HELMET

High integrity EGNSS Layer for Multimodal Eco-friendly Transportation

Horizon2020
European Union Funding
for Research & Innovation

EUSPA
European Union Agency for the Space Programme

OVERVIEW

HELMET is a European project funded by the European Union Agency for the Space Programme under the Horizon 2020 Programme that aims at developing innovative EGNSS based applications for the most impacting eco-friendly and green transportations means.

The target adopters are automated and driverless cars, connected cars, train signalling and control, and UAVs for surveillance and integrated information management of roads and railways.

Make Transport safer, more sustainable, accessible and reliable by optimising new technological infrastructures

OBJECTIVES

- To develop a **cyber-secured multimodal, multi-sensor integrity monitoring architecture** based on EGNSS to introduce High Integrity Location Determination System (LDS) for cars and trains automation aggregating the demand of monitoring rail and road assets with UAV.

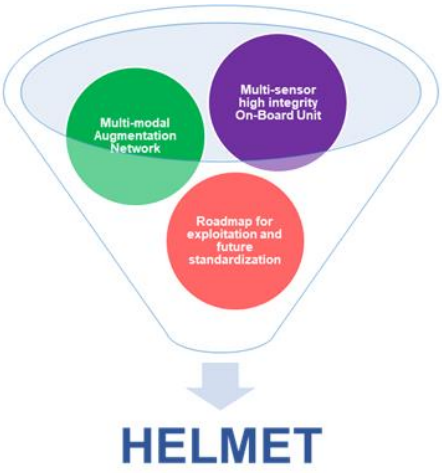
- To assess the system performance by a **Proof-of-Concept** (PoC) in real mobility environment.

- To draw a **roadmap for exploitation and future standardization and certification of HELMET** results in terms of

  - the designed multi-modal AIMN architecture
  - high integrity and accuracy OBU algorithms fully customized for land transportation (rail and road)

HELMET MOTIVATION & AMBITION

Synergy between Train and Connected cars technologies will bring to a sustainable, safer ecosystem – a priority of the European Green Deal - leveraging on osmosis of best-practices from rail to automotive car market potential for a wide spread of GNSS in the transport.



- Leverage of expertise, experience and cutting-edge technologies available in state-of-the art for designing high integrity and high accuracy multimodal AIMN for land transportation and UAV
- Design of high integrity and high accuracy multi-sensor algorithms based on COTS devices
- Contribution to draw an advanced roadmap for exploitation and future commercialisation of EGNSS solutions for land transportations;
- Contribution to the GNSS certification and authorization process into the ETCS/ERTMS and connected and semi-autonomous sectors
- Working collaboration methodology Industry 4.0

PROJECT WORKFLOW

WP2: USER & SYSTEM REQUIREMENTS

- Use cases definition
- User operational, functional, RAMS, security and regulatory requirements definition for rail, road and UAV (supporting rail and road) applications
- user requirements trade-off accounting for technical feasibility and CONcept of OPerationS (CONOPS)
- Harmonized system and subsystems requirements definition (functional, operational, RAMS, security and regulatory)
- technical and economic risks identification, analysis and assessment

WP3: ARCHITECTURE DESIGN

- Design of the multimodal AIMN and MOBUs functional and physical architectures;
- Definition of the internal and the external interfaces (subsystem level)
- Subsystems development plan
- Test plan definition

WP4: SYSTEM DEVELOPMENT & TESTING

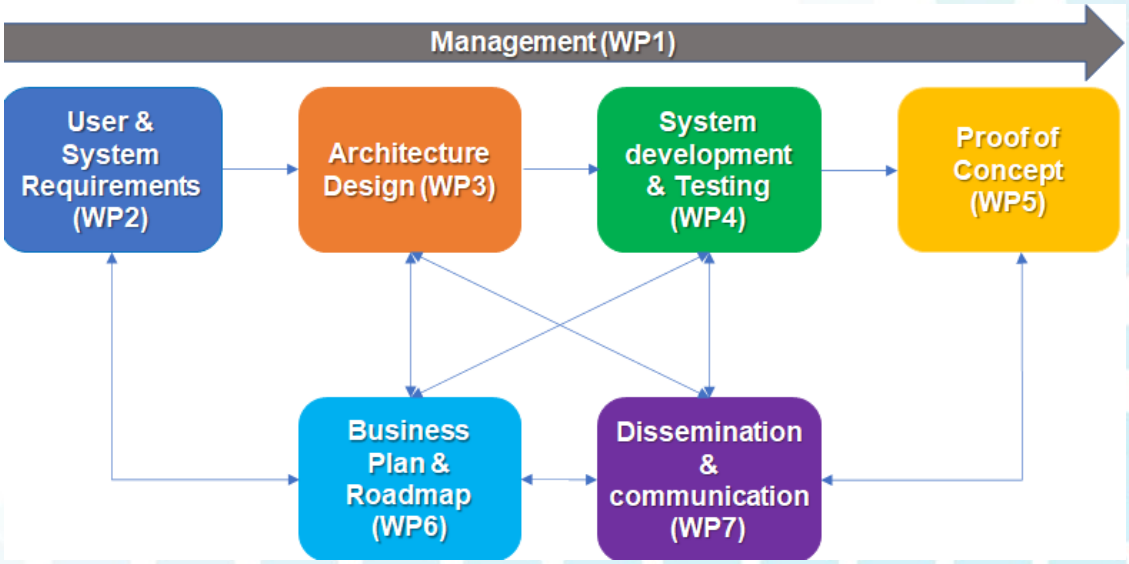
- Procurement of the external tools, hardware and services
- Subsystems Development and testing
- System integration
- Overall system Laboratory testing

WP5: PROOF OF CONCEPT

- Definition of the system testing verification matrix (subsystem + integrated platform)
- On filed testing of the HELMET integrated platform
- Validation of the HELMET platform by an independent assessor.

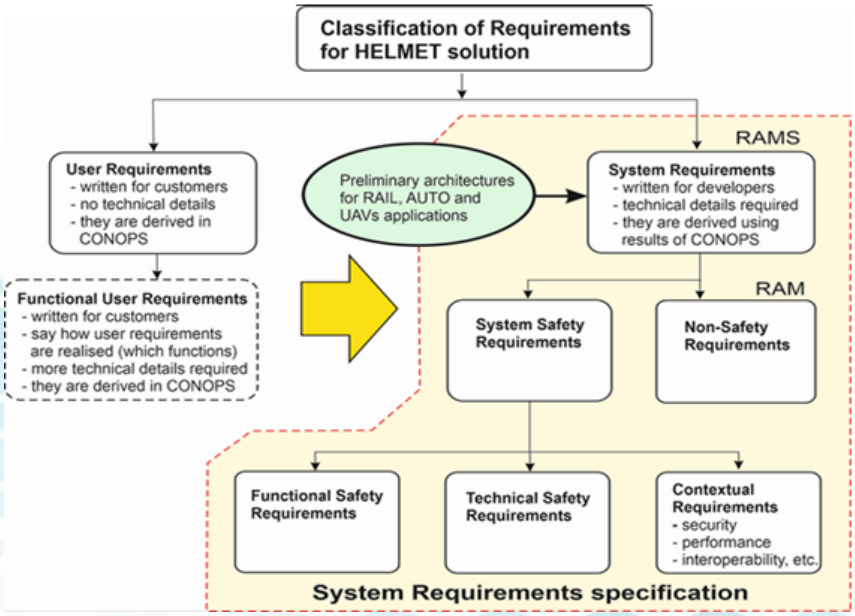
WP6: BUSINESS PLAN & ROADMAP

- Clarification of ASIL determination process using harmonised automotive risk and safety requirements;
- Proposal of harmonised standards for automotive and rail within relevant RTCM SC-134 WGs;
- Definition of the certification and authorization processes of GNSS based safety-related systems in rail and automotive sectors;
- Definition of the roadmap for the exploitation of HELMET solution
- Business plan definition



USER & SYSTEM REQUIREMENTS

One of the main tasks of the HELMET project is the identification of the requirements for the identified target users. The focus of the project is on rail and automotive considering also the UAV applications intended as support for the rail and road applications. One of the key point of the HELMET approach is the exploitation of the strong synergies among rail and road applications. As a matter of fact, the operational environment is quite similar since often roads and rails run close one to the other. The identified requirements have been provided in terms of Integrity, Accuracy, Alert Limit, Time to Alert, Availability, Continuity and Security.

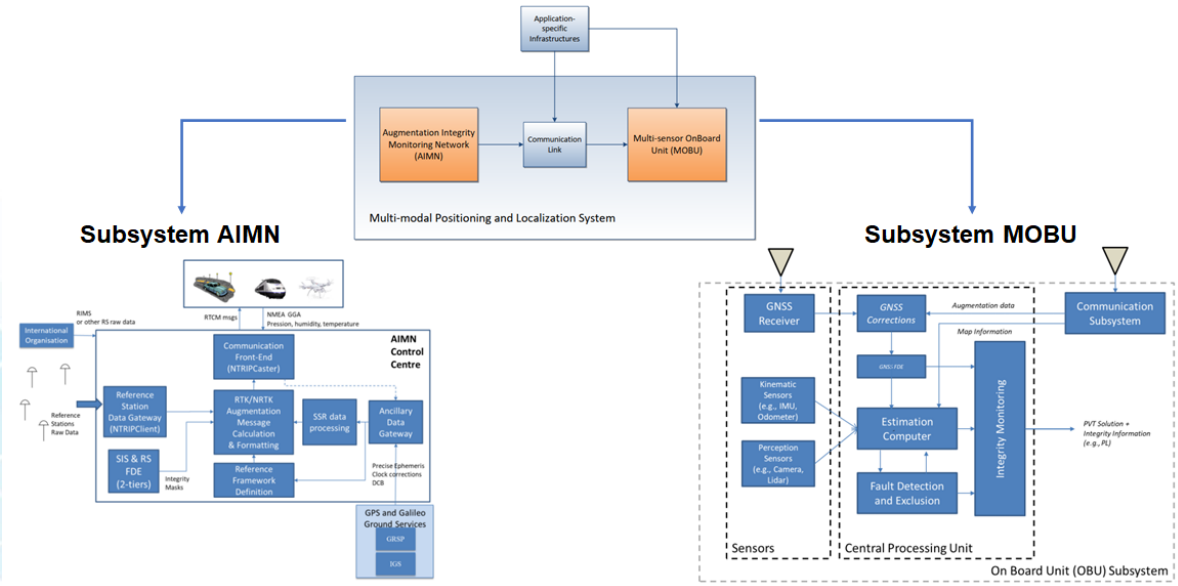


The system requirements specifications started from the HELMET CONOPS (Concept of Operations) used to define and justify high-level user requirements for rail, automotive and UAV safety applications. The conclusions of the GNSS User Consultation Platform (UCP) organised by EUSPA were also utilized. The most challenging operational scenarios in terms of accuracy and integrity were selected and the high-level user requirements for HELMET solution were specified and justified in more detail. System requirements were then derived according to the methodologies in IEC 61508, EN 50126, EN 50129 and ISO 26262. Finally, the Requirements Traceability Matrices for the individual user's groups were developed to map the links and dependencies between the high-level user requirements and the system requirements.

Application	Scenario User Requirement / Use case	Integrity	Accuracy 95%	Alert Limit	Time to alert	Availability	Continuity	Security
RAIL Localization System	Track Identification	<1e-9/h	70 cm	1.7 m	10 s – 30 s	High	N/A	Very High
	Odometry Calibration	<1e-9/h	70 cm	1.7 m	< 1 s	High	N/A	Very High
	Cold Movement Detection	<1e-9/h	2 m	5 m	< 10 s	High	N/A	Very High
Road Localization System	Automated Driving on Highway	<1e-6/h	Lat. 27 cm Long. 4.5 m	Lat. 67 cm Long. 11 m	1 s	> 99.5%	High	Very High
	Automated Driving on Local Roads	<1e-6/h	Lat. 17 cm Long. 40 cm	Lat. 42 cm Long. 1 m	1 s	> 99.5%	High	Very High
	Automated Driving on Narrow and Curved Roads	<1e-6/h	Lat. 7 cm Long. 11 cm	Lat.17 cm Long. 29 cm	1 s	> 99.5%	High	Very High

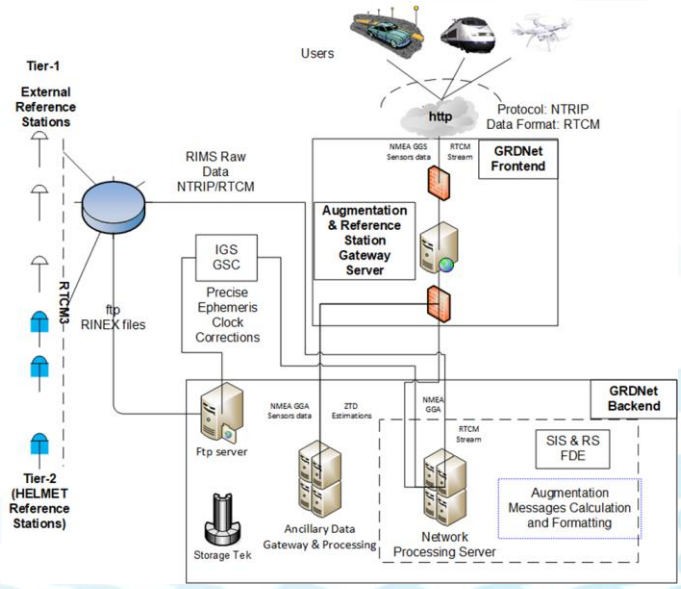
ARCHITECTURE DESIGN

HELMET multi-modal architecture is designed to operate in three different application segments: railway, automated car and UAV. It includes three different subsystems: the Augmentation subsystem, the Communication subsystem and the Multi-sensor On-Board subsystem. The Augmentation subsystem is identical for all three application segments while the communication and the On-Board subsystems are tailored to each application



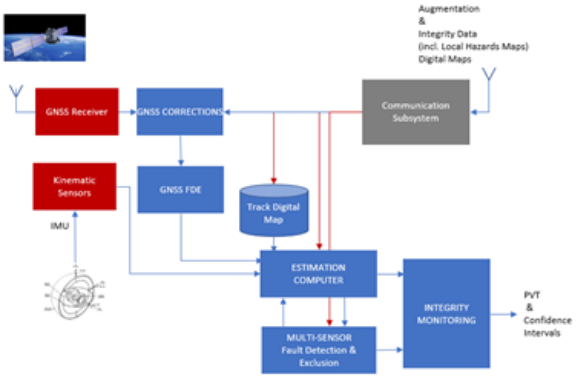
SUBSYSTEM AIMN

The designed Augmentation Subsystem is able to serve different applications in a multi-modal framework. The Augmentation Network, based on a Network of Reference Stations providing real-time raw measurements to the Control Centre, is compliant to RTCM SC-104 and RTCM SC-134 and provides two level of services. The first, suitable for the automotive sector, is based on healthy real time masks, allow the user to perform its own Integrity algorithms. The second, for very high integrity applications, as for the rail sector, is based on the 2-Tiers approach (two layers of Reference Station networks), where SIS and network statistical parameters are sent to the user (including probability of fault of satellite and constellations and measurement variances) and allows it to achieve the needed THR. The Augmentation System is independent from single receiver trademarks.

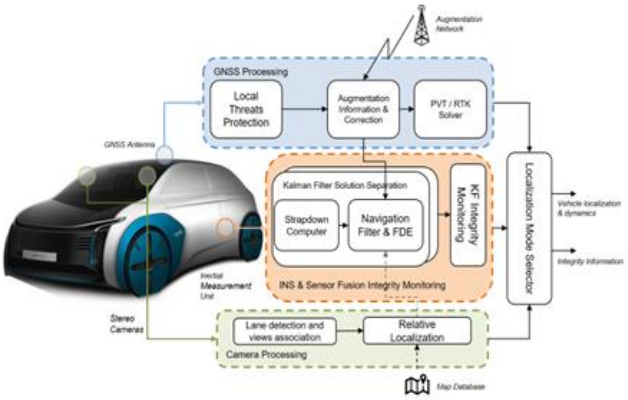


SUBSYSTEM MULTI-SENSOR ON-BOARD UNIT

The **Railway** Multi-sensor On-Board subsystem is based on both GNSS FDE and multi-sensor FDE. Particularly the integrity scheme operates at different layers as the signal domain (I/Q samples), measurement domain (Raw data) and the position domain (after PVT estimation). The a-priori knowledge of the track digital map is also exploited in the estimation computation to improve the accuracy of the PVT estimation process. The Communication subsystem guarantees the communication with the Augmentation Network.



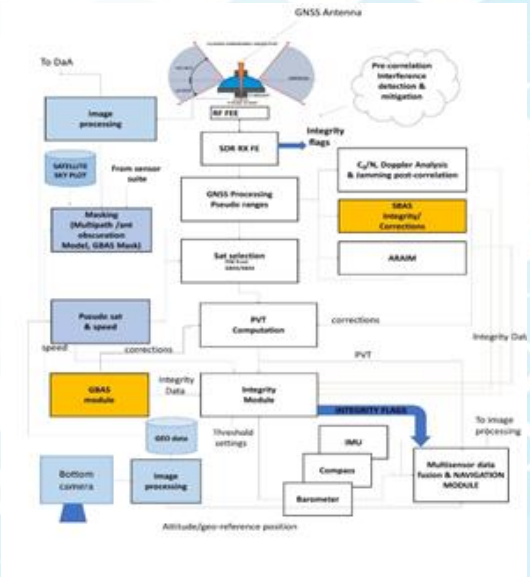
The **Automotive** MOBU collects data from the Augmentation Network and multiple sensors (GNSS, IMU and Stereo camera system), and processes them to achieve reliable navigation with integrity Information. The software processing is divided into 3 main blocks: GNSS Processing Block with dedicated local fault detectors and integrating the augmentation information, Sensor fusion & Integrity Monitoring Block able to provide a high accuracy-high integrity solution and Camera Processing Block to detect lane marks on the road. Additionally, a Localization Mode Selector Block makes smart decisions about the most suitable solution to be provided to the user. The algorithms are validated with tests performed with real data in automotive scenarios.



An **aircraft** navigation system combines the information from the On-Board sensor suit to determine and manage the following information:

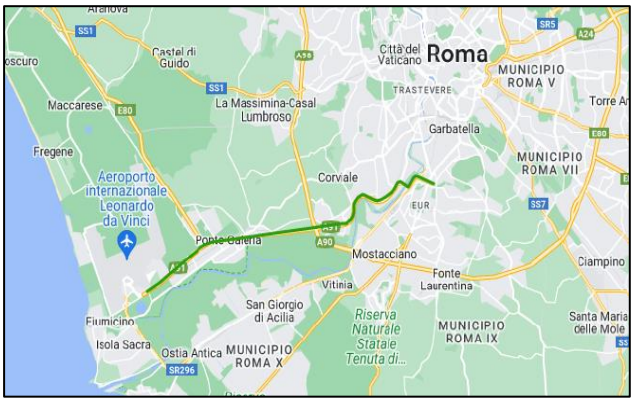
- Kinematic information (acc, & angular rates, etc)
- Navigation states
- Trajectory and track parameters
- Internal self-status

Basically, the aircraft operates based on external reference data but can also flight for same time and occasion in dead-reckoning even from one reference point to another.



HELMET PROOF OF CONCEPT

The HELMET tests were carried out on the Rome-Fiumicino A91 highway from 11 to 13 April 2022, both for the test of the automotive MOBU and the railway one, as well as AIMN. Specifically, the railway MOBU was tested on a vehicle running on a predefined route (trackDB) in order to simulate the behaviour of a train running on a railway section able to compute track constrained PVT.



Rome-Fiumicino A91 highway

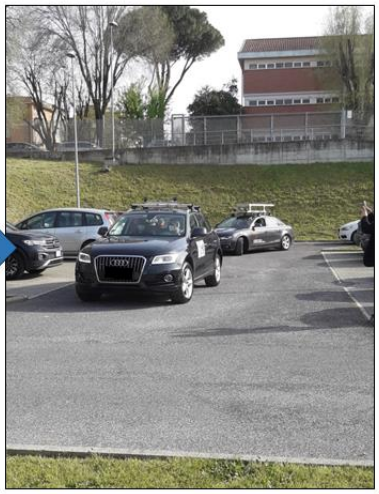
DEMO APPROACH FOR RAIL

Behavior of the train simulated by the vehicle with Track-constrained PVT calculation

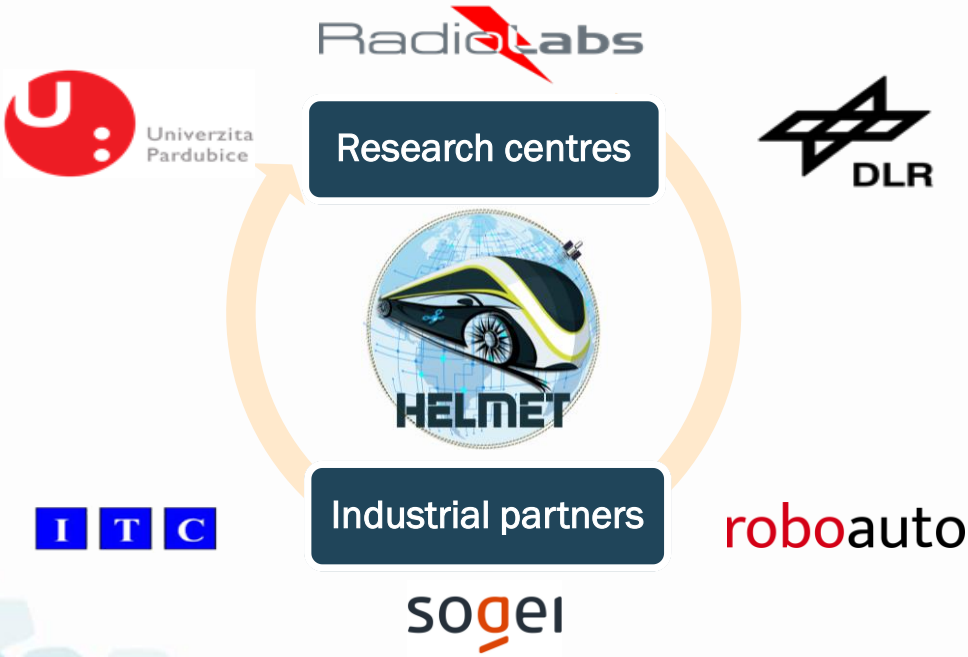
JOINT DEMO (RADIOLABS – ROBOAUTO/DLR)

Start/End Race - RomaTre University Parking

A91: Rome-Fiumicino highway



Project Partners



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