Verification Report

Bernd Gonska, checked by Marc Behrens

September 5, 2014

Abstract

This document reviews a file with the title *openETCS Determine Train Location Procedure*. The review lists deviations to the train positioning system of SUBSET-026 version 3.3.0.

1 Review of calculating location and train position 0.0.15.pdf

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	calculating location and train position 0.0.15.pdf
as part of	Train Position and Locations.zip
location	`https://github.com/openETCS/SRS-Analysis/commit/edc8a3238e59ad4d2a2440f39e4c791cf6bbf7bd`
comitter	`https://github.com/VNuhaan`
comitted	20. Jul. 2014
title	Train Position and Locations
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. Because not all sentences can be taken literally, 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: Chapter 1 Paragraph 2

Remark: To use the LRBG as a reference point is basically the right idea. If there is an unlinked balise group passed after the LRBG then two reference locations are used simultaneously. See SRS 3.6.4.7..

1.3.2 About: Chapter 1 Paragraph 5

Remark: The SRS is very specific how to calculate distances (see SRS 3.6.4.3 and 3.6.4.7). It describes how distances are relocated at every balise group (BG) passage and how the confidence interval of the train is readjusted. The only vague input is how the train estimates a traveled distance based on odometry information and how fast the estimated odometry error increases while traveling.

1.3.3 About: Chapter 1 Paragraph 5 Bullet 1

DOC: The document creates a rule that the confidence interval of a train must not increase when passing new LRBG.

SRS: There is only one confidence interval for train (based on the LRBG) and possibly one additional one for the newest unlinked BG. In the moment the

train passes a new LRBG the train has exactly one confidence interval (for all locations). Then the confidence interval is reset to be the accuracy of the new LRBG plus the balise detection inaccuracy (SUBSET-036 version 3.0.0 chapter 4.2.10.2:"Accuracy for vital purposes...shall be within ±1 m for each Balise, when a Balise has been passed."). Since BG can have larger and smaller inaccuracies, the confidence interval may increase or decrease at the new LRBG. See SRS 3.6.4.2.

1.3.4 About: Chapter 1 Paragraph 5 Bullet 2

DOC: The document suggests that the train can choose between different BG references to optimize the accuracy of a location information.

SRS: The inaccuracy of a location is always zero, the accuracy of the train position is handled via the train confidence interval. There is only one confidence interval at a time, it refers to the LRBG (there is one additional confidence interval when the last BG is unlinked). There is only one way to calculate it. See SRS 3.6.4.2 for confidence interval. See SRS 3.6.4.7 for secondary confidence interval.

1.3.5 About: Chapter 2 BG

DOC: The document extends the definition of the LRBG to the case when only one BG is known which is not linked.

SRS: The LRBG is the last relevant balise group. There are clear conditions for the train to accept a BG as an LRBG. The train can have two reference locations: One for the LRBG and one for the last unlinked BG. The last unlinked BG is only used when there is no newer LRBG. See SRS 3.6.4.3 and SRS 3.6.4.7, 3.6.4.7.1, 3.6.4.7.2.

1.3.6 About: Chapter 2 Definition concerning the location of a track side element

DOC: In case the distance between ORBG and the following LRBG is not known, the train uses an uncertain distance after it has passed the new LRBG since the distance between the LRBG and the ORBG is uncertain.

SRS: There are no inaccurate distances. See SRS 3.6.4.3. Such uncertainties are handled via the confidence interval of the train. See SRS 3.6.4.1 and SRS 3.6.4.2. The confidence interval does not depend on any distance measured before the last LRBG. See SRS 3.6.4.2.2.

Remark: As a consequence, D_LOCmin_X and D_LOCmax_X must be equal.

1.3.7 About: Chapter 3 Paragraph 1 Bullet 2

DOC: the document suggests to take the first unlinked BG as a reference in case no LRBG is known.

SRS: The last unlinked BG must be taken as a reference. See SRS 3.6.4.7.

1.3.8 About: Chapter 3 Below Figure 7 and Complete Chapter 3.1

DOC: The document suggests that the train can choose the BG from where it can determine its position.

SRS: The calculation of the confidence interval and the distance to locations depend on the current LRBG (respectively the last unlinked BG). Using a more precise estimation based on other BG position and accuracy is not permitted. See SRS 3.6.4.2. and 3.6.4.7. and 3.6.4.4.

Remark: As a consequence, Dmax_nom-det_i+1 and Q_LOCACC_i+1 + DetectionAcc_i+1 must be equal.

1.3.9 About: Chapter 4 (DEFINITION OF Dcorrection) and complete chapter 4

DOC: There are several ways to calculate the relocation value for BGs involving inaccuracies of old and/or announced BGs. This is used to determine location based inaccuracies.

SRS: The two confidence intervals of the train cover all inaccuracies that are to be used. No other inaccuracies are relevant. The distance between two BGs is exactly the value given by the linking packet or exactly the distance that is measured by traveling between the two locations. If the train reads an announced BG, then the train position and confidence interval is readjusted. The locations are relocated such that they refer to the new BG with precise distances. See SRS 3.6.4.3.b for the two relocation rules. See SRS 3.6.4.1 and 3.6.4.2 and 3.6.4.4 for the two confidence intervals. See 3.4.4.4.3 for expectation window of a BG.

Remark: As a consequence, DcorrectionMax_ORBG and DcorrectionMin_ORBG and Dcorrection_ORBG must be equal.

Remark:As a consequence, Dcorrection_ORBG = sum of D_LINKs (if known) + D_ODO_X_Y (if distance is not announced) without inaccuracy.

1.3.10 About: Chapter 5

See comments to chapter 4

1.4 Summary

The SRS introduces concepts to describe the train positioning system:

- The confidence interval of the train position (doubt over, doubt under)
- Estimated/Max/Min safe front end
- The expectation window of a balise group
- LRBG and last unlinked balise group as reference location (two parallel coordinate systems)
- Relocation of location information

The document describes a train positioning system that does not directly use these concepts. The document differs from the SRS in the way how inaccuracies are calculated and which information can be used to determine a distance between two objects. Two major deviations have been found:

- Chapter 3 and 4 are based on the assumption that the train position and the position of not announced balise groups can be determined in several ways. The SRS describes one way how these values have to be determined.
- The document assumes that locations from different ORBGs may have different accuracies. According to the SRS the train can have at most two confidence intervals. All locations are calculated without an additional location based inaccuracy interval (exception: The accuracy of an announced BG. This is not really an exception if start and end point of the expectation window are seen as locations).

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