Verification Report

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Abstract

This document reviews a file with the title *Train Position and Locations*. The review lists deviations to the train positioning system of SUBSET-026 version 3.3.0.

1 Review of DetermineTrainLocationProcedures.docx

1.1 Document and Specification

To avoid confusion the document under review will further be called *document* and this review file will be called *review*.

reviewed document	DetermineTrainLocationProcedures.docx
location	`https://github.com/openETCS/SRS-Analysis/commit/153e793955b38c986dad3bfd8d3fbfe8d5ced77e`
from	`https://github.com/UweSteinkeFromSiemens`
created	21. Jan. 2014
title	openETCS Determine Train Location Procedure
issue	`https://github.com/openETCS/validation/issues/227`
specification	SUBSET-026 (SRS) chapter 3.6 version 3.3.0. as part of the TSI-CCS [1] [2]

The review lists deviations to the train positioning system of SUBSET-26 v3.3.0.

1.2 About this Review

There are several types of reviews, they range from a simple comment to a complete verification where every sentence is linked to the SRS and individually judged to be conform or not. The review type naturally depends on the structure of the reviewed object.

The document(under review) contains explanations, new concepts and repetitions of concepts of the SRS. It does not contain references to requirements and does not indicate which statements can be literally used as a rule. The document does not completely cover chapter 3.6 of SUBSET-026 version 3.3.0.

This review will only list conceptual deviations to the SRS. Every paragraph and every formula of the document has been read. Because not all sentences can be taken literally and some statements are very general, the document may contain more deviations but they are hard to identify.

In case a deviation is found the review extracts and reformulates two statements. The first starts with DOC and represents a consequence of the document. The second begins with SRS and represents a consequence of the SRS that collides with the first statement. The second statement also contains references to the SRS to prove the deviation. Each case has its own headline to indicate where the deviation is found.

Paragraphs starting with "Remark" are comments for clarification.

The review closes with a Summary.

1.3 Results

1.3.1 About: 2.3 Distances between linked Elements (BaliseGroups, ...)

DOC: The document mixes confidence interval and expectation window information. The location accuracy of the first BG of the linking is part of this calculation.

SRS: The accuracy of the announced BG defines the size of the expectation window of that BG. The accuracy of the current LRBG (not necessarily the BG that provided the linking information) is part of the confidence interval of the train. The first BG of the linking is usually not the LRBG. The train expects a BG when the confidence interval around the balise antenna overlaps the expectation window of the announced BG. See SUBSET-026-3.4.4.4.3 and SUBSET-026-3.4.4.4.3.2.

1.3.2 About: Chapter 4.1 The OBU Coordinate System

Remark: The SRS describes the two coordinate systems: One is centered at the current LRBG. The second coordinate system is originated at the last unlinked BG. Both systems have their own location, their own confidence interval and may be readjusted differently when a new BG is passed. See SUBSET-026-3.6.4.3 and SUBSET-026-3.6.4.7. The SRS does not describe how to handle train positioning without having a last BG reference.

1.3.3 About: Chapter 4.2 Bullet 2:

Remark: Chapter 2.1 and 2.2 describe how to add and subtract intervals but not which values are used to calculate the location of unlinked BG and track elements.

1.3.4 About: Chapter 4.2 Bullet 3:

DOC: chapter 2.3 uses the location accuracy of two balise groups to determine a tolerance for a location.

SRS: For all locations only the train position itself is inaccurate. Inaccurate means that the train position has a confidence interval. All other locations are exact. There is no need to sum up tolerances for different BG. Only exception: The train can have 2 separate confidence intervals, one for the LRBG and one for the last unlinked BG. See SUBSET-026-3.6.4.1 and SUBSET-026-3.6.4.2.

1.3.5 About: Chapter 4.3 Bullet 1 and 3:

DOC: chapter 2.1 and 2.3 is about adding inaccurate distances for train position. The document does not specify what exactly is added but it involves inaccuracies of several positions.

SRS: The distance between train and LRBG is estimated via odometry. The distance between the LRBG and a desired location is recalculated to a fixed value when the train passes a new LRBG. The confidence interval of the train does only relate to the accuracy of the current LRBG(Q_LOCACC), the balise detector inaccuracy and the estimated odometry error collected between the LRBG and the current position. It does not involve older BG accuracies and former confidence intervals. See SUBSET-026-3.6.4.2, SRS 3.6.4.2.2 for confidence interval and reset at new LRBG. See SUBSET-026-3.6.4.3 and SUBSET-026-3.6.4.7 for relocation of locations at BG passage.

1.3.6 About: Chapter 5.2 The Train Position at the first Balise Group:

DOC: After the first BG the train confidence interval contains the estimated odometry error that is collected between the system start and the BG. It does not contain the default BG accuracy.

SRS: In the moment when the train accepts a new BG, the trains doubt_over (here: delta_pFrontMin) and doubt_under (here: delta_pFrontMax) is reset to: Default Location accuracy of BG + detection accuracy of balise antenna. See SUBSET-026-3.6.4.2 for confidence interval. See SUBSET-026-3.6.4.2.2 for

odometry reset at each new LRBG. See SUBSET-026-3.6.4.7 In case an unlinked BG is passed, especially SUBSET-026-3.6.4.7.2

1.3.7 About: Chapter 5.4 The Formulas

DOC: The document adds the inaccuracy of the reference BG and of the announced BG to the location of the announced BG and calls this an expectation window. It then adds other inaccuracies to determine a train position (with inaccuracy) to describe the area where to expect the announced BG.

SRS: The expectation window is defined by the location of the announced BG (without any inaccuracy) plus/minus the announced location accuracy of the announced BG. See SUBSET-026-3.4.4.4.3.1 and 3.4.4.4.3.2. The conditions when to enter the expectation window is defined using the max/min safe antenna position. See SUBSET-026-3.4.4.4.3 and 3.6.4.4. This min/max safe antenna position uses the confidence interval that contains the location accuracy of the old LRBG, the estimated odometer inaccuracy and the balise antenna inaccuracy. The old LRBG is not necessarily the reference BG for the linking (Linking provided by RBC can refer to older BGs).

1.3.8 About: Chapter 5.4 Sentence starting with "This relationship is in general valid ..."

DOC: The document states that the proposed concept for linking expectation can also be used for profile data. It does not give a precise formula for profile data but states that profile data do not have inaccuracies.

SRS: By default, all locations are handled with the estimated train front position, this is without any inaccuracy (level transition border, plain text message start ect.). The train front position differs from the train antenna position by a fixed train specific distance. Some safety critical locations are triggered with the trains max safe front/rear/antenna position. Such locations also dont have any inaccuracy, but the trains max/min front/rear/antenna position depends on the train confidence interval. This confidence interval is a sum of inaccuracies. See SUBSET-026-3.6.4.1 and 3.6.4.4 for max safe front position. See SUBSET-026-3.6.4.3 for exact calculation of locations.

1.3.9 About: Chapter 5.6 line 11

DOC: The document suggests that the location of an unlinked BG can be calculated in two different ways after a linked BG is passed. The most accurate solution shall then be taken.

SRS: The distance to the unlinked BG is defined to be the estimated traveled distance after passing that BG. See SUBSET-026-3.6.4.3.b.

Remark: The correction term in the document for the linked BG must be the same as for the unlinked BG since the estimated traveled distance between linked BG and unlinked BG does not change.

1.3.10 About: Chapter 5.6 last paragraph

Remark: The SRS describes this effect: Every location related to any previous BG(here the unlinked BG) is relocated when a new LRBG (here linked BG) is reached. The relocation determines the distance between location and the new LRBG. From then on, all these locations must be managed by observing the train distance to the current LRBG. See SUBSET-026-3.6.4.3. This even holds when the linking chain contains a hole.

1.4 Summary

Instead of using the concept of a train confidence interval, locations are calculated individually with inaccuracies. The structure and formulas of these calculations lead to a train position system that deviates in its behavior from the SRS. The concept of an expectation window and the concept of a linked balise group are different from the definition in the SRS.

1.5 Conclusions/Lessons learned

This is a review and not a verification. For a detailed verification a design document should provide the following:

- line/sentence/paragraph based numbering allowing to refer to each statement.
- A precise scope which requirements/chapters of the SRS are completely covered.
- References to requirements for each statements that implement a function of the SRS.
- Clear distinction between explanations and rules(requirements of the document).
- Clear distinction between implementation of SRS requirements and new design choices.

When this is given the following actions can be performed:

- Coverage analysis.
- Conformity check for each statement related to the SRS.
- Conformity check for each design choice.

1.6 Future Activities

Discuss how to implement the train positioning system with the authors of the design documents.

References

[1] European Union. Commission decision of 25 january 2012 on the technical specification for interoperability relating to the control-command and signalling subsystems of the trans-european rail system. *Official Journal of the European Union*, pages L51/1–L51/65, 2012.

[2] European Union. Commission decision of 6 november 2012 amending decision 2012/88/eu on the technical specifications for interoperability relating to the control-command and signalling subsystems of the trans-european rail system. *Official Journal of the European Union*, pages L311/3–L311/13, 2012.

End of Document