CLUG PROJECT

Certifiable Localisation Unit with GNSS in the Railway Environment

Our vision

Push the railway localisation system to the future with the help of game changers, such as the European satellite navigation system (E-GNSS).

Our project

Perform a mission analysis and a preliminary feasibility study of a failsafe on-board multi-sensor localisation unit consisting of a navigation core (IMU, tachometer, etc.) brought in reference using GNSS & EGNSS, digital map and a minimal number of references points.

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Project Presentation

With the digitalization of transport services, precise train localisation in real time has become increasingly important for the European railway sector and satellite-based localisation is seen as a game changer to improve railway performance in the framework of ERTMS.

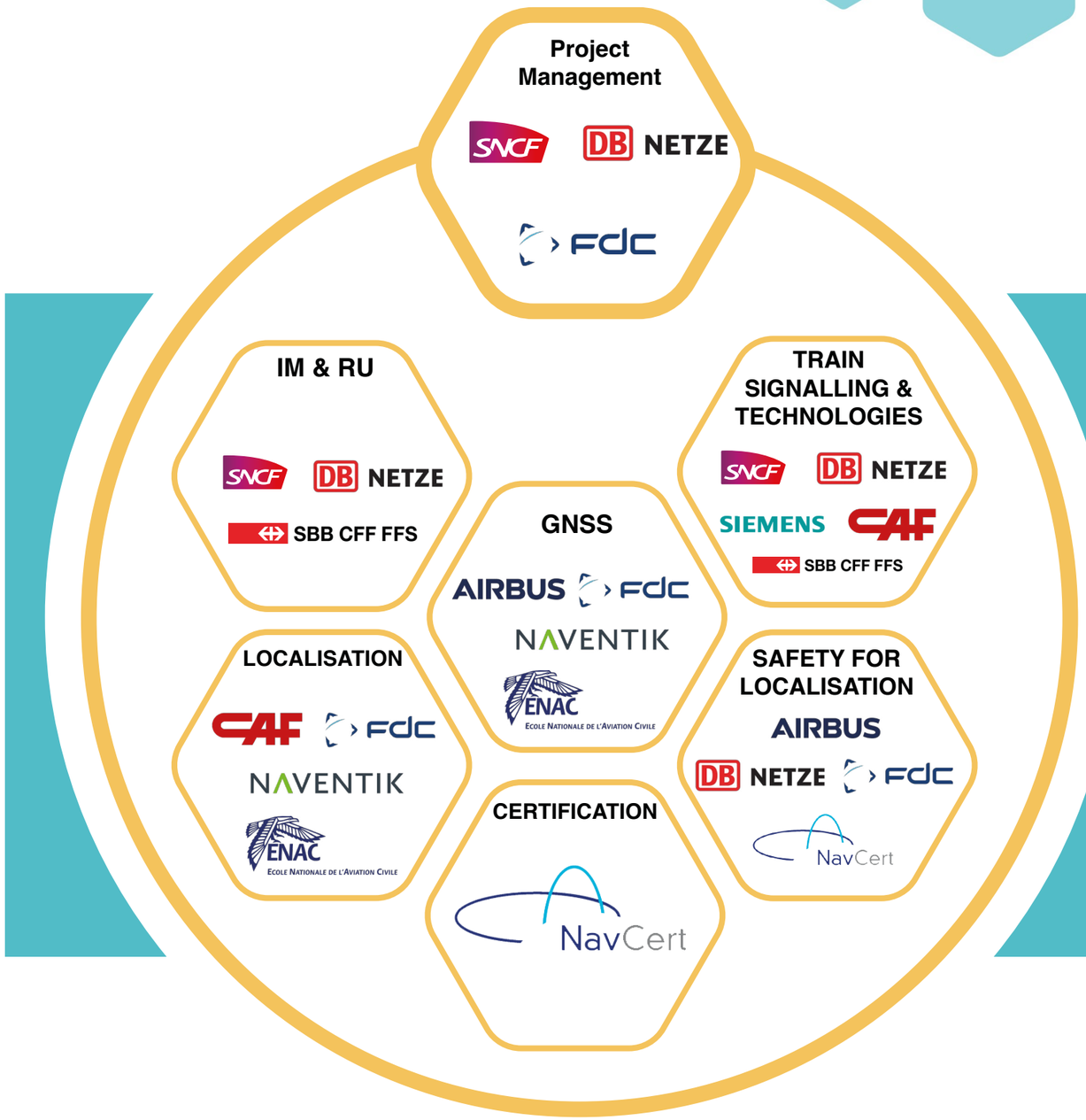
Currently, the determination of the position of the train for signalling purposes is based on trackside equipment such as balises and track circuits or axle counters, which are physical elements mounted at specific intervals along the railway track. The use of the European satellite navigation Galileo system (E-GNSS) would enable a significant reduction of trackside equipment and to improve localization performance with respect to the current system. Notably, the use of the regional augmentation system EGNOS will bring the necessary reliability to the train localization unit for the GNSS constellations GALILEO and GPS.

Key European railway companies, but also aviation companies, as presented on the next page, have decided to team together and collaborate through the CLUG project for the proof of concept of a “Certifiable Localization Unit in the railway environment”. This project is funded by the H2020 program and is managed by EUSPA.
It aims at performing a mission analysis and a preliminary feasibility study of a failsafe on-board multi-sensor localisation unit consisting of a navigation core (IMU, tachometer, etc.) brought in reference using GNSS, track map and a minimal number of references points.

Main Objectives

MISSION REQUIREMENTS AND DEFINITION	A “top down” approach establishes needs, objectives, and top-level functional and performance requirements of the train localization unit.
ARCHITECTURE DEFINITION AND ALGORITHM PROTOTYPE DEVELOPMENT	Identification system concepts that meet the requirements that have previously been defined + analysis of the current and future EGNSS services
DEMONSTRATION OF THE FEASIBILITY OF A MULTI-SENSOR APPROACH	Test prototyped architecture and algorithms in various modes to determine whether requirements are supported using real world data
DEFINITION OF PROCESS AND TOOLS FOR PROTOTYPICAL CERTIFICATION OF LOCALISATION UNIT	Initial development of tools and processes for the qualification and certification of a train localisation

Project Management



Project in Numbers

3 811 527 €
Total cost

30%
of company investiment

70%
of EU subventions

28
Number of deliverable documents

30 months
Project duration

31/05/2022
Project End

11
Partners

4
Number of countries

Project Timeline

DECEMBER 2019	JULY 2020	NOVEMBER 2020	SEPTEMBER 2021	JANUARY 2022	MAI 2022
Project kick-off	Data collection platform validation on the test train Test plan définition	High level mission and system requirements Preliminary architecture and design definition Beginning of the measurement campaign(s)	Certification methodology definition Analysis tool validation Architecture & design definition including fusion and integrity algorithms	Test results evaluation versus design Evaluation of EGNSS for rail	CLUG Final Results Final event

Test Trains and data analysis

Data collection for CLUG is mainly done by the Swiss test train, and complemented by other tests on the German and French test trains. Different IMU sensors and GNSS receivers, of several grade of quality, have been installed on the different trains to collect various qualities of IMU and GNSS data. This data is then used by the CLUG localisation algorithm, different sensor sets are benchmarked, and their performance analysed.

SWITZERLAND

This train is the main test train of the CLUG project. It is used in Switzerland operates daily in commercial service, allowing us to collect data over many hours and km, covering a large part of the network in different environments and under different seasons and weather conditions. The train is also used for dedicated test trips, where we cover unusual operational scenarios.

62'000 Number of km

2'900 Number of hours

12 Number of sensors

GERMANY

The Advanced TrainLab has a diesel-electric drive system, which enables test rides with a top speed of up to 200 km/h anywhere in DB's railway network. The 107 meter long train consists of 4 wagons, one equipped with the sensors and recording system of the CLUG project.

10'000 Number of km

300 Number of hours

7 Number of sensors

FRANCE

SNCF has a dedicated test train, named Martine consisting of a BB60137 locomotive and a VENG 234 Corail car. This train regularly proceed to trials between Vitry and Montereau in order to test various localization demonstrators and sensors.

5'000 Number of km

100 Number of hours

7 Number of sensors

EGNOS an Enabler for Safe Railway Localisation

EGNOS is the European GNSS augmentation service providing safe corrections and integrity data to GNSS receivers to improve accuracy and safety.

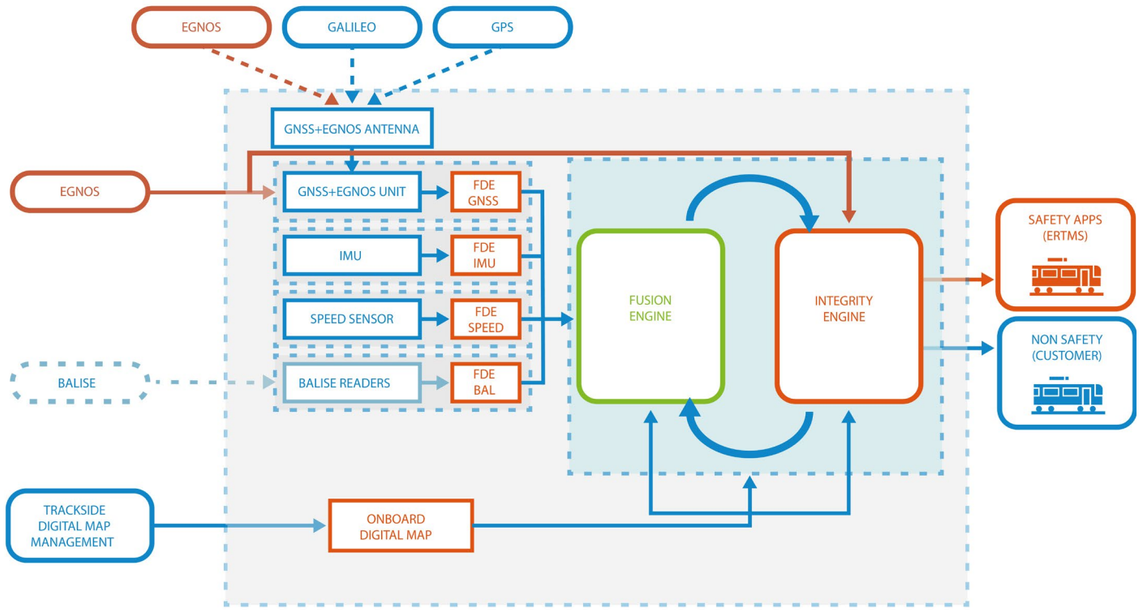
Performance assessment in simulation based on Dual Frequency Multi-Constellation (DFMC) service (EGNOS V3.2)*.

CLUG shapes a future EGNOS complementary service to meet required performances for train users

- Additional augmentation and safety critical information for train functions in position, in speed, and in track determination.
- Complementary dissemination solutions to ensure continuous EGNOS data reception with guaranteed data integrity up to the Train Localisation On Board Unit.

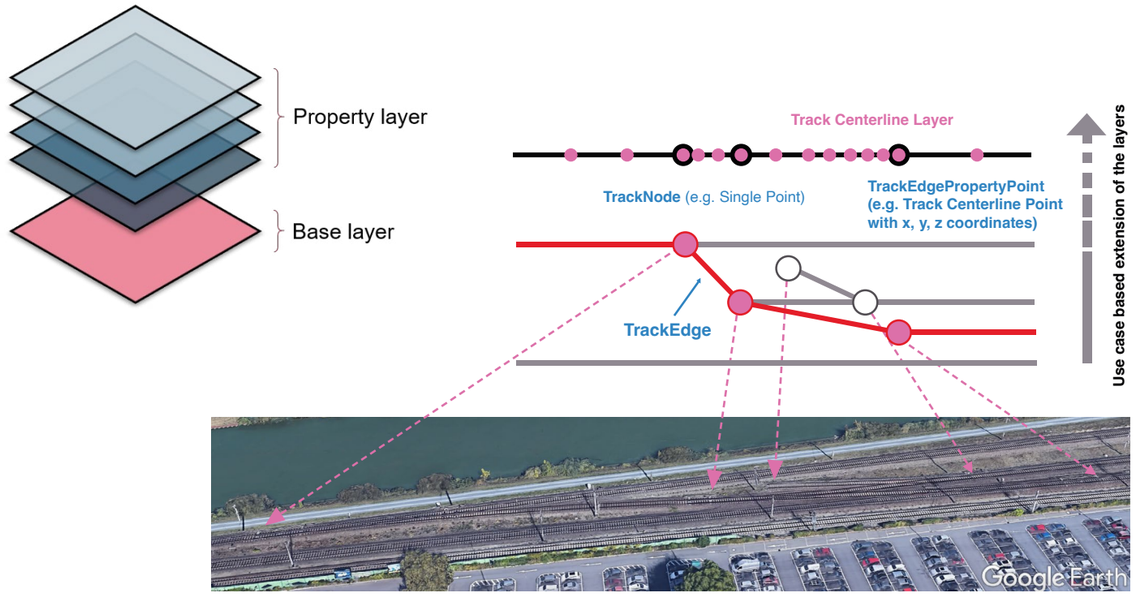
System Architecture

The architecture is articulated around two main engines: the fusion and the integrity engines, using in entry measurements from IMU, GNSS, SPEED and possibly balises to compute a position, speed and their safe error envelop and place it over the Digital Map.



* EGNOS v3 DFMC service : EGNOS service on L1/L5 GPS, E1/E5 GALILEO

Required Digital Map for Localisation



The **Digital Map (DM)** for localisation use cases is defined on the point of the airgap between trackside and train. The DM provides the required information for the localisation algorithm: **Track centerline points** with dynamic distances to describe the track layout **in 3D coordinates**. The DM is designed to be **universally extendable** with its layer structure and data model (node-edge-model). The DM design also prevents redundancies.

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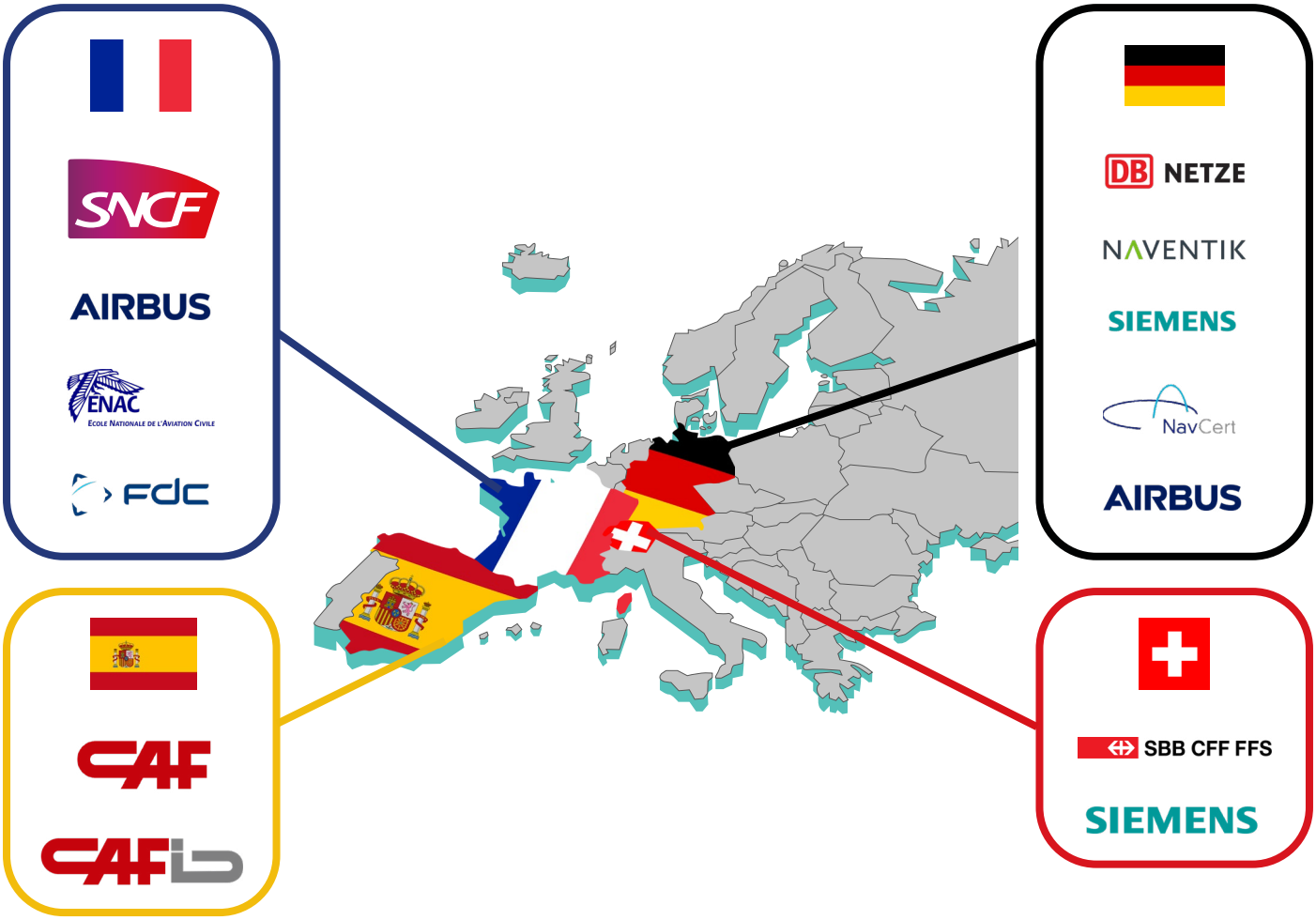

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EUSPA European Union Agency for the Space Programme

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