RCA

Reference CCS Architecture

An initiative of the ERTMS users group and the EULYNX consortium

Concept Degraded Modes in RCA

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Version history

Gamma.1	31.1.2020	U. Mosele	First release after review RCA core group.

1. Introduction

1.1. Purpose of the document

Control command signalling (CCS) systems which will be built according to RCA have to handle situations where normal operation is not possible anymore. Special situations can be caused by environmental influences (e.g., heavy rain showers) or by failures of technical systems.
This document will focus on situations where technical systems fail, and normal operation is not possible anymore.
This document does not solve the question of degraded modes for RCA but explains why degraded modes are relevant for RCA and how they will have to be addressed in the RCA specification process.

1.2. Definition of Degraded Modes

In RCA, the term “degraded mode” is defined as “Failure of a technical system/function and therefore a special operational process needs to be applied[1]”. That is, if a technical system fails and the normal operation process can still be applied, a degraded mode doesn’t occur. This can happen if, for example, a redundant system takes over control.

2. Degraded Modes in RCA

The scope of RCA is to define a reference CCS architecture with harmonised interfaces between the single architecture elements (blocks, standard product scopes). This reference architecture is defined in a way that fulfils the needs of the operational processes of the participating railways and is designed along the best practices for these processes.
To be able to harmonise interfaces, the functionalities (of the components) must be defined. For example, a train-position report which is sent to the APS MT must be handled in a defined way (e.g., extract only safe front end) to send the position of the train front end over the interface 6 (see RCA interface architecture) to the APS OA. If each IM wants to have its own solution, the interfaces become very complex.
This is also valid for situations where some technical elements don’t work anymore, and special operational processes must be carried out.

2.1. Influence of degraded modes on RCA architecture

As described above, degraded modes are also a topic in RCA and must be considered. To be able to show the impact of degraded modes on RCA, an analysis of every possible failure of elements must be done. The analysis will then be the basis for further investigations. The result of the investigation may then influence RCA.
Example: Additional functionality due to degraded modes may have influence on interactions between RCA components. T

2.2. Scope

In the context of RCA, only degraded modes which have an influence on RCA shall be considered. Therefore, the system which is influenced by RCA must be defined.
Example: Loss of catenary tension: If the train may not move anymore because of the lack of catenary tension the train must be towed away by a diesel engine. The loss of catenary tension itself is out of

[1] Note: also, a violation of a rule by a human being may lead to a degraded mode where special operation has to be applied.

scope of RCA, the towing away of trains which are not able to move anymore by themselves is in scope of RCA.

2.3. Handling of degraded modes

As described in Chapter 2.1, an analysis of all possible failures which are in the context of RCA according to Chapter 2.2 has to be done. A list with all possible cases shall be the result of this analysis. Further, each IM must describe how the single cases are ruled in their own country and infrastructure. With this information, the functionalities can be distributed not only to the single blocks of RCA but also to elements which are out of the scope of RCA (e.g., the planning system). This distribution shall return a list with all functionalities which must be handled within RCA. Furthermore, the functionalities must be described in a manner such that interfaces can be defined.
The big challenge will be the distribution and determination of the single functionalities. There may be differences between the single IMs as to how to manage single situations. Furthermore, it must be determined which differences can be handled by configuration and for which differences configuration is not possible because of complexity. The following example shows how the determination of standardised functionalities can be done.
Example: Failure of the trackside train detection (TTD) system: In a TTD system failure, a special operation process must be applied to run over the affected track section whilst the TTD system is out of service. The example below shows each single step of such a process. In brackets it is defined if a step within the special operating process can be treated in a different manner or if it must be standardised.
The process of such an event might be the following:

1. *TTD system failure*
2. *Affected track section remains occupied*
3. *The planning system recalculates all affected train movements (may be different)*
4. *The dispatcher is informed about the occupation (may be different)*
5. *The dispatcher takes over the planning for this area (may be different)*
6. *The dispatcher sets a usage restriction area (URA) over the affected track section (standardised)*
7. *APS SL checks if this URA may be accepted and sets the URA (standardised)*
8. *The dispatcher calls the engine driver which must check if the affected track section is free of obstacles (may be different[2])*
9. *The engine driver confirms the request by radio (may be different)*
10. *The dispatcher sets a movement permission over the affected track section (standardised)*
11. *APS SL checks this movement permission (e.g. vmax) and sends the MP request over APS OA to APS MT (standardised)*
12. *An "On Sight" movements authority (MA) is triggered by the APS MT and received by the EVC (standardised)*
13. *The engine driver confirms the "On Sight" request (standardised)*
14. *The train runs over the affected section and clears the section (standardised)*
15. *The dispatcher calls the engine driver if the track was clear (may be different)*
16. *The engine driver confirms by radio that no obstacle was on the track (may be different)*
17. *The dispatcher overrides the state of the affected track section (occupation -> No information) (standardised)*
18. *APS SL labels this track section (standardised)*
19. *The dispatcher releases the planning of this area (may be different)*
20. *The planning system takes over the planning of this area (may be different)*

[2] Also, a train running on the neighbor track could confirm that the affected track section is free of obstacles. Than the following steps would be different.

21. *As long as the TTD of the affected track section is not repaired this TTD information may not be used anymore for train integrity information (standardised)*

3. Actions

As described in Chapter 2, an analysis has to be done to determine the functionalities needed for RCA to handle degraded modes.

3.1. List of possible failures

A list of all possible failures has to be elaborated. This list shall show all possible system failures which can happen in the railway environment. It is worth noting that not only technical system failures can lead to a degraded mode (e.g., train trip by violating the EoA).
Example (list not exhaustive) :

#	Description of the case	Special operation needed	Safety relevant
1	*MP requests over TMS PE are not possible anymore.*	*Yes (MPs have to be requested manually)*	*No*
2	*Loss of FRMCS connection to the train*	*No*	*Yes*
2.1	*Train brakes due to the exceed of* T_NVCONTACT	*Yes*	*No*

Table 1: List of cases where a degraded mode occurs.

3.2. National operation rules

Every case in Table 1 must be treated by the IM. The IM must deliver the national/infrastructure operating processes which are requested by law or regulations for every single case according to the example provided in Chapter 2.3.
Note: The harmonization of the operating rules would simplify the RCA system, but changing operating rules takes a long time. RCA has the aim to offer a set of functionalities which will cover these differences.

3.3. Definition of the special operational processes

From the analysis presented in Chapters 3.1 and 3.2, processes must be worked out for every single case, as in the following example:

Failure of a TTD

The aim of the process

- Perform movement despite an occupancy

Prozessschnittstellen

- Perform automatic movement in GoA 2
- Perform movement in GoA 1
- Perform shunting movement
- Perform trackside maintenance work
- Perform state of the situation

Auslöser

- Occupation of a TTD

Input

- TTD indicates an occupation

Output

- Movement is performed

Activities and responsibility

Nr	Activity	Human in RCA	System in RCA	Out of RCA
0	Classification of the failure (occupation of a TDS without any movement)		X	
1	Set URA over the affected section		X	
2	Perform perturbance analysis	X		
3	Set movement permission over the affected section («On Sight» MA)	X		
4	Train runs over the affected section	X		
5	Further journeys with recognized completeness of preceding train and with the same course position without restriction but only with manual movement permission possible.	X		
9	Re-availability made		X	

Figure 1: Example of a special operational process.

3.4. Definition and allocation of functions

In a further step, the special operational process must be defined in more detail by means of a functional description. The aim of this work is to allocate the functionalities to the single RCA blocks. Therefore, flowcharts must be elaborated, as described in Figure 2.

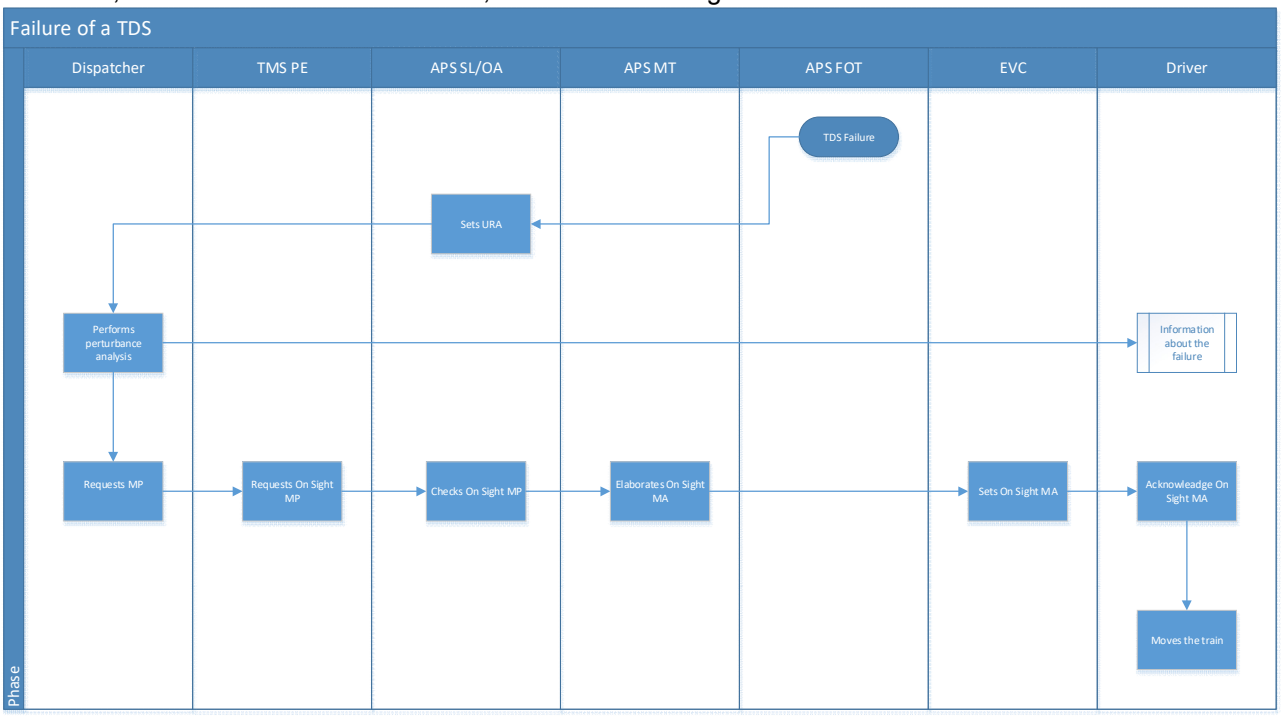

Figure 2 Flowchart of the special operational process.