CLUG2.0 WP2

LOC-OB SYSTEM DEFINITION AND REQUIREMENTS SPECIFICATION

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CLUG 2.0 has received funding from the European Union's Horizon research and

CLUG2.0 WP2 LOC-OB System Definition and Requirements Specification scope

CLUG stands for Certifiable Localisation Unit using GNSS in the railway environment.

The CLUG2.0 project will continue with the work started in the H2020-project CLUG, specifying the future on-board localisation unit with the following characteristics:

- on-board multi-sensor safe localisation system consisting of a navigation core combining GNSS, IMU and digital map information among others,
- continuous on-board localisation providing location, speed, movement direction and other dynamics of the train,
- localisation system that is operational and interoperable across the entire European rail network,
- localisation system that is compatible with ERTMS TSI current status and future evolutions

It is not in scope of CLUG2.0 developing a certifiable product, but rather consolidate and complete the specification of the system as well as progressing in the demonstration of the technological readiness of the specified LOC-OB system.

The CLUG2.0 project is subdivided into six work packages:

- WP1 "Project Management and Technical Coordination"
- WP2 "LOC-OB System Definition & Requirements Specification"
- WP3 "RAMS Analysis"
- WP4 "Design and Development"
- WP5 "Integration and Testing"
- WP6 "Communication, Dissemination, Exploitation & Business Case"

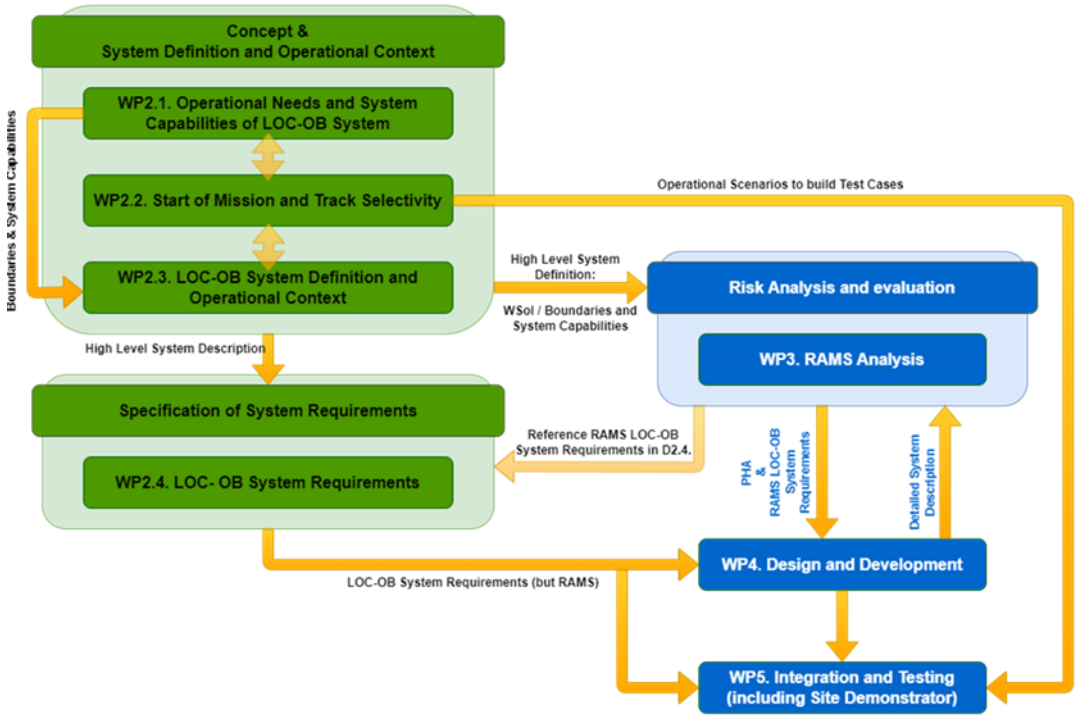

Figure 1 - Logical decomposition of WP2 and interrelationship with the rest of WPs

The objective of WP2 "LOC-OB System Definition & Requirements Specification" is consolidating and completing the LOC-OB system definition and requirements specification, including the definition and requirements to accomplish localisation needs during start of mission and for track selectivity. WP2 is subdivided in the following deliverables:

- D2.1 Operational Needs and System Capabilities for LOC-OB
- D2.2 Start of Mission and Track Selectivity
- D2.3 LOC-OB System Definition and Operational Context
- D2.4 LOC-OB System Requirements

WP2 deliverables intend to follow the structure and topics to be covered in phases 1, 2 and 4 of system definition according to CENELEC EN 50126. While deliverables D2.1, D2.2 and D2.3 cover the topics related to phases 1 and 2, D2.4 covers phase 4 by defining the set of LOC-OB system requirements. Note: Phase 3 (Risk analysis and evaluation) should be covered in WP3.

As an important remark, CLUG2.0 is a research project which do not have as goal developing a certifiable product. For this reason, it is neither the intention to describe all necessary content as defined in EN50126 nor to conduct all CENELEC phases.

EN 50126-1:2017 (E)

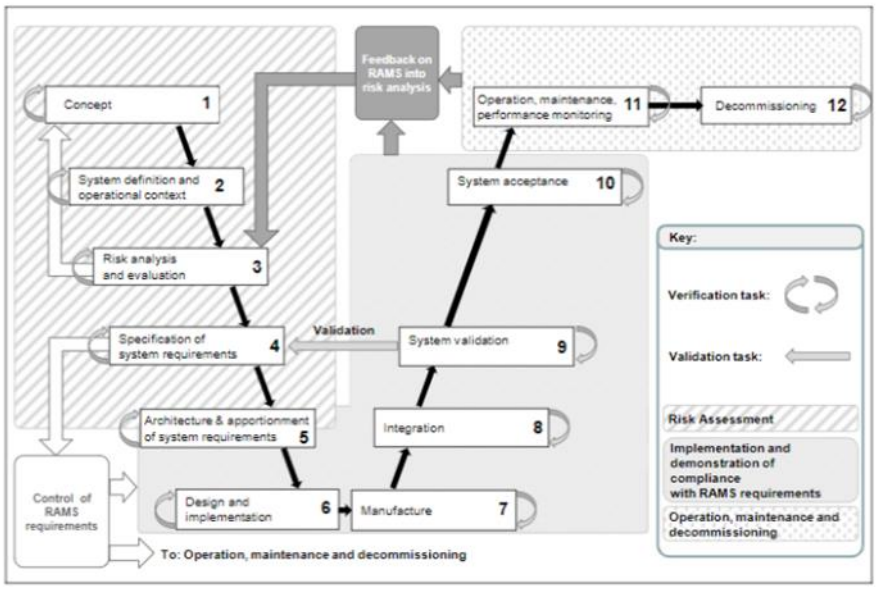

Figure 2 - V-cycle representation from EN 50126-1:2017 (E)

Previous work performed in other initiatives (RCA, OCORA, LWG, X2RAIL, CLUG…) has been considered as input and referenced where applicable.

D2.1 Operational Needs and System Capabilities of LOC-OB

The purpose of this document is specifying the set of high-level user requirements fulfilling the needs of the railway users towards localisation system.

The high-level user requirements specification defines the main targets for the localisation system, constituting the basis for the system definition, design and evaluation.

Methodology

I. The first step for specifying the set of high-level user requirements consists actually in identifying and classifying the users which have a need towards localisation. The main railway users, i.e. infrastructure managers and railway operations, are represented by the trackside and onboard systems belonging to the wider system of interest of localisation from a localisation information customer perspective.

II. The second step is identifying the functions of the systems in the wider system of interest which have a need towards localisation.

III. The third step is identifying the operational needs (type of information) that the functions of the systems belonging to the wider system-of-interest have towards localisation. The operational needs derived from these functions are classified as safety relevant and non-safety relevant in order to assess later on the preliminary safety level of the high level user requirements derived from the operational needs.

IV. The fourth step is defining the localisation system capabilities required to fulfil the identified the operational needs (e.g., localisation, speed, acceleration, movement direction…). The system capabilities will be provided as input for the functional LOC-OB architecture definition in D2.3 LOC-OB System Definition and Operational Context.

V. The fifth step is specifying the set of functional high level user requirements capturing the identified operational needs.

VI. The sixth step is analysing the quality of the localisation information needed by each function and reflect them in the set of non-functional (performance) high level user requirements specified.

VII. The seventh step is considering the operational and environmental conditions under which the localisation information is required and reflect it in the set of non-functional high level user requirements.

VIII. The last step is collecting potential external requirements such as economic constraints and modularity, compatibility and interchangeability requirements in the set of non-functional high level user requirements.

In addition, and with the focus on the capabilities and functionalities expected from LOC-OB system, the LOC-OB constraints are identified, and potential variants are discussed. The discussed variants (focused on potential supporting information required by LOC-OB) are provided as input for the boundary definition in D2.3 "LOC-OB System Definition and Operational Context".

D2.2 Start of Mission and Track Selectivity

As previously stated, the main objectives of CLUG2.0 WP2 "LOC-OB System Definition and Requirements Specification" are defining the LOC-OB system and providing the LOC-OB system requirements specification as input for the later design tasks in WP4.

The work in the predecessor project (CLUG) and set of LOC-OB (TLOBU in CLUG) system requirements provided did not fully address the topics of Start of Mission and Track Selectivity.

The scope of CLUG2.0 and specifically of this deliverable includes the analysis and recommendations to accomplish the localisation needs during start of mission and track selectivity.

Methodology

The dedicated analysis on the expectations towards on-board localisation during start of mission and regarding track selectivity is based on the study of the challenging scenarios.

To accomplish this, the first step has been set the categorisation and definition of the operational scenarios to be considered within the analysis. This categorisation has been made based on the ETCS operational scenarios, focused on the start of mission and track selectivity topics and taking into consideration the topological settings (single, parallel and parting tracks). Challenging environmental conditions for the target system are also considered in the analysis.

As a second step, the challenging scenarios have been identified and analysed for:

- Legacy system: current CSS on-board architecture as per SUBSET-026 Chapter 2
- Target system: CLUG2.0 LOC-OB system using a multi-sensor fusion architecture (considering GNSS, SBAS and inertial measurement sensors among others)

Finally, the previous analysis on the challenging scenarios is used as base to provide recommendations on start of mission and track selectivity LOC-OB requirements.

D2.3 LOC-OB System Definition and Operational Context

The main goal of this document is defining the high-level architecture of the future LOC-OB system, defining the required external interfaces and functionalities owned by LOC-OB.

Methodology

CLUG2.0 approach is defining LOC-OB system high level architecture following the "black box" approach, hence the architecture definition sticks to the external interfaces and functions description.

As a first step, current ERTMS/ETCS architecture as per SUBSET-026 as well as and future CSS on-board architecture evolutions (developed by UNISIG, ERA and EUG) are described.

Second, the architectures for the on-board localisation system specified in previous projects and initiatives (RCA, OCORA, X2RAIL, LWG, CLUG (1)) are summarized and compared.

The third step consists in consolidating the analysis done in D2.1 LOC-OB Operational Needs and System Capabilities (localisation stakeholders identification and needs, system capabilities, analysis of potential constraints and variants, set of HL User´s Requirements specified) to define the LOC-OB operational context. The LOC-OB system output boundaries are defined based on the identified system capabilities in D2.1, while the input boundaries are defined based on the potential variants discussed to overcome the identified constraints.

Once the operational context is defined, the LOC-OB external interfaces required to ensure the provision of the required localisation information and the acquisition of the required supporting information are described.

Finally, the high-level LOC-OB architecture is described by defining all the LOC-OB required functionalities.

D2.4 LOC-OB System Requirements

The purpose of the deliverable D2.4: LOC-OB System requirements is to define a set of requirements derived from the information available in:

CLUG2.0 D2.1: Operational Needs and System Capabilities of the LOC-OB System

CLUG2.0 D2.2: Start of Mission and Track Selectivity

CLUG2.0 D2.3: LOC-OB System Definition and Operational Context

Methodology

As already stated, the chosen strategy is to use a requirement engineering process to formalise the needs toward the Localisation On-Board (LOC-OB) equipment, as a "black box", without interfering in the technical choices to be achieved by the other work packages. As a result, some assumptions or detailed explanations may not have been translated into requirements.

Even if the CLUG 2.0 project is structured around the use of GNSS and SBAS augmentation in the railway environment, requirements are presented agnostically. The main goal is to provide a set of requirements that can be used as a base by any proposed safe localisation solution, not only the CLUG solution.

One of the main goals of the requirement set is to identify information present onboard that can be used by the LOC-OB to solve some identified issues as Start of Mission or Track Selectivity. These requirements are defined through interfaces that are not yet standardised. Those requirements may need to be reworked with the results and exported constraints identified in the design and test phases.

Since CLUG 2.0 is an R&D project involving uncertainties and assumptions toward the needs and external interfaces, the set of requirements may not be used for an industrial project without reworking.

Conclusion

The LOC-OB operational and system contexts consolidated in CLUG2.0 WP2 and, utterly, the set of LOC-OB system requirements provided shall be used for two main purposes:

1) As input for CLUG2.0 WP4 Design and Development and WP5 Integration and Testing
2) As input for future initiatives and projects, notably the Europe's Rail IP project FP2-R2DATO.

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