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Development of test cases for ERTMS

Support of the approval and the authorisation process for the placing in service, the construction and the railway supervision as well as the concepts of mutual recognition and the further development of TSI ZZS

Summary

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Support of the approval and the authorisation process for the placing in service, the construction and the railway supervision as well as the concepts of mutual recognition and the further development of TSI ZZS

Summary

by

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Abstract

The main aim of the research project “Development of test cases for ERTMS” was to generate a comprehensive generic test case catalogue for ETCS in Germany (State of knowledge 12/2017). Based on the operation scenario overview, the operation situation tests occurring in the national railway system were developed for the system ETCS level 2 and ESG (level 1 German version). The test case catalogue consists of more than 2.200 individual test cases. Its completeness was proved upon regular consultations with specialists and experts with experienced knowledge in the field of the railway safety technology. Moreover, a quality examination was conducted and the existing irregularities between the documents were dealt with. In addition, a comparison between the developed test cases and the published test cases from other European countries and those provided in the subset-076. The developed test case catalogue is prepared and developed for the practical application and includes numerous filter functions. Furthermore, it can be adapted as the result of continuous update and possible changes. A consideration of the security aspect influencing on the safety was also carried out

1 Introduction

1.1 Motivation

The development and introduction of the ERTMS (European Rail Traffic Management System) is an important part of the European new organisation in the railway sector. ERTMS is a traffic management system which is specified to provide train control and signalling system throughout the European area. Its key components are ETCS (European Train Control System) and the digital radio system GSM-R.

The long-term conversion of the national train control system onto ERTMS in Germany requires a special analysis in various areas. Apart from the securing the interoperability at both domestic and European level, issues associated with the maintaining and further development of the railway safety should be considered. (gem, RL 2016/791/EG Article 4 Paragraph 1a).

These considerations are of particular importance for ETCS (TSI ZZS) due to the partially harmonised implementation of the technical specifications. The areas in which the interoperability is to be applied should be standardised within the scope of the European technical specifications.

In this sense, national supplements are pressingly required to secure the safe function. These supplements consist of the aspects safety as well as security that imposes influence on safety, and must be defined, implemented and proved. This applies to the requirements themselves as well as to their integration into the structural subsystem rail vehicles and lines (both ZZS and RST and INF), the functional subsystems railway operation and the entire system.

In addition to the partial harmonisation of the TSI ZZS, the following missing product standards are to be raised:

- the combination of different producers for lines and rail vehicle products and
- parallel used ETCS-specification versions especially the system complexity.

Both the applicants and the assessment bodies and the supervisory and approval authorities are faced with new technical challenges for the proofs of the safe function.

Tests are an essential part of the proofs of the safety function. Until now, test case catalogues exist merely for the European technical specifications (TSI ZZS subset 76). The necessary supplements are only available to some extent. The transparency is, among other things, limited due to intellectual property rights.

Until the end of 2017; a complete test case catalogue consisting of the comprehensive proving of the functional and safety and security aspects should be developed according to the state of knowledge in order to support the process and examination of the ERTMS marketing.

1.2 Aims and Objectives

A comprehensive test case catalogue is to be developed by using the example of the VDE 8 authorisation for placing in service as well as the planning for the Rail-Freight- Corridor (RFC) (German part) (Table 1).

TABLE 1: LINES AS BASIS FOR TEST CASES DEVELOPMENT

Lines as basis for test cases development

LINE	COURSE	EQUIPMENT	STATUS
VDE 8.1	Erfurt – Ebensfeld – Nürnberg	ETCS Level 2	in service
VDE 8.2	Erfurt – Leipzig/Halle	ETCS Level 2	in service
RFC 1	Nationaler Teil: Duisburg – Mannheim – Basel	ETCS Level 1 LS	under planning/ equipping

The analysis and assessment of the questions as well as their answers are to be divided into two work packages as follows:

WP 1: Development of the ERTMS test cases (Test case catalogue)

WP 2: Demonstration: suitability and completeness of the test cases

At the beginning, the project objectives set up by the client were characterised with great elaboration. Subsequently, the project approaches described in the performance concept were reconsidered and adapted. The contents and approaches to achieve the project objectives were adjusted and coordinated under regular consultations with the client. The objectives of the work packages are detailed as follows:

1.2.1 Objectives WP1

The overall objective of the WP1is the creation and development of a manageable test case catalogue for ERTMS system in Germany. To achieve this, the entire system including ETCS Level 2 and ETCS Level 1 LS and the operation processes should be covered. Furthermore, the detailed requirements for the test case catalogue were set out under further consultations with the client. These are:

- Development of the test cases without structural reference of the user requirement specifications [BTSF 2], [BTSF 3], [LHESG],
- Consideration of the system functionality (without individual safety features – for this, producers' tests exist.),
- Manageability of the test case catalogue for the practical implementation with the aid of operation processes,
- Logical structuring of the test case catalogues and application of the search function (filter)
- Categorising the test cases in accordance with TSI ZZS
- Marking and incorporating the already known test situations (for example nets access tests [NZT VDE8.2]; [SIEM 2015]),
- Indicating the test cases with security effects without comprehensive security analysis

The results and the methodical development are to be elaborated in the following paragraphs of this report. The developed tests are to be handed over to the client in structured and filterable form (for example as tables in excel).

1.2.2 Objectives WP2

The overall objective of the WP 2 is the examination of the completeness and comprehensiveness of the developed test cases by using the example of VDE 8.1 commissioning. To achieve this, the contractor should develop and recommend a procedure. At the same time, it was required to incorporate the existing nets ac-cess tests of the German Federal Railway to avoid unnecessary redundancy during the running of the tests. Moreover, a comparison was conducted with the known test case catalogues from other European countries (e.g. Austria and Switzerland) to achieve the same purpose. An additional comparison with the subset 076 was also carried out for the sake of completeness.

2 Methodological Approach

2.1 Methodology

In order to develop the overview of the operation scenarios, the possible movements of a rolling stock was analysed and divided into the corresponding categories (phases). On doing so, typical movement situations of a train ride were considered, which excluded any possibility of non-consideration of a fundamental operation situation. Based on the generic descriptions of operation processes ([HÖPP 2015], five phases were developed for this:

- Preparation of a train ride
- Start of a train ride,
- Train ride in sections between successive home signals,
- End of a train ride
- Post train ride

Subsequently, this overview was stepwise subdivided in a top-down manner and the various operation implementation variants within a phase were determined, in that the general operation scenarios were specified onto the special level. Individual operation situations were then multiply subdivided until all possibilities of the operation situations were documented. A further subdivision was not any more necessary at this stage. Individual operation situation groups with multiple various operation situation subgroups were therefore developed. This consideration referred to the most advanced specification (Baseline 3) throughout the development of the test case situations, which was also defined by the client as reference.

On the basis of the operation scenario overview, the corresponding tests were developed and outlined in a neatly-arranged way. The more concrete approaches are to be detailed in the following paragraphs.

2.2 Test Case Development

At the initial phase of project, a test case definition was derived from the system requirement specifications. This methodology for the test case development had to be revised, for not all of the tools and methods were suitable for the development of the test cases. It was rather, as stated in [BEJG 2013], a selection among numerous possible tools and methods. The development of test cases (e.g. as in [KNOL 2007] stated) that was based on the analysis of the models and structures of the user system requirement specifications and their activity diagrams was therefore discarded upon mutual agreement. Instead, a technical operational approach, namely operation scenarios, was selected

For this purpose, an overview of the operation scenarios that potentially occur in ETCS operation was at first prepared. This was verified and further developed by specialists in the field of railway safety technology on a regular basis and upon discussion with the client. The operation scenarios were then detailed and in sub-sequence summarised as operation scenario groups.

Based on this, test case groups and test case subgroups were defined, which were then comprehensively prepared and listed in a generic test case catalogue. A tabular formatting of the individual test steps was prepared comparably to the test cases of the European Union Agency for Railways ([SUB 076-6-3]).

By doing this, the attention was given to the test case structure in form of the operation procedures, which guaranteed a clear allocation of the operation test situations. Test cases from the already applied test case catalogues were incorporated in the test case catalogue of this research project and marked in the columns accordingly.

During the process of the test case development, regular consultations with both experts and the client were conducted. This helped to generate an overall and consensual structure of the test cases and to ensure optimal applicability of the test case catalogue. This included the preparation of an operation scenario over-view.

2.3 Method to Review the Completeness

The completeness of the test cases was initially attempted to be graphically proved by combing the paths of the activity diagrams. Upon analysis of the documents, it was then turned out to be not applicable due to the abstract modelling of the diagrams, because they were as known not completed and did not include change requests. It is also known in other fields that a correct management of developed test cases is decisive for the correct test coverage [VIVI 2013]. Given the reasons above, the original attempt was discarded and a method developed as a result of the expert consultations was chosen upon discussion with the client. This method is a recognised procedure and is applied for new system developments in line with [EN50126] and [EN50129]. A completeness of the operation test cases can thus be unanimously confirmed by the experts at any time, until no more necessary supplements were required by them. This method is also described in [NOEL 2009] and applied in many scientific fields. In addition, a comparison with the expertise of the ETCS System Assessor was conducted as well ([TRI2013], [TRI 2015a], [TRI 2015b], [TRI 2016]).

Besides, the test case catalogue was proved against the test cases defined in the subset-076, for the sake of completeness of the contents. The test cases from subset-076 were allocated to the defined test groups accordingly.

The tests from the other implementation of other European countries were also considered and, where applicable, integrated.

3 Results

3.1 WP1 Development ERTMS-Test Cases

3.1.1 Overview Operation Scenarios

An operationally functional approach was selected and for this end, an overview of possible operation scenarios was prepared, in order to develop a test case catalogue without analysing the existing user requirement specifications [BTSF 2], [BTSF3] and [LH ESG]. This can be found in Annex B and it shows the operation scenarios that occur in the areas covered by the German Federal Railway in a generic perspective.

3.1.1.1 Structure

A functional structure of the operation scenarios was developed and it consists of five layers, which, where possible, are separated from the applied Level and operation mode.

The operation scenarios include operation scenario groups and are broken down into individual operation scenarios, test case groups and test case sub groups. The individual test cases are under the test case sub groups arranged. The level of detail of the test case sub groups varies according to the complexity of the themes. An overview of the structure is depicted in both Table 2 and Figure 1.

TABLE 2: OVERVIEW OF THE LAYERS OF THE OPERATION SCENARIOS

Overview of the Layers of the Operation Scenarios

LAYERS	**DESCRIPTION**
1	Level
2	Operation Scenario Group
3	Operation Scenario
4	Test Case Group
5	Test Case Sub Group

In all of the layers, the test cases and test groups are distinctly marked by a test case ID. Thus, individual test cases can be identified and placed under the matched test groups and operation scenarios. ETCS Levels are positioned in Layer 1. “1” stands for ETCS Level 1 LS and “2” ETCS Level 2. This will be elaborately stated in the following chapters. Examples are shown in Figure 1.

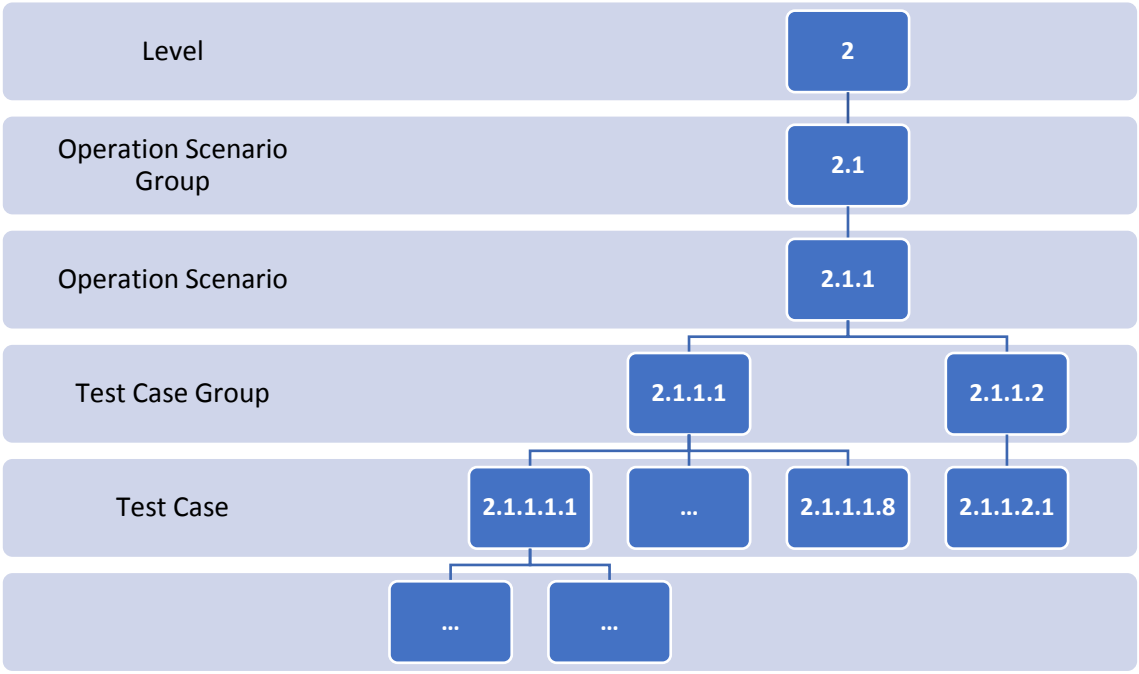

Figure 1: Structure of the Operation Scenario Overview

3.1.1.2 Defined Operation Scenario Groups

The operation processes are arranged in the layer „Operation Scenario Groups“, from the preparation, operation until post phase of a train ride. They are again subdivided into 5 operation scenario groups, which are generic and exist in different ETCS levels. TABLE 3 briefly exemplifies the selected operation scenario groups.

TABLE 3: MOVEMENT PHASES OF A ROLLING STOCK (LAYER 2)

Movement Phases of a Rolling Stock (Layer 2)

NO	PHASE	DESCRIPTION
X.1	Preparation of a train ride	The operation scenarios and actions, both of which are necessary prior to starting a train ride, such as energisation the ETCS on-board equipment and operational preparation of a train ride (coach coupling, portion working etc.)
X.2	Start of a train movement	Scenarios to start a train movement. The speed of trains under the test case groups here always begins with 0 km/h. Both permitted (e.g. Home signal shows “proceed”) and non-permitted train rides (Trains move against signals at danger without permission) are considered.

X.3	Train ride in sections between successive home signals	Scenarios and situations occurring during the movement of trains. Trackside features such as level crossings, interrupted radio coverage etc. are particularly taken into consideration.
X.4	End of a train ride	Planned end of train movements. Normal operations (Stop at a home signal) and emergency operations (Emergency stop) are taken into account.
X.5	Post train ride	Operation scenarios and actions, both of which are necessary after a train ride, such as deenergisation the ETCS on-board equipment and safe coach parking in stabling yard
X.1	Preparation of a train ride	The operation scenarios and actions, both of which are necessary prior to starting a train ride, such as energisation the ETCS on-board equipment and operational preparation of a train ride (coach coupling, portion working etc.)

3.1.1.3 Reference of Test Cases

The numeration of the individual operation scenarios and operation scenario groups was strictly developed according to the mentioned layers and can be easily found in the test case catalogue as test case ID. (Example in Figure 2) A test case group (layer 5) contains generally several test cases, a further graphical subdivision is therefore not practical for reasons of clarity (An excerpt is shown in Figure 3).

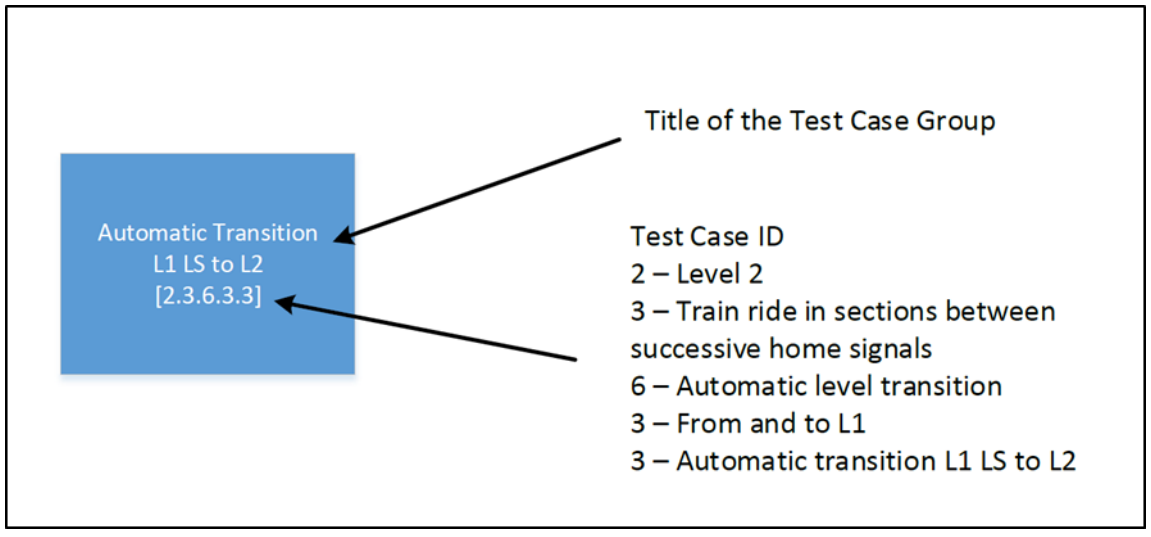

Figure 2: Explanation of the Test Case ID by Using the Example of the Automatic Level Transition from L1 LS to L2

Moreover, the existing test cases such as nets access tests for ETCS Level 2 [NZT VDE8.2]; [SIEM 2015] were incorporated into the operation scenario overview and highlighted with colour.

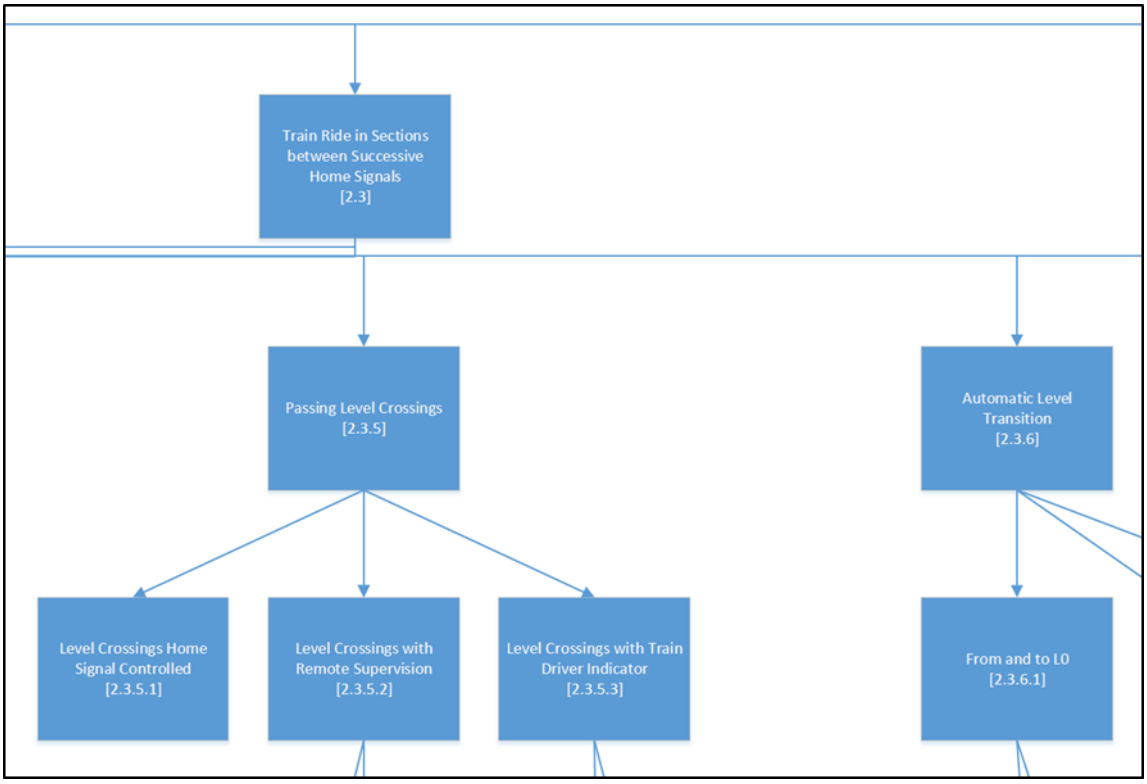

Figure 3: Cutout of the Operation Scenario Overview Level 2

3.1.2 Test case catalogue

Based on the operation scenario overview, a test case catalogue was explored for ESG (German implementation of ETCS L1 LS) and ETCS level 2. This catalogue is structured in 29 filterable columns, which are to be described as follows (Table 4).

TABLE 4: EXPLANATION OF THE COLUMNS OF THE TEST CASE CATALOGUE

NO	TERM	DESCRIPTION
1	TF-ID	Test case ID, number to identify and refer to the test case in the operation scenario overview..
2	Title	Title of test case and test case group
3	Description	Further description of title to unambiguous description, if necessary.
4	Test Type	Placement of test case to laboratory test or field test
5	Failure/Break down/Normal operation	Classification of situation considered in failure/break down or normal operation. This refers exclusively to the ETCS sys-

		tem not to normal/emergency railway operation
6	Initial Level Starting point	Initial Level at which the rolling stock travels at the starting point of the test case
7	Operation Mode Starting Point	Initial operation mode in which the rolling stock travels at the starting point of the test case
8	v (km/h) Starting Point	Maximum permitted speed in km/h of the rolling stock at the starting point of the test case
9	Level Transition	Level transition during the test case. The level transition is to be further specified, e.g. L1 → L2 (Level transition from level 1 to level 2)
10	Connection Interlocking system <--> Rolling Stock (Stw <--> Fzg)	Communication between interlocking system and rolling stock (e.g. via RBC or switchable Balises). If this is not relevant for the test case, “n.r.” will be shown in the column.
11	Connection Interlocking system <--> RBC (Stw <--> RBC)	Communication between interlocking system and RBC. If this is not relevant for the test case, „n.r.” will be shown in the column.
12	Connection RBC <--> Rolling Stock (RBC <--> Fzg)	Communication between RBC and Rolling Stock. If this is not relevant for the test case, „n.r.” will be shown in the column
13	Connection RBC<-->RBC	Communication between adjacent RBCs. If this is not relevant for the test case, „n.r.” will be shown in the column
14	End Level Ending Point	Final Level at which the rolling stock travels at the ending point of the test case
15	Operation Mode Starting Point	Final operation mode in which the rolling stock travels at the ending point of the test case
16	v (km/h) Ending Point	Maximum permitted speed in km/h of the rolling stock at the ending point of the test case

17	Actions Train Driver	Instructed actions that the train drivers must perform to operate ETCS. The common tasks to drive the train are not considered in this case.
18	Actions Train Director	Instructed actions that the train director must perform to operate ETCS. The common tasks of a train director are not considered in this case.
19	Display DMI	Indications and messages shown on the cab display, as long as this is relevant for the test case.
20	Reaction of the RBC responsible for the current rolling stock	Process taking place in the RBC that communicates with the rolling stock during the test case or prepares itself to communicate.
21	Reaction of the ETCS on-board Equipment	Process taking place in the ETCS on-board equipment (EVC) that is relevant for the test case.
22	Break Release Rolling Stock	An automatic break release initiated by ETCS. For this case, it is not relevant, which trainside break systems are to be activated.
23	EOA (End of Authority)	A place on the track that is limited by the current MA which must not be passed by the train
24	MA (Movement Authority)	Existing of a Movement Authority
25	Identical with	Reference to other test cases with the identical system behaviours and conditions, in order to avoid test case repetition.
26	Security	Security consideration that exerts an impact on the safety. This is to be divided into three categories „safety relevant“, „operation relevant „or „ none „impact, and enables therewith a further in-depth research.
27	Category TSI ZZS	Classification of the test cases into the categories defined by the TSI ZZS. Such a filter function is therefore created.
28	Notice	Additional information to supplement the handling of the test case catalogue.

In addition to title and description, the test aim as expected test result is accessible in the columns 6 – 24. Further, it is noted that the superordinate test aim can be obtained by choosing the targeted test cases.

The test cases within a test case group in the generic test case catalogue were, where possible, listed chronologically one after another. This facilitates a test flow in line with operation sequences. Consequently, each row corresponds to a test case. Processes or variants that parallel take place are subgrouped under the test case ID in a higher level and hence easily identifiable.

A test case is read from left to right, so that the initial situation (e.g. level, operation mode, vmax) is first shown and then next the status after the test (e.g. level, operation mode, vmax).

3.2 WP 2 Applicability and Completeness of the Test Cases

3.2.1 Review of Applicability

As for the second work package, the first task was to examine the suitability of the developed test case catalogue. In order to achieve this, two methods were deployed. Firstly, taken into consideration, the existing test cases (e.g. Nets access tests VDE 8.2 [NZT VDE8.2]; [SIEM 2015] were then incorporated into the generic test case catalogue during the course of its development. By doing this, the already existing test cases could be used to examine the structure and completeness of the developed test case catalogue.

Secondly, the test case catalogue was further iteratively developed through the regular consultations with the client, in order that the results with regard to the practical applicability were to be adapted for the application of the supervisory authority. The resulting proposed changes were documented and then incorporated and verified by the project team shortly after. The fundamental suitability was also confirmed at the consultations.

3.2.2 Review for Completeness

In WP2, the contractor should recommend a method to review for the completeness of the test case catalogue. The method - regular consultation with experts and specialists – was already applied during the preparation of the operation scenario overview (WP 1). 18 consultations including 18 experts and specialists were carried out, who were devoted themselves to the railway safety technology, and all of the consultations were documented. The 18 experts and specialists were also the project members and their names are given in Table 5.

The expert and specialist team has chosen a methodology, as it represented a recognised procedure for new system development in line with [EN 50126] and [EN 50129]. In the view of the experts and specialists, the test case catalogue was complete at the time of development. Nonetheless, the test case catalogue can be randomly further expanded due to its structure. If any new functions and operation procedures are integrated in the test case catalogue, new test case groups and test cases can be further developed. The expert and specialist team was an advisory board of recognised experts and specialists in railway safety technology and in particular the ETCS system. Having participated in ETCS Level 2 System assessment, (see [TRI 2013], [TRI 2015b]), the team represents a unique body of expertise and years of experience in traffic safety technology. It was composed of the employees of the CERSS Competence

Centre for Railway Safety Technology and the Chair of Railway Signalling and Transport Safety Science of the TU Dresden and thus provided the best possible basis for assessing the completeness.

TABLE 5: MEMBERS OF THE EXPERT AND SPECIALIST BOARD

Prof. Dr.-Ing. Jochen Trinckauf	Chair Holder System Assessor ETCS L2
PD Dr.-Ing. habil. Ulrich Maschek	Senior Academic Associate Expert LST ([MAS 2018]), Expert ETCS L1 LS
Dr.-Ing. Michael Kunze	Chief Engineer Expert Control and Safety Technology Expert ETCS
Dr.-Ing. Jens Buder	Research Associate Expert Control and Safety Technology, Focus Level Crossings
Yadi Han M. Sc.	Project Director CERSS Expert ETCS L2
Dipl.-Ing. Richard Kahl	Project Director TU Dresden Expert ETCS
Dipl.-Ing. Claudia Krahl	Project Member Expert Security
Dipl.-Ing. Christoph Hoefert	Project Member Expert Railway Operation
Dipl.-Ing. Michael Tanz	Expert Railway Operation Train Driver
Dipl.-Ing. Martin Sommer	Project Management, Expert Railway Operation und Control and Safety Technology

The aim of the review was to obtain a complete overview that describes the operation processes in the railway system by using the operation scenario overview. In the course of achieving this aim, numerous special cases were discussed and a comprehensive graphic overview of the railway operation was reached. Based on this, the developed test cases were then reviewed for their applicability and, if necessary, adapted. The team also provided an internal procedure to correct errors and to ensure the quality of the results.

Moreover, during the development of the research project, the procedure and the methodology of the test case development were verified by participating continuing education with the corresponding theme, such as the participation in the Test4Rail conference on the 17th-18th October 2017 in Braunschweig.

Due to the multiple comparisons of the methodology and of the test cases with the expertise of the ETCS system Assessor, an additional review of the completeness could be achieved. Opinions and recommendations of the Assessor were integrated and considered during the test case development. The current existing ETCS system assessments were also analysed (see [TRI 2013], [TRI 2015a], [TRI 2015b], [TRI 2016]).

4 Recommendations

In order to be able to optimise the developed generic test case catalogue, a continuous further development is firstly recommended. This aims primarily to minimise the test case repetition that resulted from test case recurrence or the same system behaviour. The contractor also suggests a modularisation of the test case catalogue, which will enable a reuse of the module that reoccurs. This will reduce not only repetition but also errors.

Secondly, it is advisable to continue to add new test cases to the test case catalogue as soon as these are relevant, which guarantees a complete test case catalogue for ETCS at any time. An example of this is the level transition between level 0 and L1 LS, although it is not currently implemented in Germany and was therefore not considered in this research. Another possibility is to add new operation functions or changes of test cases resulting from the changes of the ETCS-specifications.

Thirdly, future findings gained from the test of those lines equipped with ETCS should be integrated as well, in order to consider latest influences. Here the focus lies on the particular features outside of laboratory environment.

Fourthly, the practical operability of the test case catalogue should be examined, aiming to include the supplements revealed. The irregularities such as between requirement specifications, planning guidelines and system specifications that were discovered during the development of the test case catalogue should also be documented and discussed with specialists and experts. An example of this is the different handling of a malfunctioning level crossing with train driver indicator in level 2 and ESG (level 1 German version).

Fifthly, a commentary regarding the test case catalogue should be taken into account, in order to incorporate subsequent suggestions, comments and recommendation.

Overall, it is strongly recommended that the test case catalogue be put into trial and further to be improved and optimised. All the extensions that occur can consequently be incorporated. It is also recommended that the available repetition be analysed and possibly supplemented by reference. Further, an assessment scale indicating the test results should be developed for the entire test case catalogue, so that not every test leads to unsafe operation if the test result is negative. The combination of several cases that are not critical to safety can, however, result in reaction of the whole system that is then critical to safety, which is necessary to be avoided. For this, additional methods based on advanced knowledge concerning the test case catalogue and the ETCS system must be worked out.

5 Summary

The main aim of the research project „Development of test cases for ERTMS" was to generate a comprehensive generic test case catalogue for ETCS in Germany (State of knowledge 12/2017). Based on the operation scenario overview, the operation situation tests occurring in the national railway system were developed for the system ETCS level 2 and ESG (level 1 German version). The test case catalogue consists of more than 2.200 individual test cases. Its completeness was proved upon regular consultations with specialists and experts with experienced knowledge in the field of the railway safety technology. Moreover, a quality examination was conducted and the existing irregularities between the documents were dealt with. In addition, a comparison between the developed test cases and the published test cases from other European countries and those provided in the subset-076. The experience and the advanced system knowledge of the System Assessor for ETCS level 2 was also integrated.

The developed test case catalogue is prepared and developed for the practical application and includes numerous filter functions. Furthermore, it can be adapted as the result of continuous update and possible changes. A consideration of the security aspect influencing on the safety was also carried out.

6 List of Abbreviations

ABBREVIATIONS	DEFINITION
GSM-R	Global System for Mobile Communications – Railway
ERTMS	European Rail Traffic Management System
WP	Work Package
CENELEC	European Committee for Electrotechnical Standard
ESG	ETCS Level 1 LS (German Version)
ETCS	European Train Control System
LS	Operation Mode Limited Supervision
MA	Movement Authority

7 List of Figures

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9 Literature

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10 Annex

10.1 Comparison with Subset 076

SPALTE	REFERENZ	GETESTETE FUNKTION	TESTFALLNUMMER IM TESTFALLKATALOG
1	Subset-076-5-2-4060300	Transitions Conditions Table	2.3.7
2	Subset-076-5-2-3120500	Level Crossings	2.3.5
3	Subset-076-5-2-3131050	Requirements for Release speed monitoring (Tables 13, 14 and 15)	2.3.1
4	Subset-076-5-2-5100100	Level Transitions General requirements	2.3.6
5	Subset-076-5-2-4080431	Accepted Information depending on the modes - RBC Transition Order	2.3.9
6	Subset-076-5-2-5180800	Advisinga tunnel stopping area	2.3.10
7	Subset-076-5-2-5040500	Degraded Situations	2.2
8	Subset-076-5-2-3080500	MA Update and Extension	2.3.9
9	Subset-076-5-2-5080200	Selection of an Override	2.2
10	Subset-076-5-2-5160000	Procedure passing a non protected Level Crossing	2.3.5
11	Subset-076-5-2-5060200	Table of requirements for Shunting Initiated by Driver procedure	None
12	Subset-076-5-2-3150100	RBC/RBC Handover	2.3.9
13	Subset-076-5-2-4080403	Accepted Information depending on the modes - Assignment of Coordinate system	2.3.9
14	Subset-076-5-2-3070300	Extension, replacement of track description and linking infor-	2.3.9

		mation	
15	Subset-076-5-2-3050300	Establishing a communication session	2.2
16	Subset-076-5-2-4080432	Accepted Information depending on the modes - Repositioning information	2.2
17	Subset-076-5-2-4041300	TRIP	2.3.7
18	Subset-076-5-2-4080442	Accepted Information depending on the modes - Track A head Free Request	2.3.7
19	Subset-076-5-2-3130233	Gradients	2.3.9
20	Subset-076-5-2-3050500	Terminating a communication session	2.3.9
21	Subset-076-5-2-4100103	What happens to accepted and stored information when entering a given mode	2.3.7
22	Subset-076-5-2-5090200	On Sight is requested for current location (from modes different from Stand By and Post Trip)	2.3.7 2.2
23	Subset-076-5-2-4080500	Handling of transition buffer in case of level transition announcement or RBC/RBC handover	2.3.9
24	Subset-076-5-2-5100200	Table of priority of trackside supported levels	2.3.6
25	Subset-076-5-2-3160400	Error reporting to RBC	2.3.4
26	Subset-076-5-2-4080438	Accepted Information depending on the modes - SR Authorisation	2.2
27	Subset-076-5-2-5080300	Once the Override procedure has been triggered	2.2
28	Subset-076-5-2-5190300	Limited Supervision is requested for a further location	None

29	Subset-076-5-2-3131040	Requirements for Target speed monitoring (Tables 8, 9, 10, 11 and 12)	2.3.1
30	Subset-076-5-2-3040400	Linking	2.3.7.4
31	Subset-076-5-2-4080434	Accepted Information depending on the modes - Reversing Supervision Information	2.3.9
32	Subset-076-5-2-3110500	Temporary Speed Restrictions	2.3.1
33	Subset-076-5-2-3090200	Infill by loop	None
34	Subset-076-5-2-3130237	National Values for speed and distance monitoring	2.3.1
35	Subset-076-5-2-3150900	Virtual Balise Cover	None
36	Subset-076-5-2-3100200	Emergency Stop	2.3.1
37	Subset-076-5-2-4040400	NO POWER	None
38	Subset-076-5-2-6060302	6.6.3.2 Packets received from balise, loop, RIU, RBC	2.3.9
39	Subset-076-5-2-4040700	STAND BY	2.1
40	Subset-076-5-2-4080440	Accepted Information depending on the modes - Temporary Speed Restriction	2.3.1
41	Subset-076-5-2-3160300	Radio	2.3.1
42	Subset-076-5-2-4080406	Accepted Information depending on the modes - Trackside constituent System Version	2.3.7
43	Subset-076-5-2-4080100	Acceptance of received information	2.3.9
44	Subset-076-5-2-3160200	Balises	2.3.9
45	Subset-076-5-2-4080427	Accepted Information depending	2.3.9

		on the modes - Plain Text Information	
46	Subset-076-5-2-4080437	Accepted Information depending on the modes - Session Management	2.3.9
47	Subset-076-5-2-4080425	Accepted Information depending on the modes - Movement Authority	2.3.9
48	Subset-076-5-2-3120400	Mode Profile	None
49	Subset-076-5-2-9990502	A Handling of Actions in Specific Situations	2.3.9
50	Subset-076-5-2-9990400	A Handling of Stored Information in specific Situations	2.3.9
51	Subset-076-5-2-4040600	SLEEPING	None
52	Subset-076-5-2-4080420	Accepted Information depending on the modes – Linking	2.3.7
53	Subset-076-5-2-3131030	Requirements for Ceiling speed monitoring (Tables 5, 6 and 7)	2.3.7
54	Subset-076-5-2-3170200	Determination of the operated system version	2.3.8
55	Subset-076-5-2-5030100	Scope and Purpose	2.2
56	Subset-076-5-2-4080433	Accepted Information depending on the modes - Reversing Area Information	None
57	Subset-076-5-2-5120400	The driver uses the same engine (a Shunting movement is ongoing)	None
58	Subset-076-5-2-4080441	Accepted Information depending on the modes - Temporary Speed Restriction Revocation	2.3.7
59	Subset-076-5-2-4080409	Accepted Information depending on the modes - Default Balise	2.3.9

		Information	
60	Subset-076-5-2-5050400	Degraded Situation	2.2
61	Subset-076-5-2-5050300	End of Mission Procedure	2.5.1
62	Subset-076-5-2-3080400	Use of the MA on board the train	2.3.1
63	Subset-076-5-2-5180200	Passing a powerless section with pantograph to be lowered	2.5.2
64	Subset-076-5-2-3130810	Determination of targets and brake deceleration curves	2.3.1
65	Subset-076-5-2-4080418	Accepted Information depending on the modes - International SSP	2.3.7
66	Subset-076-5-2-3130235	Reduced Adhesion Conditions	2.3.1
67	Subset-076-5-2-9990200	A List of National/Default Data	None
68	Subset-076-5-2-4041800	REVERSING	None
69	Subset-076-5-2-4080414	Accepted Information depending on the modes - Fixed Text Information	2.3.7
70	Subset-076-5-2-8040100	Common Rules	None
71	Subset-076-5-2-4080401	Accepted Information depending on the modes - Acknowledgement of train data	2.3.7
72	Subset-076-5-2-4042000	PASSIVESHUNTING	None
73	Subset-076-5-2-4080452	Accepted Information depending on the modes - Initiation of session	2.3.7
74	Subset-076-5-2-8040400	Rules for Euroradio messages	None
75	Subset-076-5-2-4080300	Accepted information depending on the level and transmission media	2.3.6

76	Subset-076-5-2-4080444	Accepted Information depending on the modes - Track Condition big metal masses	2.3.7
77	Subset-076-5-2-5040300	Table of requirements for Start of Mission procedure	2.2
78	Subset-076-5-2-4080417	Accepted Information depending on the modes - Infill location reference	2.3.7
79	Subset-076-5-2-4080407	Accepted Information depending on the modes - Cooperative Shortening of MA	2.3.7
80	Subset-076-5-2-3131060	Transitions between types of Speed and distance monitoring (Table 16)	2.3.6
81	Subset-076-5-2-4041500	NONLEADING	2.3.9
82	Subset-076-5-2-3120200	Route Suitability	2.3.9
83	Subset-076-5-2-3080200	MA request to the RBC	2.2.1
84	Subset-076-5-2-4080453	Accepted Information depending on the modes - Data to be used by applications outside ERTMS/ETCS	None
85	Subset-076-5-2-4090100	What happens to accepted and stored information when entering a given level	2.2
86	Subset-076-5-2-5120200	The driver uses the same engine	2.2
87	Subset-076-5-2-4080419	Accepted Information depending on the modes - Level Transition Order	2.3.6
88	Subset-076-5-2-5150400	Degraded Situations	2.3.9
89	Subset-076-5-2-6060304	Messages transmitted to RBC/RIU	2.3.9

90	Subset-076-5-2-3130232	Trackside related speed restrictions	2.3.1
91	Subset-076-5-2-3040200	Balise Coordinate System	2.3.1 2.2
92	Subset-076-5-2-3110700	Mode related speed restrictions	2.3.1
93	Subset-076-5-2-4080447	Accepted Information depending on the modes - Unconditional Emergency Stop	2.3.1
94	Subset-076-5-2-3050700	Safe Radio Connection Indication	2.3.9
95	Subset-076-5-2-5180300	Passing a powerless section with main power switch to be switched off	2.5.2
96	Subset-076-5-2-5100300	Specific Additional Requirements	2.3.6 2.3.9
97	Subset-076-5-2-4080408	Accepted Information depending on the modes - Danger for SH information	None
98	Subset-076-5-2-3110800	Train related speed restriction	2.3.1
99	Subset-076-5-2-4080423	Accepted Information depending on the modes - MA Request Parameters	2.2
100	Subset-076-5-2-4080430	Accepted Information depending on the modes - Radio Network Registration	2.2
101	Subset-076-5-2-4040800	SHUNTING	None
102	Subset-076-5-2-5110400	Degraded Situations	2.3.9 2.2
103	Subset-076-5-2-4080421	Accepted Information depending on the modes - List of balises for SH Area	None
104	Subset-076-5-2-3131020	General requirements	2.3.1

105	Subset-076-5-2-3110200	Definition of Static Speed Restriction	None
106	Subset-076-5-2-3130234	Track conditions	2.3.1
107	Subset-076-5-2-3060500	Position Reporting to the RBC	2.3.7
108	Subset-076-5-2-3180500	Date and Time	2.2
109	Subset-076-5-2-5180400	Passing a non stopping area	2.3.9
110	Subset-076-5-2-4080404	Accepted Information depending on the modes - Axle Load speed profile	2.3.9
111	Subset-076-5-2-3060600	Geographical position reporting	None
112	Subset-076-5-2-5181000	Changing the traction system	None
113	Subset-076-5-2-4080435	Accepted Information depending on the modes - Revocation of Emergency Stop (Conditional or Unconditional)	2.3.1
114	Subset-076-5-2-5180700	Inhibition of a defined type of brake	2.3.1
115	Subset-076-5-2-4070200	DMI versus Mode Table - Input	2.3.9
116	Subset-076-5-2-3180200	National/Default Values	2.3.8
117	Subset-076-5-2-4080411	Accepted Information depending on the modes - EOLM information	None
118	Subset-076-5-2-3170300	Management of ERTMS/ETCS system versions	None
119	Subset-076-5-2-4080410	Accepted Information depending on the modes - Default Gradient for TSR	2.3.1
120	Subset-076-5-2-9990500	A Handling of Actions in Specific Situations	None

121	Subset-076-5-2-4080446	Accepted Information depending on the modes - Train running number	2.2
122	Subset-076-5-2-3040300	Balise Information Types and Usage	2.2
123	Subset-076-5-2-3111100	Speed restriction to ensure permitted braking distance	2.3
124	Subset-076-5-2-3180600	Data view	2.3
125	Subset-076-5-2-4070201	DMI versus Mode Table - Output	2.3
126	Subset-076-5-2-4050200	Active Functions Table Empty case = function shall be inactive	2.3
127	Subset-076-5-2-3100300	Revocation of an Emergency Message	2.3
128	Subset-076-5-2-3150800	Cold Movement Detection	None
129	Subset-076-5-2-3120100	Track Conditions	2.3.9
130	Subset-076-5-2-3110400	Axle Load Speed Profile	2.3.9
131	Subset-076-5-2-5090300	On Sight is requested for a further location	2.2
132	Subset-076-5-2-4080415	Accepted Information depending on the modes - Geographical Position	2.3.7
133	Subset-076-5-2-4080450	Accepted Information depending on the modes - SH refused	None
134	Subset-076-5-2-4080405	Accepted Information depending on the modes - Conditional Emergency Stop	2.3.7
135	Subset-076-5-2-4080422	Accepted Information depending on the modes - Location Identity (NID_C + NID_BG transmitted in the balise telegram)	2.3.7

136	Subset-076-5-2-3130700	Determination of Most Restrictive Speed Profile (MRSP)	2.3.9
137	Subset-076-5-2-4041400	POST TRIP	2.3.7 2.3.9
138	Subset-076-5-2-5100315	Transition initiated by driver	2.5.1
139	Subset-076-5-2-5170200	Table of requirements for Changing Train Data from sources different from the driver procedure	2.3.9
140	Subset-076-5-2-5110200	Table of requirements for Train Trip procedure	2.3.9
141	Subset-076-5-2-4080426	Accepted Information depending on the modes - National Values	2.3.9
142	Subset-076-5-2-6060303	Messages received from RBC/RIU	2.3.9
143	Subset-076-5-2-3180400	Additional Data	2.3.9
144	Subset-076-5-2-3060300	Validity direction of transmitted Information	2.3.9
145	Subset-076-5-2-3060200	Location of Data Transmitted to the On-Board Equipment	2.3.9
146	Subset-076-5-2-3120300	Text Transmission	2.3.9
147	Subset-076-5-2-5080400	End of Override procedure	2.2
148	Subset-076-5-2-5100400	Acknowledgement of the level transition	2.3.6
149	Subset-076-5-2-3050400	Maintaining a communication session	2.3.4
150	Subset-076-5-2-3180300	Train Data	2.2
151	Subset-076-5-2-5060400	Degraded Situation	None
152	Subset-076-5-2-4080451	Accepted Information depending on the modes - SH authorised +	none

		(optional) List of Balises for SH Area)	
153	Subset-076-5-2-4080429	Accepted Information depending on the modes - Radio Infill Area information	None
154	Subset-076-5-2-3070200	Responsibility for completeness of information	None
155	Subset-076-5-2-4041100	STAFF RESPONSIBLE	2.3.7.1
156	Subset-076-5-2-5190200	Limited Supervision is requested for current location (from modes different from Stand By and Post Trip)	1.3.6
157	Subset-076-5-2-3080300	Structure of a Movement Authority (MA)	2.2
158	Subset-076-5-2-3060100	Location Principles and Train Position and Train Orientation	2.2
159	Subset-076-5-2-4080445	Accepted Information depending on the modes - Track Conditions excluding sound horn, non stopping areas, tunnel stopping areas and big metal masses	2.3.7
160	Subset-076-5-2-3151000	Advance display of route related information	2.3.9
161	Subset-076-5-2-3111200	Gradients	2.3.9
162	Subset-076-5-2-4080443	Accepted Information depending on the modes - Track Ahead Free up to level 2/3 transition location	2.3.9
163	Subset-076-5-2-3060400	Train Position Confidence Interval	2.3.9
164	Subset-076-5-2-4040500	SYSTEM FAILURE	2.3.1
165	Subset-076-5-2-7040200	PACKETS: TRACK TO TRAIN	None
166	Subset-076-5-2-4080416	Accepted Information depending	2.3.7

		on the modes - Gradient Profile	
167	Subset-076-5-2-3110600	Signalling related speed restrictions	2.3.1
168	Subset-076-5-2-9990600	A Deletion of accepted and stored information when used	2.3.7
169	Subset-076-5-2-4080424	Accepted Information depending on the modes - Mode Profile	2.3.7
170	Subset-076-5-2-3110300	Static Speed Profile (SSP)	2.3.9
171	Subset-076-5-2-5180900	Sounding the horn	None
172	Subset-076-5-2-5190600	Exit of Limited Supervision mode	1.3.6.2
173	Subset-076-5-2-3090300	Infill by radio	None
174	Subset-076-5-2-3140300	Reverse Movement Protection	2.3.1
175	Subset-076-5-2-4080413	Accepted Information depending on the modes - Exception [5]	2.3.9
176	Subset-076-5-2-7050100	Definitions of Variables	2.3.7
177	Subset-076-5-2-3050600	Registering to the Radio Network	2.2 2.3.9
178	Subset-076-5-2-4080402	Accepted Information depending on the modes - Adhesion factor	2.3.7
179	Subset-076-5-2-5070300	Shunting is requested for a further location	None
180	Subset-076-5-2-5180600	Passing an air tightness area	2.3.9
181	Subset-076-5-2-3150700	Tolerance of Big Metal Mass	None
182	Subset-076-5-2-3140100	Brake Command Handling	2.3.7.4
183	Subset-076-5-2-4080439	Accepted Information depending on the modes - Stop if in SR mode	2.3.7.1

184	Subset-076-5-2-4080428	Accepted Information depending on the modes - Position Report Parameters	2.2
185	Subset-076-5-2-3150400	Reversing of movement direction	2.2
186	Subset-076-5-2-4080436	Accepted Information depending on the modes - Route Suitability Data	2.2
187	Subset-076-5-2-5180500	Passing a radio hole	2.3.9

10.2 Operation Scenario Overview

The operation scenario overview is available separately: Annex 2. German language only.

10.3 Test Case Catalogue

The developed test case catalogue for ESG (German implementation of ETCS L1 LS) and ETCS level 2 is available separately: Annex 3. German language only.