

## ERTMS/ETCS – Class 1

### Methodology to Prepare Features

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## 3. INTRODUCTION

### 3.1 Need of the Feature List

In the System Requirement Specification (ERTMS /ETCS – SRS 2.3.0 and the related documents), UNISIG specified those needed requirements for interoperable ETCS system.

For many requirements it is not possible to test them directly at the standardised interfaces.

Turning every requirement into a test case would result in a vast number of test cases.

To solve both, a concept of a reduced number of functional entities is necessary. These shall be called features.

Every SRS requirement shall be identified in at least one feature, every feature shall be linked to the corresponding SRS requirements.

#### Definition:

A Feature is a group of requirements, which fulfilment can be tested at the available interfaces.

For the sake of a proper management, test case features should have the following properties:

- **Simplicity:**  
Restriction to the direct stimulation and reaction at the available interfaces to a test stimulation of the test object (single cause/effect relation). The reaction is thereby a mandatory sequence of defined outputs at the available interfaces.
- **Independency:**  
The test of a feature should be widely independent of all other features, which could be active at the same time. **Essential functionality** (of an ATP system; especially ETCS) offers the necessary independence without taking into consideration the implementation of the feature.

Together with the settings:

- Only in the reference architecture from standardised interfaces are available for interoperability tests. Only reactions at these standardised interfaces are declared as outwardly visible. (this point of the test architecture is still open)
- Interoperability tests comprise the entire functionality of the ETCS.

The definition of a feature could be completed in the following matter.

#### Realisation of definition:

**Features** are essential functional entities (essential system features, functions, capabilities, essential properties or characteristics) of the ATP system ETCS, that are outwardly visible (effective for the operator or user) and decomposed to basic cause/effect relations. In this

sense, “features” can be understood as characteristics expected from a system by the operator or user.

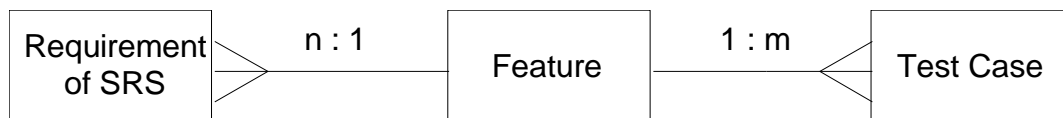
Thus it is possible to group the detailed requirements of the SRS (i.e. all required functions and properties) in features. As a result, functional groups of requirements are created, i.e. groups with one or more requirements, which are summarised in the sense of outwardly visibility and manageable, widely independent portions for test.

By the property: “simplicity” follows, that each alternative in the containing requirements and therefore in the feature, needs its own test case as far as the verification shall be accomplished by test. That promotes the arrangement of test cases to test trips, because by each usage of a feature within a test trip only one alternative is needed.

For features, which have test cases that are theoretically proved (not tested), a corresponding statement shall be made in the concerning test cases.

For each feature it could give more the one test case for the on-board as well as the track-side subsystem.

The cardinalities of the declaration above, can be demonstrated in the following entity relation diagram:



**Figure 1: Entity Relations to Feature**

Such a list-type composition of the essential system features makes possible:

- to test the requirements of the SRS at the available interfaces,
- to reduce the quantity of test cases through concentration to the regular cases by the view of the entire ETCS,
- to reduce the complexity of test cases through widely independent, basic test cases,
- to compose test cases to widely independent test trips,
- to measure the degree of technical interoperability e.g. by the number of fulfilled test cases,
- in addition to provide a complete overview of the system’s capabilities.

## 3.2 Tasks of the Feature List

The Tasks of the feature list corresponding to the possibilities of the feature list are:

- To group the requirements of the SRS in testable features at the standardised interfaces. No manipulation of existing requirements and no new requirements shall emerge when composing a feature.
- The feature list shall contain features of the entire ETCS, no imperative separation between on-board and track-side.
- To provide manageable test cases in size and independence. Define the scope of the test cases.
- To provide the basis to compose widely independent test trips.
- By testing the features all requirements of the SRS are tested and proved, which are relevant for technical interoperability and therefore have to be tested. These requirements have to be traced.



## 4. PRINCIPLES OF THE FEATURE LIST

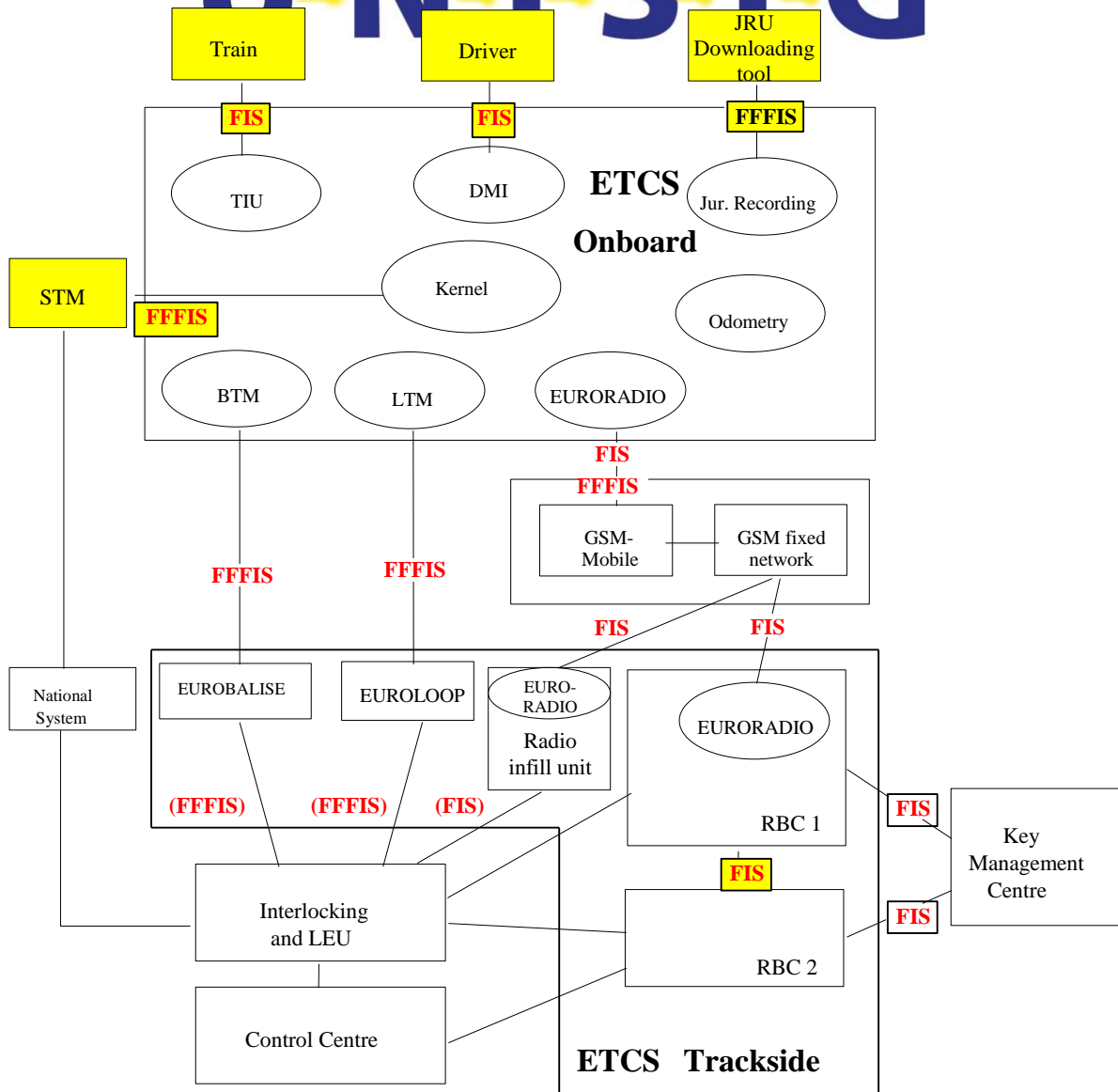
### 4.1 Scope

The feature list covers all requirements of the ERTMS / ETCS Class-1 UNISIG SRS 2.3.0 and it is also taking into account the performance document, the relevant contents of the engineering rules and the following documents:

- FIS DMI
- FIS TIU
- FIS RBC-RBC
- FIS part JRU FFFIS
- FIS part STM FFFIS.

The feature list contains the features of the entire ETCS (on-board and track-side as one unit) limited to features with relevance for technical interoperability. The national portions/elements such as the connection to the interlocking, control centre, etc. are not included.

The features must be outwardly effective at the standardised, system boundaries. Using the following reference architecture, features must be effective at the interfaces to the driver, the train, the JRU downloading tool and the STM or the RBC-RBC interface; but **not** at the airgap interfaces (EUROBALISE, EUROLOOP and EURORADIO).



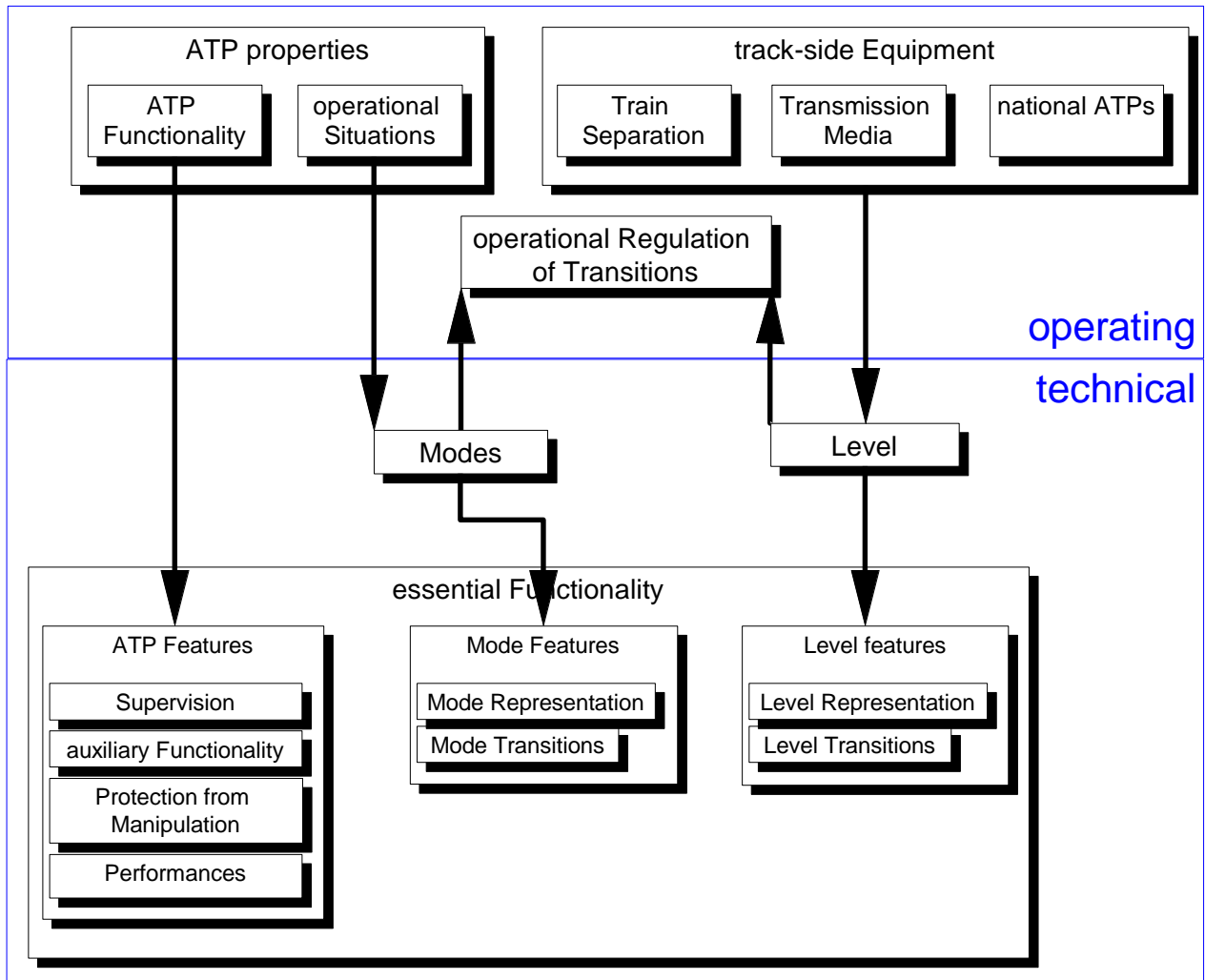
**Figure 2: ERTMS/ETCS reference architecture**

For this scope, all features of the feature list are relevant to an operator or user of the ERTMS / ETCS Class-1, which can be used as criteria when creating the features.

## 4.2 Structure of the Feature List

Referencing the definition of a Feature, it is useful for preparation of the features to structure the feature list according to the sources for essential functional entities of the ATP system ETCS. The following figure will illustrate the cause of technical ETCS features by the operating conditions.





**Figure 3: Sources for essential functional entities of the ATP system ETCS**

This approach delivers the following uppermost hierarchy:

#### ATP Features

- Supervision Features
- Auxiliary Functionality
- Protection from Manipulation
- Performances

#### Mode Features

- Mode Representation Features
- Mode Transitions

#### ERTMS/ETCS Level Features

- ERTMS/ETCS Level Representation Features



## - ERTMS/ETCS Level Transitions

Further lower levels of the hierarchy are used to gather the essential functionality of ETCS to the uppermost hierarchy and to break down this functionality to basic functionality with the scope of outward visibility.

Only at the end of the hierarchy, at the lowest level are the intrinsic features. A feature must not have subordinated features.

### **4.3 Comprehensibility of Features**

Analogously to requirements, each feature must be clearly understandable, even without context, if possible.

### **4.4 Independence of Features**

Each feature should be independent of other features. Superior features must not exist.

The hierarchical subdivision just serves the purpose of better readability.

Often used functionality in several different features could be separated in own features. This offers the possibility to test them with all aspects only at once, when the specific software architecture allows that. This kind of features hurt the above mentioned independence in a restricted manner of completely use in other features. These features are not testable by themselves. They will be tested together with the features, which use them.

### **4.5 Identification of a Feature**

Within the whole lifecycle, each feature must be clearly identifiable.

### **4.6 Features & ERTMS/ETCS Level**

For each feature, it shall be stated the corresponding ETCS level. The reason why is because L1 features can slightly differ from that ones in L2/L3. ,

## 5. PRACTICAL REALISATION OF THE FEATURE LIST

### 5.1 Check List for Features

The created features must have the following properties. In order to check this according to a check list, the questions allocated to the properties must be answered positively.

#### 5.1.1 Comprehensibility

- Is the feature readable in the plain text?
- Is the feature comprehensible?
  - a) for notified bodies
  - b) for the operator / user
  - c) for developers
- Has the coherence of the requirements been:
  - a) completely explained?
  - b) Is it comprehensible for this feature?

#### 5.1.2 Unambiguousness

- Has the feature a clear (explicit) identifier (can a clear reference be made)?
- Has the feature an unambiguous name?
- Can the feature be clearly interpreted (without misinterpretation)?

#### 5.1.3 Traceability

- Have no modifications or no new requirements been stated by grouping SRS requirements to Features? Can a complete reference be made to the allocated requirements?
- Are all references available?
- Are the requirements allocated to the feature
  - a) Correct and precisely referenced?
  - b) Completely allocated?

If not, the interesting part shall be sufficiently bounded through references to the paragraphs and sentences?  
(A requirement should not be distributed to different features; however, it may be completely allocated to several features. Otherwise a correction in the SRS might be needed.)

## 5.1.4 Testability

- Can the fulfilment of the feature be sufficiently proved?
- Are all pieces of information required for the evaluation of the tests outwardly visible (for the user) / can it be measured at the existing interfaces?

## 5.1.5 Completeness

- Have all requirements been grouped in features?
- Have all alternatives in requirements been grouped in features?
- Are the requirements summarised in the feature:
  - a) Necessary?
  - b) Sufficient?
  - c) Clearly delimited for this feature?
- Have all possible restrictions of the features been completely described with requirements?

## 5.1.6 Consistency

- Have requirements and terms been correctly used (without misinterpretation of the SRS)?

## 5.1.7 Granularity

- Are the features basic in the sense of a single cause/effect relation (there aren't less or more direct outwardly visible effects)?

## 5.2 Links/ References

Concerning the feature list, the following links shall be established:

- Traceability:
  - Each feature included in the list shall be referenced to the corresponding SRS requirements needed.
  - Each test case shall be only referenced to the SRS requirements for its feature.
- Completeness:

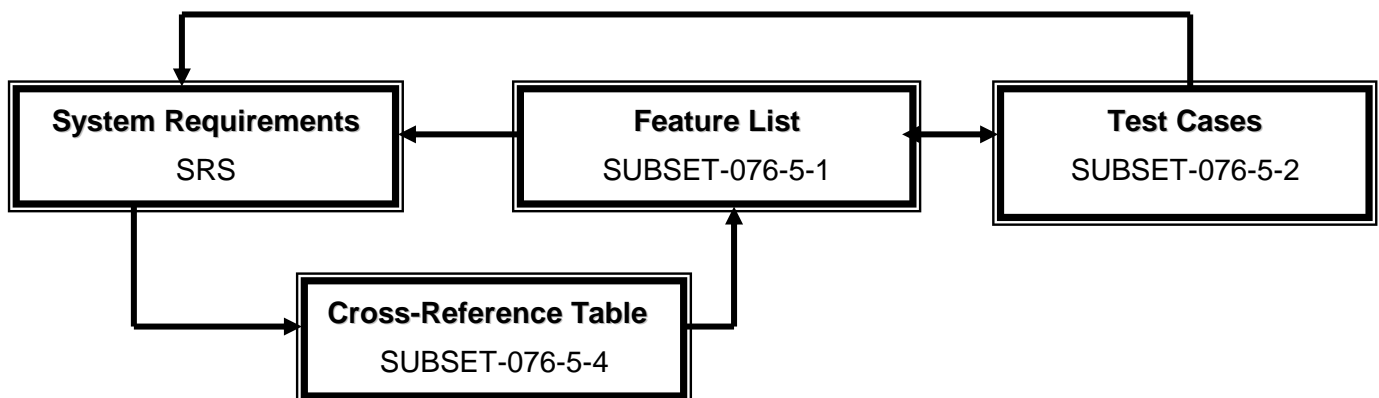
- A cross-reference table between SRS requirements and the feature list must be created (out of the links from the feature list to the SRS requirements) to prove the complete coverage of the requirements by the feature list. If it turns out that for some requirements it is not possible to be covered by a feature, this has to be clearly indicated and solutions for the certifications of these requirements have to be proposed.

This cross-reference table has been created in the document “SRS v2.3.0 Traceability” SUBSET-076-5-4 v2.3.0. This document contains a table of all the SRS requirements, specifying the features where each requirement is included.

The SRS paragraphs that are non requirements are included in the non requirements chapter of the feature list.

The different requirements included in each feature, are split up in the corresponding test cases of this feature where they are really tested. Each Test case includes a list of the requirements really tested.

The following figure summarizes the links around the Feature List related with the SRS requirements.



**Figure 4: Links / references around the feature list**

## 5.3 Tools

For the creation of the Feature List, the template similar to the example indicated in Chapter 6 shall be used.

### 5.3.1 Column Type:

The column “Type” defines the nature for each row/ entry in the List. Four different types shall be used:

“Hierarchy” - For all titles and subtitles



“Feature” - For each feature

“Req. Ref.” - For each reference to a requirement assigned to a feature and proved within the subordinated Test Case

For each reference to a requirement, a new row of the table shall be used.

### **5.3.2 Column Feature ID**

For each Feature a unique identifier shall be assigned. The identifier of a feature shall be repeated for each requirement reference, in order to make it possible to sort the feature list without losing the assignment of the reference to the feature (necessary to create the cross reference table).

No identifier shall be assigned to titles or subtitles (marked as type “Hierarchy“).

### **5.3.3 Column Contents**

The column “Contents” shall be used to specify for:

- Entries of the Type “Hierarchy” - Numbering & title
- Entries of the Type “Feature” - Name of the feature
- Entries of the Type “Req. Ref.” - Number of the Requirement

All features shall have at least one subordinate Title or Subtitle. For every feature at least one Test Case shall be assigned. For each Test case at least one requirement shall be assigned.

### **5.3.4 Column Description**

The column “Description” can be used to give further explanations for each entry in the List

### **5.3.5 Column Available in Modes**

For each feature it shall be stated in the column “Available in Modes” to which ETCS modes it belongs. The “Available in Modes” information shall be only indicated in the rows with entries of the Type “Feature”.

### **5.3.6 Columns ETCS Environment - Level**

For each feature it shall be stated in the column “Level” to which ETCS levels it belongs. This is not necessarily the level where in the feature is executed but the levels where the implementation of the feature is required (example: the establishment of a radio communication session is also executed in the levels 0, STM and 1, but is required for a Level 2 or 3 implementation).

The “Level” information shall be only indicated in the rows with entries of the Type “Feature”.

No level information shall be given to titles or subtitles.

### **5.3.7 Columns ETCS Environment - Options**

These columns specify different options needed to perform the sequence of test included in the test cases of each feature. It mentions if the onboard equipment is connected to Service brake, if



STM modules are available, and if the onboard equipment has Euroloop, Eurobalise and Radio In-fill Unit interfaces.

## 6. EXAMPLES

Type	F ID	Lot	Contents	Description	Available in Modes														ETCS Environment																					
					FS	OS	SR	SH	UN	SL	SB	TR	PT	SF	IS	NP	NL	SE	SN	RW	0	1	2	3	STM	No SB	EE & SB	No STM	No	No P1U										
SERVED FOR FILTER LISTS																																								
Hierarchy																																								
Feature	154	2	Roll away protection		X	X	X	X																																
Req. Ref.			<a href="#">Subset-026-cp-3.6.4.4.a)</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.11</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.15</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.2.2</a>																																					
Req. Ref.			<a href="#">Subset-026-3.14.2.3</a>																																					
Req. Ref.			<a href="#">Subset-026-3.14.2.4</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.2.6</a>																																					
Req. Ref.			<a href="#">Subset-026-3.14.2.7</a>																																					
Req. Ref.			<a href="#">Subset-026-A.3.2</a> row: Distance to be used in Roll Away protection, Reverse movement protection and Standstill supervision																																					
Req. Ref.			<a href="#">Subset-026-7.5.1.17</a> : Variable D_NVROLL	Packet 3																																				
Feature	155	2	Standstill protection	No variables						X																														
Req. Ref.			<a href="#">Subset-026-cp-3.6.4.4.a)</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.11</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.15</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.4.1</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.4.2</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-3.14.4.4</a>																																					
Req. Ref.			<a href="#">Subset-026-A.3.2</a> row: Distance to be used in Roll Away protection, Reverse movement protection and Standstill supervision																																					
Req. Ref.			<a href="#">Subset-026-4.4.7.15</a>																																					
Req. Ref.			<a href="#">Subset-026-4.4.7.3.1</a>																																					
Feature	156	4	Supervise list of balises during shunting movement					X																																
Req. Ref.			<a href="#">Subset-026-cp-4.4.8.11b)</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-5.7.3.7</a>																																					
Req. Ref.			<a href="#">Subset-026-7.5.1.85</a> : Variable MID_BG(k)	Packet 49																																				
Req. Ref.			<a href="#">Subset-026-cp-7.4.2.12</a> : Packet 49 – List of Balises for SH	Packet 49																																				
Feature	157	4	Supervise “Stop in Shunting Mode” balises during shunting movements					X																																
Req. Ref.			<a href="#">Subset-026-cp-4.4.8.11a)</a>																																					
Req. Ref.			<a href="#">Subset-026-cp-4.4.8.3.1</a>																																					

### 6.1 Bad Examples

In this sense, the braking curve calculation (SSP and DSP) is, for example, no feature of ETCS. It is just a technical mean for the fail-safe supervision of the EoA / DP, speed restrictions for certain train categories, etc.

The train location function is no feature of its own either, however, the indication of the geographical position or the supervision of trackside elements are features.