Params
4347         NID_PACKET = 58 (3Ah) (00111010)
4348         Q_DIR = 0 (0h) (00) "Reverse"
4349         L_PACKET = 56 (38h) (0000000111000)
4350         Q_SCALE = 1 (1h) (01) "1 m scale"
4351         T_CYCLOC = 10 (Ah) (00001010)
4352         D_CYCLOC = 32767 (7FFFh) (111111111111111) "The
           train has not to report cyclically its
           position"
4353         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
4354 N_ITER = 0 (0h) (00000)
4355 Packet 5 - TrackToTrain - Linking
4356         NID_PACKET = 5 (5h) (00000101)
4357         Q_DIR = 0 (0h) (00) "Reverse"
4358         L_PACKET = 69 (45h) (0000001000101)
4359         Q_SCALE = 1 (1h) (01) "1 m scale"
4360         D_LINK = 634 (27Ah) (000001001111010) "634m"
4361 Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
4362         NID_BG = 1013 (3F5h) (00001111110101)
4363         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
4364         Q_LINKREACTION = 2 (2h) (10) "No reaction"
4365         Q_LOCACC = 1 (1h) (000001)
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4366     N_ITER = 0 (0h) (00000)
4367     Packet 27 - TrackToTrain - International SSP
4368         NID_PACKET = 27 (1Bh) (00011011)
4369         Q_DIR = 0 (0h) (00) "Reverse"
4370         L_PACKET = 86 (56h) (0000001010110)
4371         Q_SCALE = 1 (1h) (01) "1 m scale"
4372         D_STATIC = 0 (0h) (0000000000000000) "0m"
4373         V_STATIC = 10 (Ah) (0001010) "50 km/h"
4374         Q_FRONT = 1 (1h) (1) "No train length delay on
            validity end point of profile element"
4375     N_ITER = 0 (0h) (00000)
4376     N_ITER = 1 (1h) (00001)
4377         [0] D_STATIC = 718 (2CEh) (000001011001110)
            "718m"
4378         [0] V_STATIC = 127 (7Fh) (1111111) "Non
            numerical value telling that the static
            speed profile description ends at D_STATIC(n
            )"
4379         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
            validity end point of profile element"
4380     [0] N_ITER = 0 (0h) (00000)
4381     Packet 21 - TrackToTrain - Gradient Profile
4382         NID_PACKET = 21 (15h) (00010101)
4383         Q_DIR = 0 (0h) (00) "Reverse"
4384         L_PACKET = 102 (66h) (0000001100110)
4385         Q_SCALE = 1 (1h) (01) "1 m scale"
4386         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
4387         Q_GDIR = 1 (1h) (1) "Uphill"
4388         G_A = 15 (Fh) (00001111) "15 o/oo"
4389     N_ITER = 2 (2h) (00010)
4390         [0] D_GRADIENT = 601 (259h) (000001001011001)
            "601m"
4391         [0] Q_GDIR = 1 (1h) (1) "Uphill"
4392         [0] G_A = 5 (5h) (00000101) "5 o/oo"
4393         [1] D_GRADIENT = 117 (75h) (000000001110101)
            "117m"
4394         [1] Q_GDIR = 0 (0h) (0) "Downhill"
4395         [1] G_A = 255 (FFh) (11111111) "Non numerical
            value telling that the current gradient
            description ends at D_GRADIENT(n)"
4396 12:13:01.190442 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
            :192.168.0.132
4397     10000100 00000110 10000010 11010101 00100101 11000001
            11010111 00100000 01110100 01000100 00000000 00001000
            00010000 00000010 00001111 11011100 01000001
            01001000 00000000 00110010 00000000 01100100 10000000
            11111000 00010100 00000011
4398     NID_MESSAGE = 132 (84h) (10000100)
4399     L_MESSAGE = 26 (1Ah) (0000011010)

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C. Simulation Traces

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4400 T_TRAIN = 190093063 (B549707h)
      (00001011010101001001011100000111)
4401 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
4402 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
4403 Packet 0 - TrainToTrack - Pos Report
4404 NID_PACKET = 0 (0h) (00000000)
4405 L_PACKET = 129 (81h) (00000100000001)
4406 Q_SCALE = 0 (0h) (00) "10 cm scale"
4407 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4408 NID_C = 2 (2h) (0000000010)
4409 NID_BG = 1015 (3F7h) (00001111110111)
4410 D_LRBG = 2089 (829h) (000100000101001) "208.9m"
4411 Q_DIRLRBG = 0 (0h) (00) "Reverse"
4412 Q_DLRBG = 0 (0h) (00) "Reverse"
4413 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4414 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
      "
4415 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
4416 L_TRAININT = 248 (F8h) (000000011111000)
4417 V_TRAIN = 10 (Ah) (0001010) "50 km/h"
4418 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4419 M_MODE = 0 (0h) (0000) "Full Supervision"
4420 M_LEVEL = 3 (3h) (011) "Level 2"
4421 12:13:11.206710 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
      :192.168.0.132
4422 10000100 00000110 10000010 11010101 00100110 10111100
      00010111 00100000 01110100 01000100 00000000 00001000
      00010000 00000010 00001111 11011100 01101100
      10110000 00000000 00110010 00000000 01100100 10000000
      11111000 00010100 00000011
4423 NID_MESSAGE = 132 (84h) (10000100)
4424 L_MESSAGE = 26 (1Ah) (0000011010)
4425 T_TRAIN = 190094064 (B549AF0h)
      (00001011010101001001101011110000)
4426 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
4427 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
4428 Packet 0 - TrainToTrack - Pos Report
4429 NID_PACKET = 0 (0h) (00000000)
4430 L_PACKET = 129 (81h) (00000100000001)
4431 Q_SCALE = 0 (0h) (00) "10 cm scale"
4432 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4433 NID_C = 2 (2h) (0000000010)
4434 NID_BG = 1015 (3F7h) (00001111110111)
4435 D_LRBG = 3478 (D96h) (000110110010110) "347.8m"
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4436         Q_DIRLRBG = 0 (0h) (00) "Reverse"
4437         Q_DLRBG = 0 (0h) (00) "Reverse"
4438         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4439         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
         "
4440     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4441         L_TRAININT = 248 (F8h) (000000011111000)
4442         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
4443         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4444         M_MODE = 0 (0h) (0000) "Full Supervision"
4445     M_LEVEL = 3 (3h) (011) "Level 2"
4446 12:13:11.233540 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
         (PK21) - Train 6062545 - Dest:192.168.0.134
4447     00000011 00010000 10000010 11010101 00100110 10111100
         00000000 00010000 01111110 11100001 11100000 00010110
         00010000 00000000 00000000 00000001 01100111
         00010000 00000000 00011111 10000111 00100000 00001100
         01000110 01111111 11110000 10100011 10100000
         00000111 00001000 01010111 11111111 11110010 00000000
         01010000 00001000 10101000 00100111 10100000
         01111110 10101000 00010000 00001101 10000000 01010110
         01000000 00000000 00001010 10000000 00100000
         10110011 10111111 10000000 00101010 00000001 10011001
         00000000 00000001 00001111 00010000 00100101
         10011000 00101000 00000111 01010111 11111000
4448     NID_MESSAGE = 3 (3h) (00000011)
4449     L_MESSAGE = 66 (42h) (0001000010)
4450     T_TRAIN = 190094064 (B549AF0h)
         (00001011010101001001101011110000)
4451     M_ACK = 0 (0h) (0) "No acknowledgement required"
4452     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4453         NID_C = 2 (2h) (0000000010)
4454         NID_BG = 1015 (3F7h) (00001111110111)
4455     Packet 15 - TrackToTrain - Level 2/3 MA
4456         NID_PACKET = 15 (Fh) (00001111)
4457         Q_DIR = 0 (0h) (00) "Reverse"
4458         L_PACKET = 88 (58h) (0000001011000)
4459         Q_SCALE = 1 (1h) (01) "1 m scale"
4460         V_EMA = 0 (0h) (0000000) "0 km/h"
4461         T_EMA = 0 (0h) (0000000000)
4462     N_ITER = 0 (0h) (00000)
4463         L_ENDSECTION = 718 (2CEh) (000001011001110)
         "718m"
4464     Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
         information"
4465     Q_ENDTIMER = 0 (0h) (0) "No End Section timer
         information"
4466     Q_DANGERPOINT = 1 (1h) (1) "Danger point information to

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follow"
4467         D_DP = 0 (0h) (0000000000000000) "0m"
4468         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
          calculated release speed"
4469     Q_OVERLAP = 0 (0h) (0) "No overlap information"
4470     Packet 57 - TrackToTrain - MA Request Params
4471         NID_PACKET = 57 (39h) (00111001)
4472         Q_DIR = 0 (0h) (00) "Reverse"
4473         L_PACKET = 49 (31h) (0000000110001)
4474         T_MAR = 25 (19h) (00011001)
4475         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
          request triggering with regards to this
          function"
4476         T_CYCRQST = 10 (Ah) (00001010)
4477     Packet 58 - TrackToTrain - Pos Report Params
4478         NID_PACKET = 58 (3Ah) (00111010)
4479         Q_DIR = 0 (0h) (00) "Reverse"
4480         L_PACKET = 56 (38h) (0000000111000)
4481         Q_SCALE = 1 (1h) (01) "1 m scale"
4482         T_CYCLOC = 10 (Ah) (00001010)
4483         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
          train has not to report cyclically its
          position"
4484         M_LOC = 1 (1h) (001) "Every LRBG compliant
          balise group"
4485     N_ITER = 0 (0h) (00000)
4486     Packet 5 - TrackToTrain - Linking
4487         NID_PACKET = 5 (5h) (00000101)
4488         Q_DIR = 0 (0h) (00) "Reverse"
4489         L_PACKET = 69 (45h) (0000001000101)
4490         Q_SCALE = 1 (1h) (01) "1 m scale"
4491         D_LINK = 634 (27Ah) (000001001111010) "634m"
4492     Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
          administration, no NID_C follows"
4493         NID_BG = 1013 (3F5h) (00001111110101)
4494         Q_LINKORIENTATION = 0 (0h) (0) "The balise
          group is seen by the train in reverse
          direction"
4495         Q_LINKREACTION = 2 (2h) (10) "No reaction"
4496         Q_LOCACC = 1 (1h) (000001)
4497     N_ITER = 0 (0h) (00000)
4498     Packet 27 - TrackToTrain - International SSP
4499         NID_PACKET = 27 (1Bh) (00011011)
4500         Q_DIR = 0 (0h) (00) "Reverse"
4501         L_PACKET = 86 (56h) (0000001010110)
4502         Q_SCALE = 1 (1h) (01) "1 m scale"
4503         D_STATIC = 0 (0h) (0000000000000000) "0m"
4504         V_STATIC = 10 (Ah) (0001010) "50 km/h"
4505         Q_FRONT = 1 (1h) (1) "No train length delay on
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                                validity end point of profile element"
4506     N_ITER = 0 (0h) (00000)
4507     N_ITER = 1 (1h) (00001)
4508     [0] D_STATIC = 718 (2CEh) (000001011001110)
                                "718m"
4509     [0] V_STATIC = 127 (7Fh) (1111111) "Non
                                numerical value telling that the static
                                speed profile description ends at D_STATIC(n
                                )"
4510     [0] Q_FRONT = 0 (0h) (0) "Train length delay on
                                validity end point of profile element"
4511     [0] N_ITER = 0 (0h) (00000)
4512     Packet 21 - TrackToTrain - Gradient Profile
4513     NID_PACKET = 21 (15h) (00010101)
4514     Q_DIR = 0 (0h) (00) "Reverse"
4515     L_PACKET = 102 (66h) (0000001100110)
4516     Q_SCALE = 1 (1h) (01) "1 m scale"
4517     D_GRADIENT = 0 (0h) (000000000000000) "0m"
4518     Q_GDIR = 1 (1h) (1) "Uphill"
4519     G_A = 15 (Fh) (00001111) "15 o/oo"
4520     N_ITER = 2 (2h) (00010)
4521     [0] D_GRADIENT = 601 (259h) (000001001011001)
                                "601m"
4522     [0] Q_GDIR = 1 (1h) (1) "Uphill"
4523     [0] G_A = 5 (5h) (00000101) "5 o/oo"
4524     [1] D_GRADIENT = 117 (75h) (000000001110101)
                                "117m"
4525     [1] Q_GDIR = 0 (0h) (0) "Downhill"
4526     [1] G_A = 255 (FFh) (11111111) "Non numerical
                                value telling that the current gradient
                                description ends at D_GRADIENT(n)"
4527     12:13:12.191723 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
                                :192.168.0.132
4528     10000100 00000110 10000010 11010101 00100110 11010100
                                11010111 00100000 01110100 01000100 00000000 00001000
                                00010000 00000010 00001111 11011100 01110001
                                00011000 00000000 00110010 00000000 01100100 10000000
                                11111000 00010100 00000011
4529     NID_MESSAGE = 132 (84h) (10000100)
4530     L_MESSAGE = 26 (1Ah) (0000011010)
4531     T_TRAIN = 190094163 (B549B53h)
                                (00001011010101001001101101010011)
4532     NID_ENGINE = 6062545 (5C81D1h)
                                (010111001000000111010001)
4533     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
                                the perturbation location reached"
4534     Packet 0 - TrainToTrack - Pos Report
4535     NID_PACKET = 0 (0h) (00000000)
4536     L_PACKET = 129 (81h) (00000100000001)

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4537         Q_SCALE = 0 (0h) (00) "10 cm scale"
4538     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4539         NID_C = 2 (2h) (0000000010)
4540         NID_BG = 1015 (3F7h) (00001111110111)
4541         D_LRBG = 3619 (E23h) (000111000100011) "361.9m"
4542         Q_DIRLRBG = 0 (0h) (00) "Reverse"
4543         Q_DLRBG = 0 (0h) (00) "Reverse"
4544         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4545         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
         "
4546     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4547         L_TRAININT = 248 (F8h) (000000011111000)
4548         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
4549         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4550         M_MODE = 0 (0h) (0000) "Full Supervision"
4551     M_LEVEL = 3 (3h) (011) "Level 2"
4552 12:13:22.202789 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
         :192.168.0.132
4553     10000100 00000110 10000010 11010101 00100111 11001111
         00010111 00100000 01110100 01000100 00000000 00001000
         00010000 00000010 00001111 11011100 10011100
         10000000 00000000 00110010 00000000 01100100 10000000
         11111000 00010100 00000011
4554     NID_MESSAGE = 132 (84h) (10000100)
4555     L_MESSAGE = 26 (1Ah) (0000011010)
4556     T_TRAIN = 190095164 (B549F3Ch)
         (00001011010101001001111100111100)
4557     NID_ENGINE = 6062545 (5C81D1h)
         (010111001000000111010001)
4558     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
         the perturbation location reached"
4559     Packet 0 - TrainToTrack - Pos Report
4560         NID_PACKET = 0 (0h) (00000000)
4561         L_PACKET = 129 (81h) (00000100000001)
4562         Q_SCALE = 0 (0h) (00) "10 cm scale"
4563     NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4564         NID_C = 2 (2h) (0000000010)
4565         NID_BG = 1015 (3F7h) (00001111110111)
4566         D_LRBG = 5008 (1390h) (001001110010000) "500.8m"
         "
4567         Q_DIRLRBG = 0 (0h) (00) "Reverse"
4568         Q_DLRBG = 0 (0h) (00) "Reverse"
4569         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4570         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
         "
4571     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4572         L_TRAININT = 248 (F8h) (000000011111000)

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4573         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
4574         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4575         M_MODE = 0 (0h) (0000) "Full Supervision"
4576         M_LEVEL = 3 (3h) (011) "Level 2"
4577 12:13:22.224316 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK5) (PK27)
         (PK21) - Train 6062545 - Dest:192.168.0.134
4578         00000011 00010000 10000010 11010101 00100111 11001111
         00000000 00010000 01111110 11100001 11100000 00010110
         00010000 00000000 00000000 00000001 01100111
         00010000 00000000 00011111 10000111 00100000 00001100
         01000110 01111111 11110000 10100011 10100000
         00000111 00001000 01010111 11111111 11110010 00000000
         01010000 00001000 10101000 00100111 10100000
         01111110 10101000 00010000 00001101 10000000 01010110
         01000000 00000000 00001010 10000000 00100000
         10110011 10111111 10000000 00101010 00000001 10011001
         00000000 00000001 00001111 00010000 00100101
         10011000 00101000 00000111 01010111 11111000
4579         NID_MESSAGE = 3 (3h) (00000011)
4580         L_MESSAGE = 66 (42h) (0001000010)
4581         T_TRAIN = 190095164 (B549F3Ch)
         (00001011010101001001001111100111100)
4582         M_ACK = 0 (0h) (0) "No acknowledgement required"
4583         NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4584         NID_C = 2 (2h) (0000000010)
4585         NID_BG = 1015 (3F7h) (00001111110111)
4586         Packet 15 - TrackToTrain - Level 2/3 MA
4587         NID_PACKET = 15 (Fh) (00001111)
4588         Q_DIR = 0 (0h) (00) "Reverse"
4589         L_PACKET = 88 (58h) (0000001011000)
4590         Q_SCALE = 1 (1h) (01) "1 m scale"
4591         V_EMA = 0 (0h) (0000000) "0 km/h"
4592         T_EMA = 0 (0h) (0000000000)
4593         N_ITER = 0 (0h) (00000)
4594         L_ENDSECTION = 718 (2CEh) (000001011001110)
         "718m"
4595         Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
         information"
4596         Q_ENDTIMER = 0 (0h) (0) "No End Section timer
         information"
4597         Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
         follow"
4598         D_DP = 0 (0h) (0000000000000000) "0m"
4599         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
         calculated release speed"
4600         Q_OVERLAP = 0 (0h) (0) "No overlap information"
4601         Packet 57 - TrackToTrain - MA Request Params
4602         NID_PACKET = 57 (39h) (00111001)
4603         Q_DIR = 0 (0h) (00) "Reverse"

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4604         L_PACKET = 49 (31h) (0000000110001)
4605         T_MAR = 25 (19h) (00011001)
4606         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
           request triggering with regards to this
           function"
4607         T_CYCRQST = 10 (Ah) (00001010)
4608 Packet 58 - TrackToTrain - Pos Report Params
4609         NID_PACKET = 58 (3Ah) (00111010)
4610         Q_DIR = 0 (0h) (00) "Reverse"
4611         L_PACKET = 56 (38h) (0000000111000)
4612         Q_SCALE = 1 (1h) (01) "1 m scale"
4613         T_CYCLOC = 10 (Ah) (00001010)
4614         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
           train has not to report cyclically its
           position"
4615         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
4616         N_ITER = 0 (0h) (00000)
4617 Packet 5 - TrackToTrain - Linking
4618         NID_PACKET = 5 (5h) (00000101)
4619         Q_DIR = 0 (0h) (00) "Reverse"
4620         L_PACKET = 69 (45h) (0000001000101)
4621         Q_SCALE = 1 (1h) (01) "1 m scale"
4622         D_LINK = 634 (27Ah) (000001001111010) "634m"
4623         Q_NEWCOUNTRY = 0 (0h) (0) "Same country / railway
           administration, no NID_C follows"
4624         NID_BG = 1013 (3F5h) (00001111110101)
4625         Q_LINKORIENTATION = 0 (0h) (0) "The balise
           group is seen by the train in reverse
           direction"
4626         Q_LINKREACTION = 2 (2h) (10) "No reaction"
4627         Q_LOCACCC = 1 (1h) (000001)
4628         N_ITER = 0 (0h) (00000)
4629 Packet 27 - TrackToTrain - International SSP
4630         NID_PACKET = 27 (1Bh) (00011011)
4631         Q_DIR = 0 (0h) (00) "Reverse"
4632         L_PACKET = 86 (56h) (0000001010110)
4633         Q_SCALE = 1 (1h) (01) "1 m scale"
4634         D_STATIC = 0 (0h) (0000000000000000) "0m"
4635         V_STATIC = 10 (Ah) (0001010) "50 km/h"
4636         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
4637         N_ITER = 0 (0h) (00000)
4638         N_ITER = 1 (1h) (00001)
4639         [0] D_STATIC = 718 (2CEh) (000001011001110)
           "718m"
4640         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n

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) "
4641 [0] Q_FRONT = 0 (0h) (0) "Train length delay on
      validity end point of profile element"
4642 [0] N_ITER = 0 (0h) (00000)
4643 Packet 21 - TrackToTrain - Gradient Profile
4644 NID_PACKET = 21 (15h) (00010101)
4645 Q_DIR = 0 (0h) (00) "Reverse"
4646 L_PACKET = 102 (66h) (0000001100110)
4647 Q_SCALE = 1 (1h) (01) "1 m scale"
4648 D_GRADIENT = 0 (0h) (000000000000000) "0m"
4649 Q_GDIR = 1 (1h) (1) "Uphill"
4650 G_A = 15 (Fh) (00001111) "15 o/oo"
4651 N_ITER = 2 (2h) (00010)
4652 [0] D_GRADIENT = 601 (259h) (000001001011001)
      "601m"
4653 [0] Q_GDIR = 1 (1h) (1) "Uphill"
4654 [0] G_A = 5 (5h) (00000101) "5 o/oo"
4655 [1] D_GRADIENT = 117 (75h) (000000001110101)
      "117m"
4656 [1] Q_GDIR = 0 (0h) (0) "Downhill"
4657 [1] G_A = 255 (FFh) (11111111) "Non numerical
      value telling that the current gradient
      description ends at D_GRADIENT(n)"
4658 12:13:23.187315 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
      :192.168.0.132
4659 10000100 00000110 10000010 11010101 00100111 11100111
      10010111 00100000 01110100 01000100 00000000 00001000
      00010000 00000010 00001111 11011100 10100000
      11010000 00000000 00110010 00000000 01100100 10000000
      11111000 00010100 00000011
4660 NID_MESSAGE = 132 (84h) (10000100)
4661 L_MESSAGE = 26 (1Ah) (0000011010)
4662 T_TRAIN = 190095262 (B549F9Eh)
      (00001011010101001001111110011110)
4663 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
4664 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
4665 Packet 0 - TrainToTrack - Pos Report
4666 NID_PACKET = 0 (0h) (00000000)
4667 L_PACKET = 129 (81h) (00000100000001)
4668 Q_SCALE = 0 (0h) (00) "10 cm scale"
4669 NID_LRBG = 33783 (83F7h) (000000001000001111110111)
4670 NID_C = 2 (2h) (0000000010)
4671 NID_BG = 1015 (3F7h) (00001111110111)
4672 D_LRBG = 5146 (141Ah) (001010000011010) "514.6m
      "
4673 Q_DIRLRBG = 0 (0h) (00) "Reverse"
4674 Q_DLRBG = 0 (0h) (00) "Reverse"

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4675         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4676         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
         "
4677     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4678         L_TRAININT = 248 (F8h) (000000011111000)
4679         V_TRAIN = 10 (Ah) (0001010) "50 km/h"
4680         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4681         M_MODE = 0 (0h) (0000) "Full Supervision"
4682     M_LEVEL = 3 (3h) (011) "Level 2"
4683 12:13:33.204504 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
         :192.168.0.132
4684     10000100 00000110 10000010 11010101 00101000 11100010
         00010111 00100000 01110100 01000100 00000000 00001000
         00010000 00000010 00001111 11010100 00000101
         00010000 00000000 00110010 00000000 01100100 10000000
         11111000 00010010 00000011
4685     NID_MESSAGE = 132 (84h) (10000100)
4686     L_MESSAGE = 26 (1Ah) (0000011010)
4687     T_TRAIN = 190096264 (B54A388h)
         (00001011010101001010001110001000)
4688     NID_ENGINE = 6062545 (5C81D1h)
         (010111001000000111010001)
4689     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
         the perturbation location reached"
4690     Packet 0 - TrainToTrack - Pos Report
4691         NID_PACKET = 0 (0h) (00000000)
4692         L_PACKET = 129 (81h) (00000100000001)
4693         Q_SCALE = 0 (0h) (00) "10 cm scale"
4694     NID_LRBG = 33781 (83F5h) (000000001000001111110101)
4695         NID_C = 2 (2h) (0000000010)
4696         NID_BG = 1013 (3F5h) (00001111110101)
4697         D_LRBG = 162 (A2h) (000000010100010) "16.2m"
4698         Q_DIRLRBG = 0 (0h) (00) "Reverse"
4699         Q_DLRBG = 0 (0h) (00) "Reverse"
4700         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4701         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
         "
4702     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4703         L_TRAININT = 248 (F8h) (000000011111000)
4704         V_TRAIN = 9 (9h) (0001001) "45 km/h"
4705         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4706         M_MODE = 0 (0h) (0000) "Full Supervision"
4707     M_LEVEL = 3 (3h) (011) "Level 2"
4708 12:13:33.234303 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
         - Train 6062545 - Dest:192.168.0.134
4709     00000011 00001101 10000010 11010101 00101000 11100010
         00000000 00010000 01111110 10100001 11100000 00010110

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00010000 00000000 00000000 00000000 00101010
00010000 00000000 00011111 10000111 00100000 00001100
01000110 01111111 11110000 10100011 10100000
00000111 00001000 01010111 11111111 11110010 00000001
10110000 00001010 11001000 00000000 00000001
01010000 00000100 00000010 10100111 11110000 00000101
01000000 00100111 00100000 00000000 00100000
10100001 00000000 10101000 11111111
4710 NID_MESSAGE = 3 (3h) (00000011)
4711 L_MESSAGE = 54 (36h) (0000110110)
4712 T_TRAIN = 190096264 (B54A388h)
(00001011010101001010001110001000)
4713 M_ACK = 0 (0h) (0) "No acknowledgement required"
4714 NID_LRBG = 33781 (83F5h) (000000001000001111110101)
4715 NID_C = 2 (2h) (0000000010)
4716 NID_BG = 1013 (3F5h) (00001111110101)
4717 Packet 15 - TrackToTrain - Level 2/3 MA
4718 NID_PACKET = 15 (Fh) (00001111)
4719 Q_DIR = 0 (0h) (00) "Reverse"
4720 L_PACKET = 88 (58h) (0000001011000)
4721 Q_SCALE = 1 (1h) (01) "1 m scale"
4722 V_EMA = 0 (0h) (00000000) "0 km/h"
4723 T_EMA = 0 (0h) (0000000000)
4724 N_ITER = 0 (0h) (00000)
4725 L_ENDSECTION = 84 (54h) (000000001010100) "84m"
4726 Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
information"
4727 Q_ENDTIMER = 0 (0h) (0) "No End Section timer
information"
4728 Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
follow"
4729 D_DP = 0 (0h) (0000000000000000) "0m"
4730 V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
calculated release speed"
4731 Q_OVERLAP = 0 (0h) (0) "No overlap information"
4732 Packet 57 - TrackToTrain - MA Request Params
4733 NID_PACKET = 57 (39h) (00111001)
4734 Q_DIR = 0 (0h) (00) "Reverse"
4735 L_PACKET = 49 (31h) (0000000110001)
4736 T_MAR = 25 (19h) (00011001)
4737 T_TIMEOUTRQST = 1023 (3FFh) (111111111) "No MA
request triggering with regards to this
function"
4738 T_CYCRQST = 10 (Ah) (00001010)
4739 Packet 58 - TrackToTrain - Pos Report Params
4740 NID_PACKET = 58 (3Ah) (00111010)
4741 Q_DIR = 0 (0h) (00) "Reverse"
4742 L_PACKET = 56 (38h) (0000000111000)
4743 Q_SCALE = 1 (1h) (01) "1 m scale"

```

C. Simulation Traces

```

4744         T_CYCLOC = 10 (Ah) (00001010)
4745         D_CYCLOC = 32767 (7FFFh) (1111111111111111) "The
           train has not to report cyclically its
           position"
4746         M_LOC = 1 (1h) (001) "Every LRBG compliant
           balise group"
4747     N_ITER = 0 (0h) (00000)
4748     Packet 27 - TrackToTrain - International SSP
4749         NID_PACKET = 27 (1Bh) (00011011)
4750         Q_DIR = 0 (0h) (00) "Reverse"
4751         L_PACKET = 86 (56h) (0000001010110)
4752         Q_SCALE = 1 (1h) (01) "1 m scale"
4753         D_STATIC = 0 (0h) (0000000000000000) "0m"
4754         V_STATIC = 10 (Ah) (0001010) "50 km/h"
4755         Q_FRONT = 1 (1h) (1) "No train length delay on
           validity end point of profile element"
4756     N_ITER = 0 (0h) (00000)
4757     N_ITER = 1 (1h) (00001)
4758         [0] D_STATIC = 84 (54h) (000000001010100) "84m"
4759         [0] V_STATIC = 127 (7Fh) (1111111) "Non
           numerical value telling that the static
           speed profile description ends at D_STATIC(n
           )"
4760         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
           validity end point of profile element"
4761     [0] N_ITER = 0 (0h) (00000)
4762     Packet 21 - TrackToTrain - Gradient Profile
4763         NID_PACKET = 21 (15h) (00010101)
4764         Q_DIR = 0 (0h) (00) "Reverse"
4765         L_PACKET = 78 (4Eh) (0000001001110)
4766         Q_SCALE = 1 (1h) (01) "1 m scale"
4767         D_GRADIENT = 0 (0h) (0000000000000000) "0m"
4768         Q_GDIR = 1 (1h) (1) "Uphill"
4769         G_A = 5 (5h) (00000101) "5 o/oo"
4770     N_ITER = 1 (1h) (00001)
4771         [0] D_GRADIENT = 84 (54h) (000000001010100) "84
           m"
4772         [0] Q_GDIR = 0 (0h) (0) "Downhill"
4773         [0] G_A = 255 (FFh) (11111111) "Non numerical
           value telling that the current gradient
           description ends at D_GRADIENT(n)"
4774 12:13:34.183778 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
           :192.168.0.132
4775     10000100 00000110 10000010 11010101 00101000 11111010
           10010111 00100000 01110100 01000100 00000000 00001000
           00010000 00000010 00001111 11010100 00001000
           01101000 00000000 00110010 00000000 01100100 10000000
           11111000 00010000 00000011
4776     NID_MESSAGE = 132 (84h) (10000100)

```

```

4777 L_MESSAGE = 26 (1Ah) (0000011010)
4778 T_TRAIN = 190096362 (B54A3EAh)
      (00001011010101001010001111101010)
4779 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
4780 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
4781 Packet 0 - TrainToTrack - Pos Report
4782 NID_PACKET = 0 (0h) (00000000)
4783 L_PACKET = 129 (81h) (0000010000001)
4784 Q_SCALE = 0 (0h) (00) "10 cm scale"
4785 NID_LRBG = 33781 (83F5h) (000000001000001111110101)
4786 NID_C = 2 (2h) (0000000010)
4787 NID_BG = 1013 (3F5h) (00001111110101)
4788 D_LRBG = 269 (10Dh) (000000100001101) "26.9m"
4789 Q_DIRLRBG = 0 (0h) (00) "Reverse"
4790 Q_DLRBG = 0 (0h) (00) "Reverse"
4791 L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4792 L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
      "
4793 Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
      integrity monitoring device"
4794 L_TRAININT = 248 (F8h) (000000011111000)
4795 V_TRAIN = 8 (8h) (0001000) "40 km/h"
4796 Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4797 M_MODE = 0 (0h) (0000) "Full Supervision"
4798 M_LEVEL = 3 (3h) (011) "Level 2"
4799 12:13:44.255456 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
      :192.168.0.132
4800 10000100 00000110 10000010 11010101 00101001 11110100
      11010111 00100000 01110100 01000100 00000000 00001000
      00010000 00000010 00001111 11010100 00011000
      01100000 00000000 00110010 00000000 01100100 10000000
      11111000 00000010 00000011
4801 NID_MESSAGE = 132 (84h) (10000100)
4802 L_MESSAGE = 26 (1Ah) (0000011010)
4803 T_TRAIN = 190097363 (B54A7D3h)
      (00001011010101001010011111010011)
4804 NID_ENGINE = 6062545 (5C81D1h)
      (010111001000000111010001)
4805 Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
      the perturbation location reached"
4806 Packet 0 - TrainToTrack - Pos Report
4807 NID_PACKET = 0 (0h) (00000000)
4808 L_PACKET = 129 (81h) (0000010000001)
4809 Q_SCALE = 0 (0h) (00) "10 cm scale"
4810 NID_LRBG = 33781 (83F5h) (000000001000001111110101)
4811 NID_C = 2 (2h) (0000000010)
4812 NID_BG = 1013 (3F5h) (00001111110101)

```

C. Simulation Traces

```

4813         D_LRBG = 780 (30Ch) (000001100001100) "78.0m"
4814         Q_DIRLRBG = 0 (0h) (00) "Reverse"
4815         Q_DLRBG = 0 (0h) (00) "Reverse"
4816         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4817         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m"
         "
4818         Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4819         L_TRAININT = 248 (F8h) (000000011111000)
4820         V_TRAIN = 1 (1h) (0000001) "5 km/h"
4821         Q_DIRTRAIN = 0 (0h) (00) "Reverse"
4822         M_MODE = 0 (0h) (0000) "Full Supervision"
4823         M_LEVEL = 3 (3h) (011) "Level 2"
4824 12:13:44.284830 # MA (MsgId 3) (PK15) (PK57) (PK58) (PK27) (PK21)
         - Train 6062545 - Dest:192.168.0.134
4825         00000011 00001101 10000010 11010101 00101001 11110100
         11000000 00010000 01111110 10100001 11100000 00010110
         00010000 00000000 00000000 00000000 00101010
         00010000 00000000 00011111 10000111 00100000 00001100
         01000110 01111111 11110000 10100011 10100000
         00000111 00001000 01010111 11111111 11110010 00000001
         10110000 00001010 11001000 00000000 00000001
         01010000 00000100 00000010 10100111 11110000 00000101
         01000000 00100111 00100000 00000000 00100000
         10100001 00000000 10101000 11111111
4826         NID_MESSAGE = 3 (3h) (00000011)
4827         L_MESSAGE = 54 (36h) (0000110110)
4828         T_TRAIN = 190097363 (B54A7D3h)
         (00001011010101001001010011111010011)
4829         M_ACK = 0 (0h) (0) "No acknowledgement required"
4830         NID_LRBG = 33781 (83F5h) (000000001000001111110101)
4831         NID_C = 2 (2h) (0000000010)
4832         NID_BG = 1013 (3F5h) (00001111110101)
4833         Packet 15 - TrackToTrain - Level 2/3 MA
4834         NID_PACKET = 15 (Fh) (00001111)
4835         Q_DIR = 0 (0h) (00) "Reverse"
4836         L_PACKET = 88 (58h) (0000001011000)
4837         Q_SCALE = 1 (1h) (01) "1 m scale"
4838         V_EMA = 0 (0h) (0000000) "0 km/h"
4839         T_EMA = 0 (0h) (0000000000)
4840         N_ITER = 0 (0h) (00000)
4841         L_ENDSECTION = 84 (54h) (000000001010100) "84m"
4842         Q_SECTIONTIMER = 0 (0h) (0) "No Section Timer
         information"
4843         Q_ENDTIMER = 0 (0h) (0) "No End Section timer
         information"
4844         Q_DANGERPOINT = 1 (1h) (1) "Danger point information to
         follow"
4845         D_DP = 0 (0h) (000000000000000) "0m"

```

```

4846         V_RELEASEDP = 126 (7Eh) (1111110) "Use onboard
              calculated release speed"
4847     Q_OVERLAP = 0 (0h) (0) "No overlap information"
4848     Packet 57 - TrackToTrain - MA Request Params
4849         NID_PACKET = 57 (39h) (00111001)
4850         Q_DIR = 0 (0h) (00) "Reverse"
4851         L_PACKET = 49 (31h) (0000000110001)
4852         T_MAR = 25 (19h) (00011001)
4853         T_TIMEOUTRQST = 1023 (3FFh) (1111111111) "No MA
              request triggering with regards to this
              function"
4854         T_CYCRQST = 10 (Ah) (00001010)
4855     Packet 58 - TrackToTrain - Pos Report Params
4856         NID_PACKET = 58 (3Ah) (00111010)
4857         Q_DIR = 0 (0h) (00) "Reverse"
4858         L_PACKET = 56 (38h) (0000000111000)
4859         Q_SCALE = 1 (1h) (01) "1 m scale"
4860         T_CYCLOC = 10 (Ah) (00001010)
4861         D_CYCLOC = 32767 (7FFFh) (11111111111111) "The
              train has not to report cyclically its
              position"
4862         M_LOC = 1 (1h) (001) "Every LRBG compliant
              balise group"
4863     N_ITER = 0 (0h) (00000)
4864     Packet 27 - TrackToTrain - International SSP
4865         NID_PACKET = 27 (1Bh) (00011011)
4866         Q_DIR = 0 (0h) (00) "Reverse"
4867         L_PACKET = 86 (56h) (0000001010110)
4868         Q_SCALE = 1 (1h) (01) "1 m scale"
4869         D_STATIC = 0 (0h) (000000000000000) "0m"
4870         V_STATIC = 10 (Ah) (0001010) "50 km/h"
4871         Q_FRONT = 1 (1h) (1) "No train length delay on
              validity end point of profile element"
4872     N_ITER = 0 (0h) (00000)
4873     N_ITER = 1 (1h) (00001)
4874         [0] D_STATIC = 84 (54h) (000000001010100) "84m"
4875         [0] V_STATIC = 127 (7Fh) (1111111) "Non
              numerical value telling that the static
              speed profile description ends at D_STATIC(n
              )"
4876         [0] Q_FRONT = 0 (0h) (0) "Train length delay on
              validity end point of profile element"
4877     [0] N_ITER = 0 (0h) (00000)
4878     Packet 21 - TrackToTrain - Gradient Profile
4879         NID_PACKET = 21 (15h) (00010101)
4880         Q_DIR = 0 (0h) (00) "Reverse"
4881         L_PACKET = 78 (4Eh) (0000001001110)
4882         Q_SCALE = 1 (1h) (01) "1 m scale"
4883         D_GRADIENT = 0 (0h) (000000000000000) "0m"

```

C. Simulation Traces

```

4884         Q_GDIR = 1 (1h) (1) "Uphill"
4885         G_A = 5 (5h) (00000101) "5 o/oo"
4886     N_ITER = 1 (1h) (00001)
4887         [0] D_GRADIENT = 84 (54h) (000000001010100) "84
         m"
4888         [0] Q_GDIR = 0 (0h) (0) "Downhill"
4889         [0] G_A = 255 (FFh) (11111111) "Non numerical
         value telling that the current gradient
         description ends at D_GRADIENT(n)"
4890 12:13:45.177977 # MA Req (MsgId 132) (PK0) - Train 6062545 - Dest
         :192.168.0.132
4891     10000100 00000110 10000010 11010101 00101010 00001101
         10010111 00100000 01110100 01000100 00000000 00001000
         00010000 00000010 00001111 11010100 00011000
         01100000 00000000 00110010 00000000 01100100 10000000
         11111000 00000001 00000011
4892     NID_MESSAGE = 132 (84h) (10000100)
4893     L_MESSAGE = 26 (1Ah) (0000011010)
4894     T_TRAIN = 190097462 (B54A836h)
         (00001011010101001010100000110110)
4895     NID_ENGINE = 6062545 (5C81D1h)
         (010111001000000111010001)
4896     Q_MARQSTREASON = 2 (2h) (00010) "Time before reaching
         the perturbation location reached"
4897     Packet 0 - TrainToTrack - Pos Report
4898         NID_PACKET = 0 (0h) (00000000)
4899         L_PACKET = 129 (81h) (00000100000001)
4900         Q_SCALE = 0 (0h) (00) "10 cm scale"
4901     NID_LRBG = 33781 (83F5h) (000000001000001111110101)
4902         NID_C = 2 (2h) (0000000010)
4903         NID_BG = 1013 (3F5h) (00001111110101)
4904         D_LRBG = 780 (30Ch) (000001100001100) "78.0m"
4905         Q_DIRLRBG = 0 (0h) (00) "Reverse"
4906         Q_DLRBG = 0 (0h) (00) "Reverse"
4907         L_DOUBTOVER = 50 (32h) (000000000110010) "5.0m"
4908         L_DOUBTUNDER = 50 (32h) (000000000110010) "5.0m
         "
4909     Q_LENGTH = 1 (1h) (01) "Train integrity confirmed by
         integrity monitoring device"
4910         L_TRAININT = 248 (F8h) (000000011111000)
4911         V_TRAIN = 0 (0h) (0000000) "0 km/h"
4912         Q_DIRTRAIN = 2 (2h) (10) "Unknown"
4913         M_MODE = 0 (0h) (0000) "Full Supervision"
4914     M_LEVEL = 3 (3h) (011) "Level 2"

```


Appendix D

Simulation Verification

In the following, the CTL verification of the SCP||B model is shown. These verifications were run on an Ubuntu 16.04.7 LTS system running 256Gb Ram DDR4, AMZ Ryzen Threadripper 3990X 64-Core Processor with a clock speed of 100MHz, in 0m23.886s for the Simple model, and 1m4.121s for the Moorgate Holloway model.

Simple Model

```
1 time probrun Interlocking.mch -csp-guide Control.csp -ctlformula
   "AG(not(e(collision)))" > ctl-verification-basic.txt
2
3 % Symmetry is potentially useful for this machine
4 open_cspm_file(Control.csp)
5 reading_cspm_file(Control.csp)
6 getting_parser_cmd
7 parser(/home/aled/ProB/lib/cspm)
8 /home/aled/ProB/lib/cspm
9 exit(exit(0))
10 consulting(Control.csp.pl)
11 consult_without_redefine(Control.csp.pl)
12 % Initialising datatype constructor types: Unit POINT Connector
   Marker Balise Route TRAIN MARKERBOARD ANSWERS DIRECTION
   PointPosition BaliseDirection TrainLevel Orientation
13 ALLTRACK trackPoint trackConnectors baliseConnectors
   LeftwardMarker
14 % Precompiling datatype constants: Unit POINT Connector Marker
   Balise Route TRAIN MARKERBOARD ANSWERS DIRECTION PointPosition
   BaliseDirection TrainLevel Orientation ALLTRACK trackPoint
   trackConnectors baliseConnectors LeftwardMarker
15 % Finding Definite CSP Processes: ERR/0 MAIN/0 RBC/1 RBC1/2 RBC2
   /2 UnifiedTrain/7 EntryRequest/2 TrainEntry/2;;
16
17 % Finding Possible CSP Processes: first/1 second/1 unitLeftOf/1
   unitRightOf/1 connectorRightOf*curUnit__1/2 connectorLeftOf*
   curUnit2__1/2 oldDirectionCheck/3 newDirectionCheck/3
```

D. Simulation Verification

```
UnifiedTrain*oldUnit__1/7 UnifiedTrain*newUnit__1/7;;
18 % Checking Definitions:
19 % Analyzing nametypes: Direction Move
20 % Precompiling datatype constructor types: Unit POINT Connector
    Marker Balise Route TRAIN MARKERBOARD ANSWERS DIRECTION
    PointPosition BaliseDirection TrainLevel Orientation
21 ALLTRACK trackPoint trackConnectors baliseConnectors
    LeftwardMarker
22 % Analyzing channels: train_NextAction train_to_ixl_TrackChange
    train_PassedBalise train_AtEoA train_to_ixl_Enter
    train_to_ixl_Exit train_to_rbc_MARrequest rbc_to_train_MAGrant
    rbc_to_ixl_RequestToProceed rbc_to_ixl_Request
    rbc_to_ixl_Release ixl_to_rbc_GrantRoute rbc_to_ixl_ClearRoute
    rbc_to_train_RequestAccepted collision exceededEOA
23 CTL model checking formula
24 B,none
25 calling_ltl_parser(/usr/bin/java,[-cp,/home/aled/ProB/lib/
    probcliparser.jar,de.prob.cliparser.LtlConsoleParser,-ctl,-
    lang,B,none,/tmp/ltl_formulas1227588216.txt])
26 % found_enumeration_of_constants(10,10)
27 % backtrack(found_enumeration_of_constants(10,10))
28 res(computing)
29 CTL check took 21.770 seconds
30 Witness found:
31 [2]
32 exec(2,[0,1,2],[0,1,2])
33 exec(2,[],[])
34 % size of table for ltl:sat_eu_table/5: 11647
35
36 CTL Formula TRUE.
37 No counter example found for AG(not(e(collision))).
38
39 real    0m23.886s
40 user    0m23.444s
41 sys     0m0.198s
```

Moorgate-Holloway Model

```
1 time probrun Interlocking.mch -csp-guide Control.csp -ctlformula
    "AG(not(e(collision)))" > ctl-verification-MH.txt
2
3 % Symmetry is potentially useful for this machine
4 open_cspm_file(Control.csp)
5 reading_cspm_file(Control.csp)
6 getting_parser_cmd
7 parser(/home/aled/ProB/lib/cspm)
8 /home/aled/ProB/lib/cspm
9 exit(exit(0))
10 consulting(Control.csp.pl)
```

```

11 consult_without_redefine(Control.csp.pl)
12 % Initialising datatype constructor types: Unit POINT Connector
    MARKERBOARD Balise Route TRAIN ANSWERS DIRECTION PointPosition
    BaliseDirection TrainLine TrainLevel Orientation
13 ALLTRACK trackPoint trackConnectors baliseConnectors
    upperBaliseConnectors lowerBaliseConnectors LeftwardMarker
14 % Precompiling datatype constants: Unit POINT Connector
    MARKERBOARD Balise Route TRAIN ANSWERS DIRECTION PointPosition
    BaliseDirection TrainLine TrainLevel Orientation ALLTRACK
    trackPoint trackConnectors baliseConnectors
    upperBaliseConnectors lowerBaliseConnectors LeftwardMarker
15 % Finding Definite CSP Processes: ERR/0 MAIN/0 RBC/1 RBC1/2 RBC2
    /2 UnifiedTrain/7 EntryRequest/2 TrainEntry/2;;
16
17 % Finding Possible CSP Processes: first/1 second/1 unitLeftOf/1
    unitRightOf/1 oldDirectionCheck/4 newDirectionCheck/4
    UnifiedTrain*oldUnit__1/7 UnifiedTrain*newUnit__1/7;;
18 % Checking Definitions:
19 % Analyzing nametypes: Direction Move
20 % Precompiling datatype constructor types: Unit POINT Connector
    MARKERBOARD Balise Route TRAIN ANSWERS DIRECTION PointPosition
    BaliseDirection TrainLine TrainLevel Orientation
21 ALLTRACK trackPoint trackConnectors baliseConnectors
    upperBaliseConnectors lowerBaliseConnectors LeftwardMarker
22 % Analyzing channels: train_NextAction train_to_ixl_TrackChange
    train_PassedBalise train_AtEoA train_to_ixl_Enter
    train_to_ixl_Exit train_to_rbc_MARequest rbc_to_train_MAGrant
    rbc_to_ixl_RequestToProceed rbc_to_ixl_Request
    rbc_to_ixl_Release ixl_to_rbc_GrantRoute rbc_to_ixl_ClearRoute
    rbc_to_train_RequestAccepted collision exceededEOA
    TrainEntryDetails
23 CTL model checking formula
24 B,none
25 calling_ltl_parser(/usr/bin/java,[-cp,/home/aled/ProB/lib/
    probcliparser.jar,de.prob.cliparser.LtlConsoleParser,-ctl,-
    lang,B,none,/tmp/ltl_formulas7420028504.txt])
26 % found_enumeration_of_constants(20,20)
27 % backtrack(found_enumeration_of_constants(20,20))
28 res(computing)
29 CTL check took 60.320 seconds
30 Witness found:
31 [2]
32 exec(2,[0,1,2],[0,1,2])
33 exec(2,[],[])
34 % size of table for ltl:sat_eu_table/5: 21909
35
36 CTL Formula TRUE.
37 No counter example found for AG(not(e(collision))).
38

```

D. Simulation Verification

```
39 real    1m2.964s
40 user    1m4.121s
41 sys     0m0.460s
```

Appendix E

Log File Lexer

In the following, the Lexer used for extracting messages of interest are given. Depending on what messages are required, functions within the lexer can be included or excluded as needed.

Initial Model

Siemens RETS DataLogger Lexer

```
1 import re
2
3 ma_pattern = re.compile(r"\bMsgId\s132\b")
4 tgm_pattern = re.compile(r"\bTelegram\b")
5 mg_pattern = re.compile(r"\bMsgId\s3\b")
6 msg_pattern = re.compile(r"\s")
7
8
9 with open ('File.txt', 'rt') as trace:
10     inlines = []
11     for line in trace:
12         inlines.append(line.rstrip('\n'))
13
14 inlines2 = inlines
15 outlines = []
16 length = len(inlines)
17 x = 0
18 found = False
19
20 for line in inlines:
21     if found == True:
22         if (line.find("09:") != False): # Needs to match
23             timestamp of message
24             outlines.append(line)
25         else:
26             found = False
```

E. Log File Lexer

```
26     if found == False:
27         if ((ma_pattern.search(line) != None) or (mg_pattern.
28             search(line) != None)): # (tgm_pattern.search(line) ==
29                 None) for all messages
30                 outlines.append(line)
31                 found = True
32 f= open("Filtered Logs/Test-MA-messages.txt","w+")
33 for line in outlines:
34     f.write(line + "\n")
```