CLUG 2.0: Project overview

EUSPA UCP – 07/11/23

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Context & Objectives
CLUG 2.0 In a Nutshell

Partners: 10

Duration: 24 months

Starting date: Feb 23

End date: Jan 25
CLUG 2.0 OBJECTIVES

- The main objectives of CLUG 2.0 are based on work performed in CLUG
  - Consolidation of user needs and system requirements (Along Track, Start of Mission and Track selectivity)
  - Consolidation of safe localization system architecture and prototype new critical functionality
    - Track Selectivity and Safety
    - Sensor and system levels FDE algorithms
    - Confidence Intervals computation and global Integrity concept
  - RAMS analysis on the consolidated functional architecture of the system.
  - Live demonstration (Switzerland) and Replay to consolidate readiness of the CLUG multi-sensor fusion algorithms

Demonstrate the technological readiness of an on-board GNSS+EGNOS based multi-sensor fusion architecture enabling absolute safe train positioning for signalling in a ETCS frame
CLUG REASONING and ROADMAP

PROJECTS

- CLUG
- X2RAIL5
- EGNSS-R

STANDARDISATION

- TSI 2022
- Next TSI’s

ERJU IP FP2-R2DATO WP21/22

CLUG 2.0

2019
2020
2021
2022
2023
2024
2025
2026
2027

ERJU SP
CLUG architecture

EGNOS SF
EGNOS DFMC
EGNOS EAR
Ground / Space
Dissemination

GALILEO
GPS

GNSS+EGNOS ANTENNA

GNSS+EGNOS UNIT

IMU SENSOR

SPEED SENSOR

BALISE DATA

ONBOARD DIGITAL MAP

Multiple Data Fault Detection & Exclusion

Initialisation and Start of mission

TRACK SELECTIVITY

ALONG-TRACK FUSION

INTEGRITY

Estimated data & Integrity data

SAFE OUTPUT (e.g. ERTMS)

NON SAFE OUTPUT

Estimated data: 3D position, velocity, acceleration and attitudes

Non safe data: 3D position, velocity, acceleration and attitudes

Legend:
- Continuous / Discontinuous link
- Outside the focus
- No safety level
- Safety-critical level
- Safety catastrophic level

30/11/2023
WP organisation

CLUG 2.0 PROJECT

WP1
Project management and coordination
Duration: M1 to M24

WP2
LOC-OB System Definition & Requirements Specification
Duration: M1 to M10

WP3
RAMS Analysis
Duration: M1 to M24

WP4
Design and Development
Duration: M1 to M24

WP5
Integration & Testing (including Site Demonstrator)
Duration: M1 to M24

WP6
Communication, Dissemination, Exploitation and Business Case
Duration: M1 to M24
High level timeline

- Project kick off
  - 02.2023

- Start of the measurement campaign
  - 10.2023
  - 01.2024

- Algorithms (fusion, Track selectivity, integrity)
  - Stable architecture
  - 04.2024
  - 05.2024

- RAMS analysis and performances
  - Initial data analysis
  - 09.2024
  - 12.2024

- Final architecture
  - Safety performance analysis
  - 02.2025

- Test campaign performance evaluation
  - Business case
  - Architecture trade-off and gap analysis

- Start of the measurement campaign

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  - Stable architecture

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  - Business case
  - Architecture trade-off and gap analysis
Project technical status
WP2

Define the user needs, operational context, initial assumptions, system boundary and requirements

Scope of work

• Operational needs of IM and RU and system capabilities to be fulfilled by absolute safe train positioning.
• Operational scenarios including nominal and degraded scenarios with regards to Start of Mission and track selectivity.
• System context, functions, and constrains of a LOC-OB system.
• LOC-OB System requirements including functional and non-functional requirements.

Status

• WP2 documents delivered to EUSPA by end of November 2023; publicly released early 2024
• The documents and their content is already been used in WP21 of FP2-R2DATO project in ERJU
To specify RAMS requirements and to demonstrate the safety targets for the CLUG LOC-OB, with respect to Common Safety Methods and CENELEC standards

Scope of work

- To specify the Reliability, Availability, Maintainability and Safety (RAMS) requirements in line with the overall SIL criteria of a railway embedded system to obtain a certifiable CLUG Localisation On-Board (LOC-OB) System
- To demonstrate that the CLUG LOC-OB functional system architecture and interfaces are in line with the specified safety targets
- To consolidate the remaining work to be performed to obtain a certifiable localisation unit in the future

Status

- RAMS Plan and PHA are about to be delivered (11/23)
- FMEA, RAM, functional and external interfaces analyses are about to start (11/23)
WP4

Scope of work

- Refine LOC-OB system and functions functional architecture
- LOC-OB critical Functions prototypes for design demonstrations: implementation of data FDE, track selectivity, Confidence status and Intervals computation, Along Track position and speed small upgrade
- LOC-OB safety performance analysis by engineering simulation: integrity availability assessment to provide compliant output data in accuracy and within the integrity level (SIL).
- EGNOS services data generation to enable prototyping tests in WP5.

Status

- Data FDE have been consolidated, ongoing prototyping
- Track Selectivity algorithm design & development ongoing
- On going along-track algo robustification

30/11/2023
WP5

Design and develop tools and an onboard demonstrator to analyse and improve the performance of the CLUG positioning solution.

**Scope of work**

- Develop and install a system to collect field data from all sensors for the offline simulation of the CLUG solution, and perform live demonstrations on a train of SBB
- Prepare the data sets, generate the Ground Truth and validate the Digital Map for post processing with the fusion and integrity algorithms developed in WP4
- Analyse the performance of the developed solution and identify potential improvements

**Status**

- Onboard demonstrator has been developed and installed. On going validation
- Ongoing ground Truth process and Digital Map validation
- Test plan definition
- Ongoing analysis tools improvement

30/11/2023
Scope of work

- Perform a cost-benefit-analysis (CBA), starting over the EUG-LWG CBA performed in 2022.
- Perform architecture Trade-off Analysis and Proposed Localisation On-Board System
- Conduct Gap Analysis on Proposed Localisation On-Board System Requirements
- Publish technical papers

Status

- Paper submitted for the TRA24 conference by SNCF/ADS, “Sensor fusion and GNSS augmentation services for safe train positioning - Accuracy and integrity performance evaluations”
Way forward

• Share the work performed in WP2 with ERJU, notably FP2-R2DATO WP21 regarding rail user needs and system requirements

• Share the work performed in WP6 with ERJU, notably FP2-R2DATO WP22 regarding the ETCS gap analysis and LOC-OB system boundaries wrt ETCS

• Demonstrate the CLUG solution performance in the frame of FP2-R2DATO WP22
Thank you

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CLUG 2.0 has received funding from the European Union’s Horizon research and innovation programme under grant agreement No 101082624