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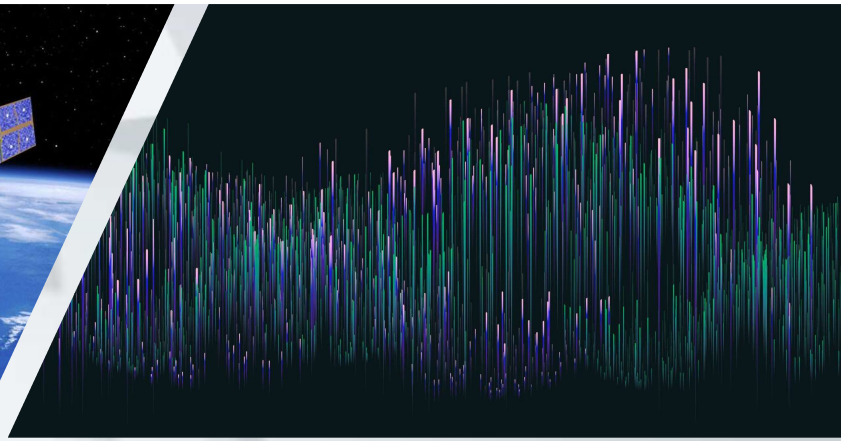
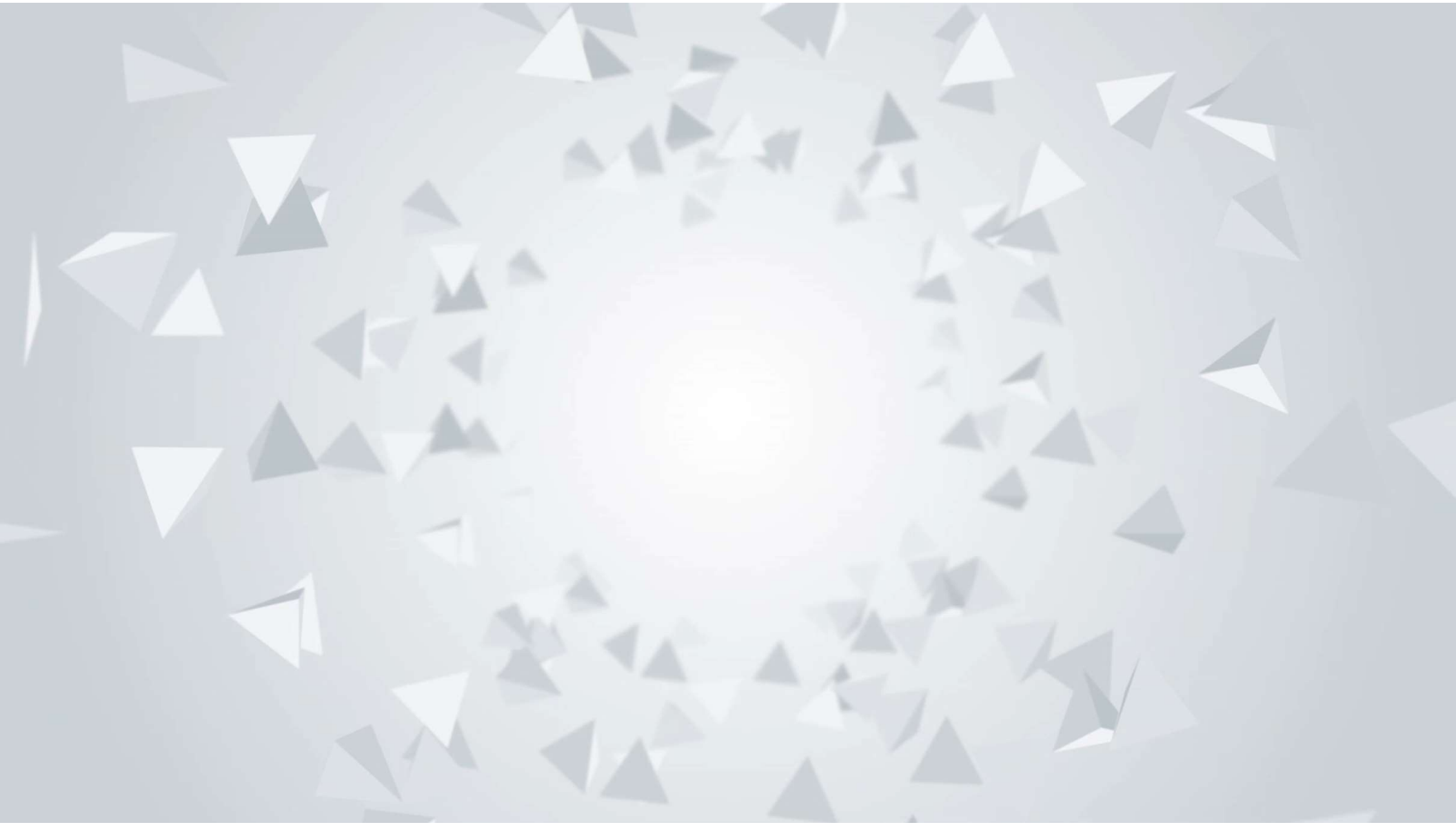


Geolocalizzazione ad alta Integrità per l'ERTMS: stato dell'arte ed evoluzione

Ing. Alessia Vennarini
alessia.vennarini@radiolabs.it

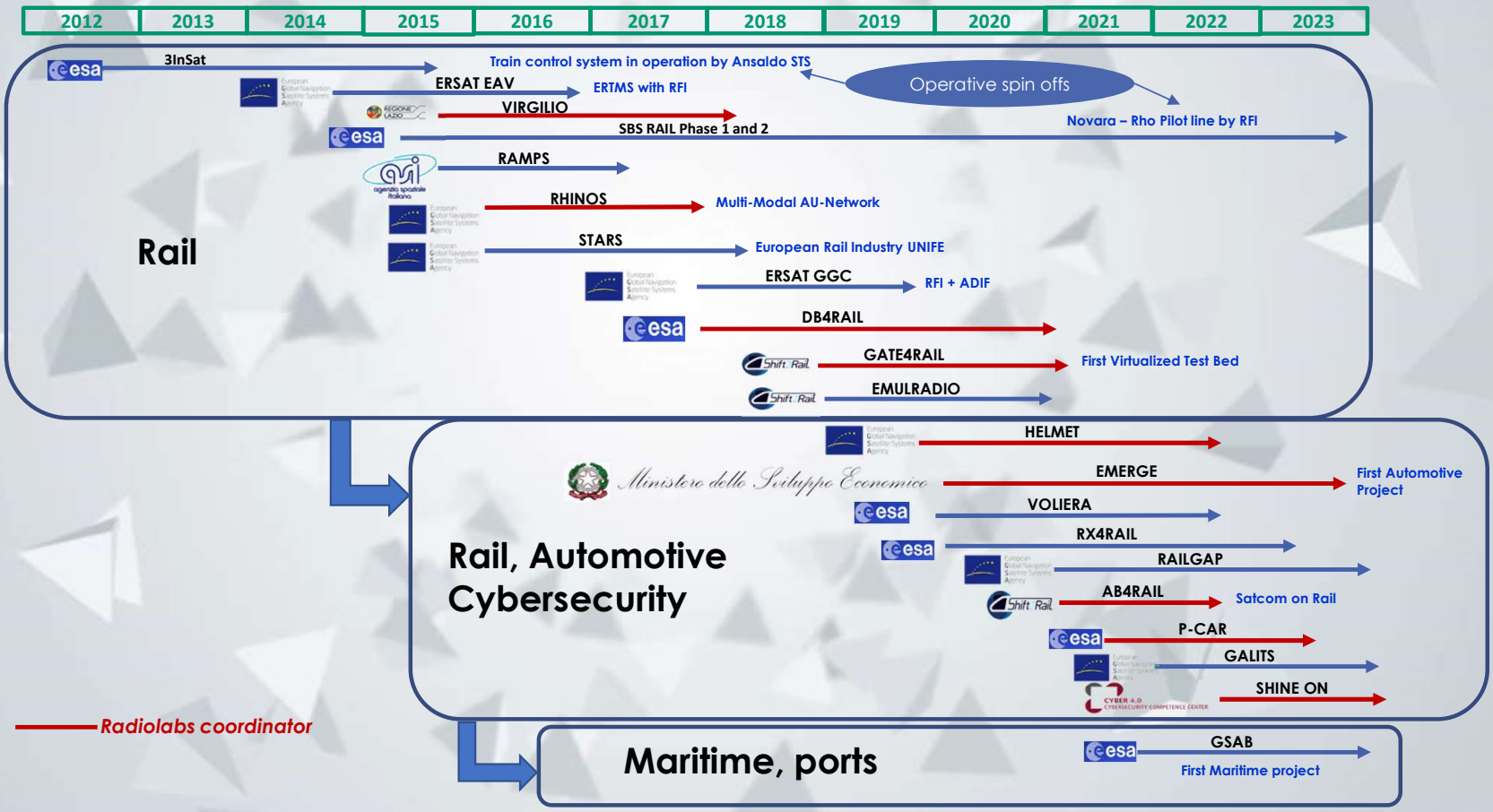


Roadmap and projects: last 10 years

Satellite technologies for a connected, cooperative, safe and decarbonized transport system

Technological synergies to enable automation for cars, trains, ships

Key potential users involved since the beginning



Introduction

- GNSS positioning is a core technology for automating transportation systems
- Key differentiator with respect to other applications is the safety attribute

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Why Satellites Technologies?

Reduce operating and maintenance costs and increase line capacity

MAIN CHALLENGE:

Achieving the same

LEVEL OF SECURITY as provided by traditional technologies

High Accuracy, High Integrity Positioning

To satisfy accuracy and safety (i.e. integrity) requirements two types of unintentional hazards must be mitigated:

- **Global Hazards**
- **Local Hazards**

In addition, **security attacks** targeting the Signal in Space must be tackled

Global Hazards Mitigations

- Dual Frequency Rx
  - Iono Free combinations
- DFMC SBAS
  - EGNOS V3
- Multimodal Multiservice Augmentation Networks
  - HELMET
- GALILEO HAS

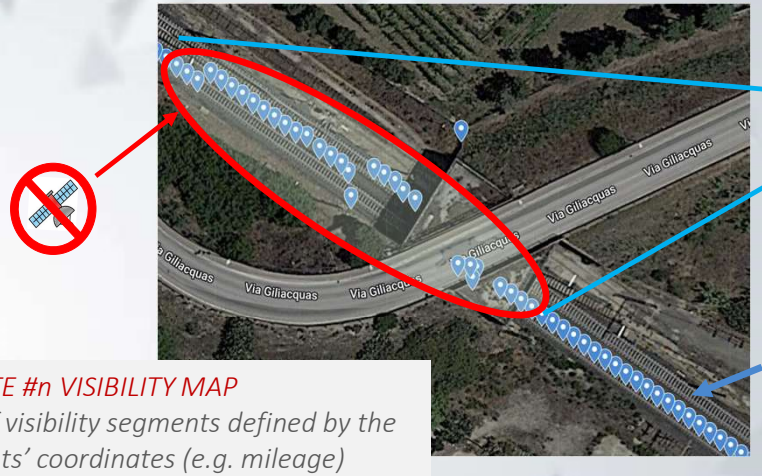
Local Hazards Mitigations

- Advanced RAIM
  - Fault detection and Exclusion
  - Solution Separation
  - Local Hazard Causes Maps
- Multi-Sensor Positioning
  - IMU,
  - Imaging &Visual Odometry
  - LIDAR, …

Local Context: Integrity

To enhance Integrity, "***Local Hazard Source Maps"*** can be exploited:

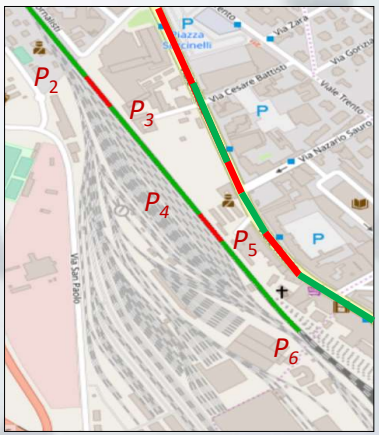
- **Satellite visibility Map**, whose purpose is the exclusion of those satellites with a LoS signal strength not enough so that they can be used for GNSS fixing
- **Map of LoS Multipath Hazard Causes** providing the information about the local multipath statistical model
- **Map of Radio Frequency Interference Hazard Causes** (RFI)



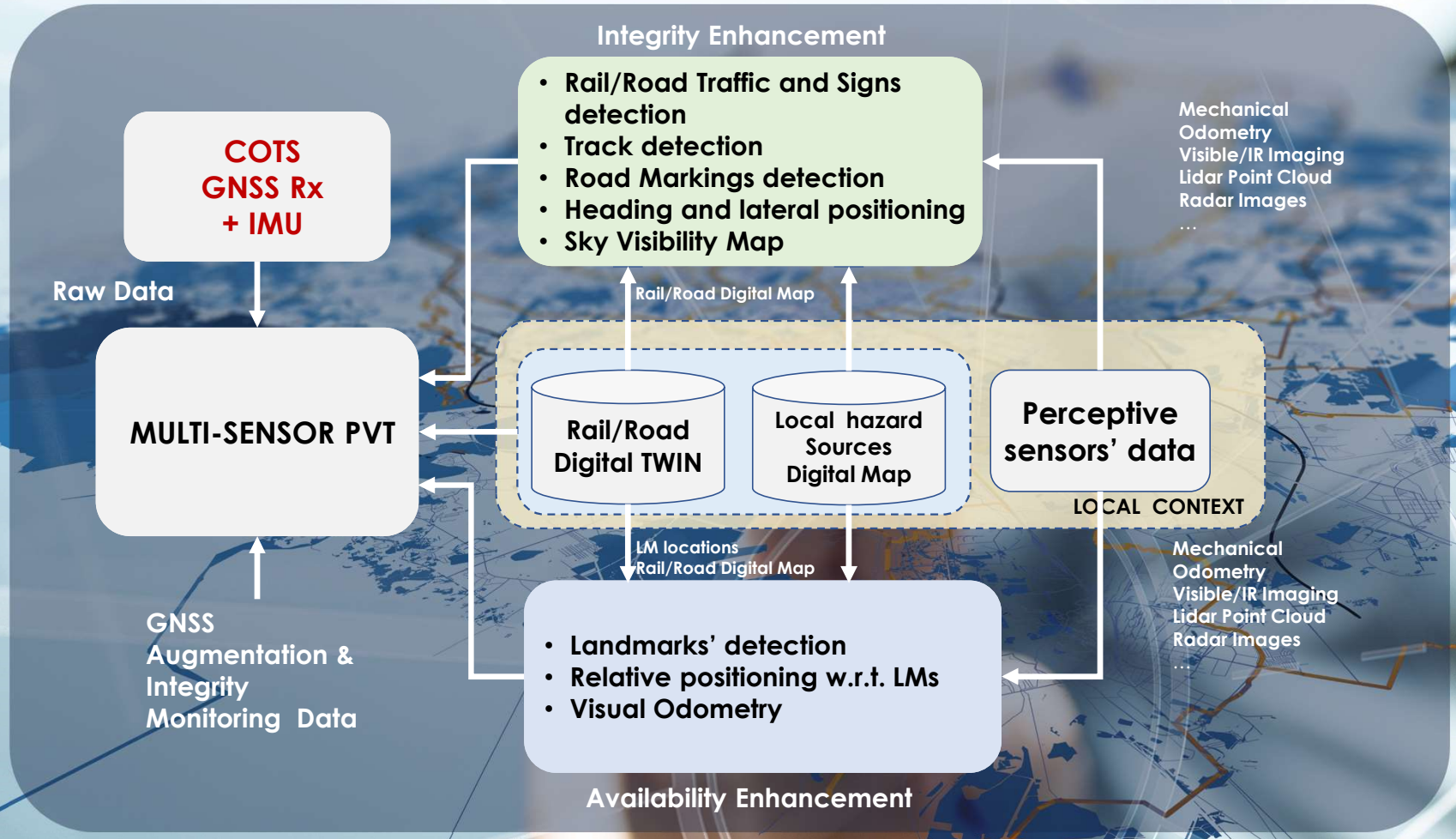
GNSS only train position estimate (RTK)

SATELLITE #n VISIBILITY MAP

As list of visibility segments defined by the end points' coordinates (e.g. mileage)



Multi-Sensor PVT



Railway Digital Twin

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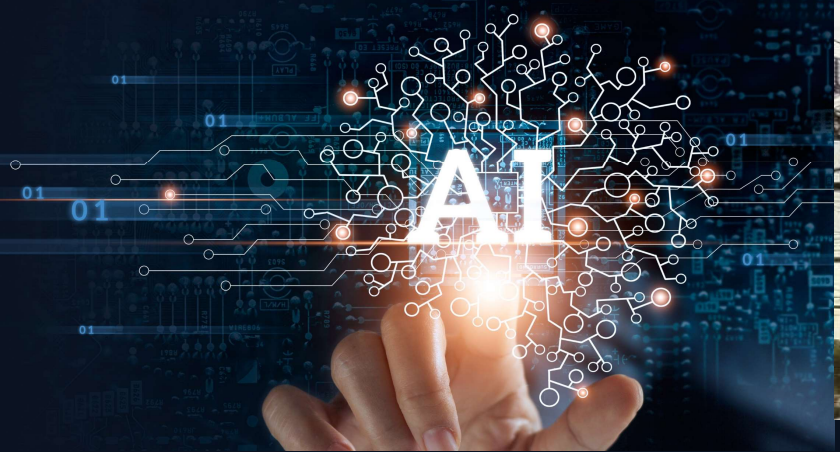
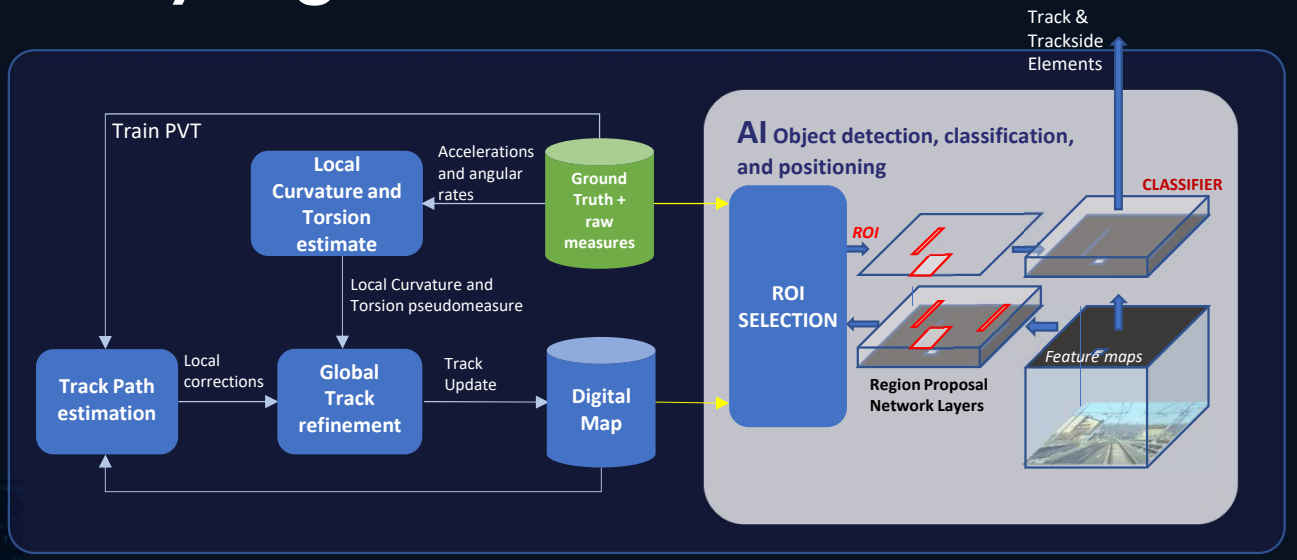
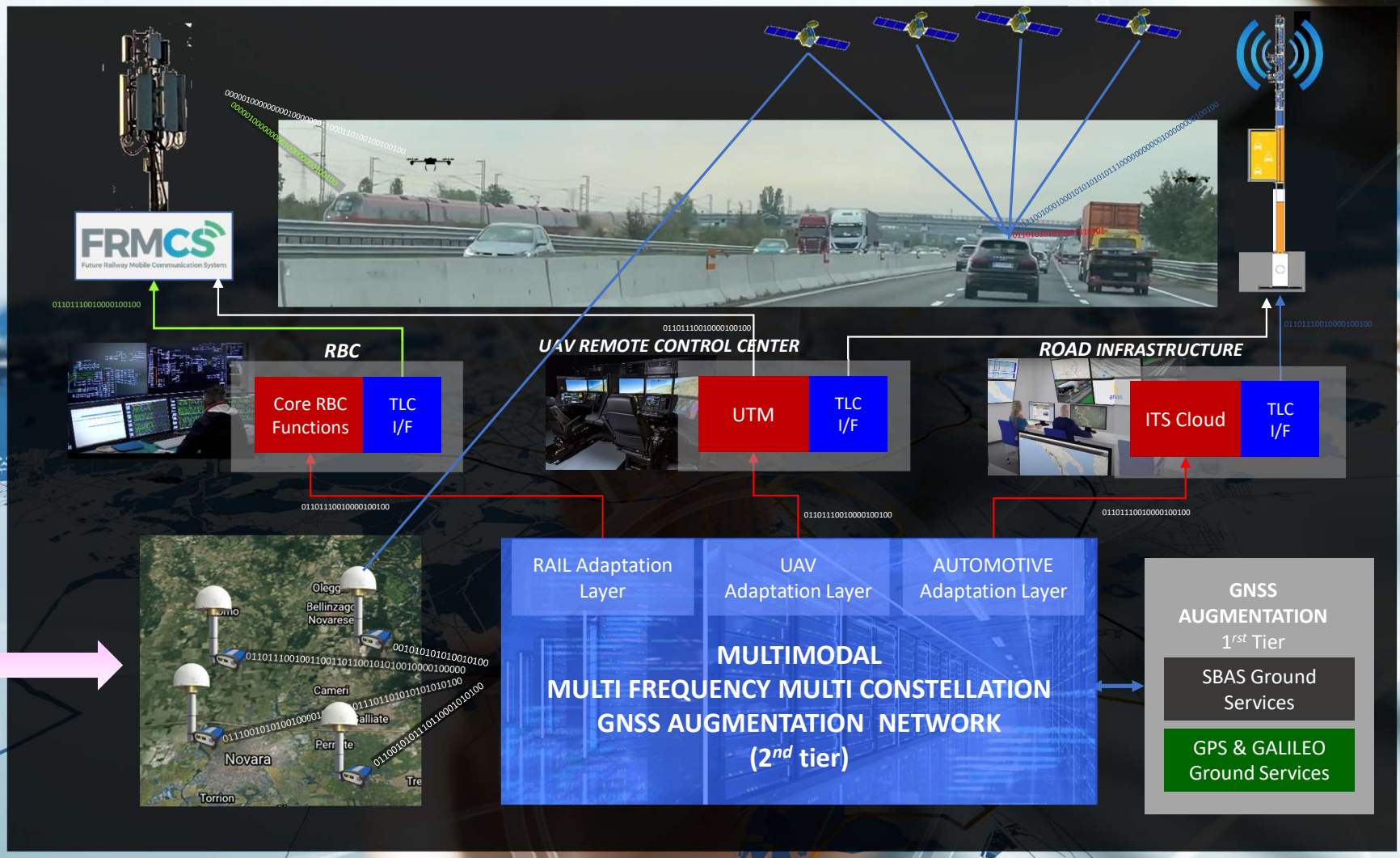
RAILGAP

- Use of Local Landmarks (LMs)
- LM class id and Location part of the Digital Twin





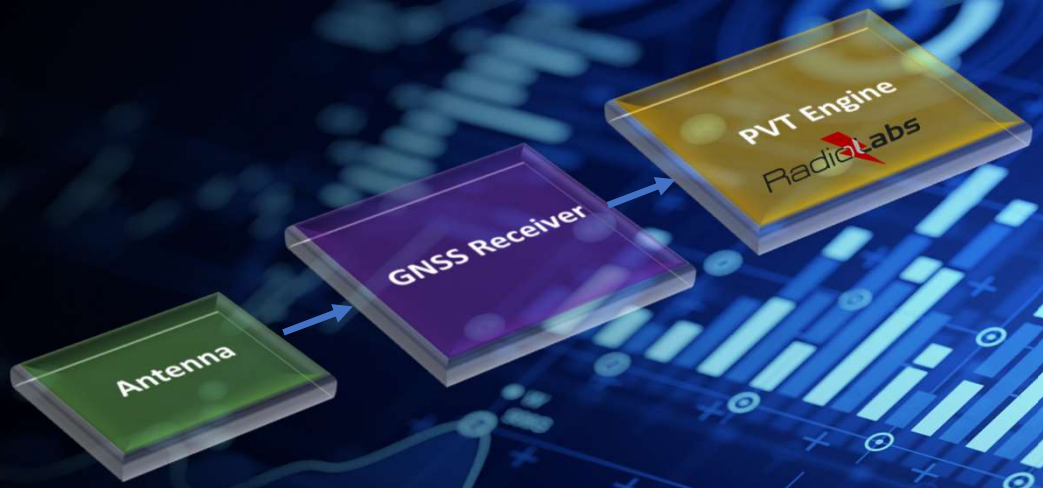
Global Hazards Mitigations



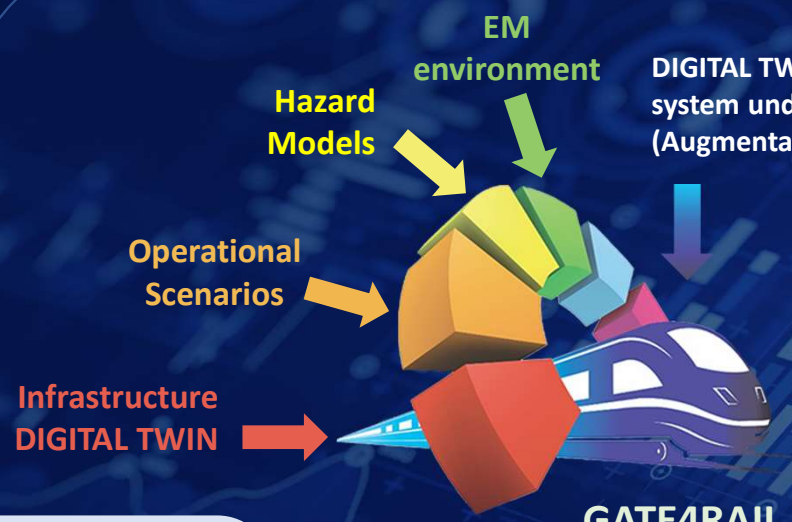
Use of a network of stations at known positions to monitor satellite health and estimate corrections

GALITS
GAlileo Localization In Train Signalling

- Innovative, flexible and customizable GNSS receiver and antenna suitable for safety-related railway applications
- Enhanced GNSS receiver chain for high accuracy high integrity train localization
- Advanced integrity algorithms, based on reduced complexity DFMC ARAIM schemes with coupling to on-board sensors
- Designed to be integrated with additional sensors and compatible with on-board train control systems for various applications



The Zero on-Site Test Approach



KNOW-HOW on

- GNSS behaviour in the operational environment
- Impact on the Vehicle Control System (VB detection in Rail)

REDUCTION of

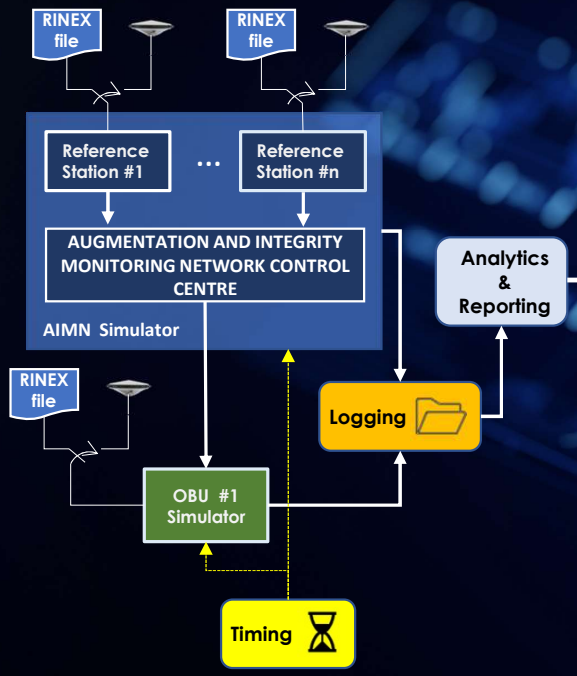
- Experimentation costs (*Test before Invest*)
- Certification cost
- Time to market

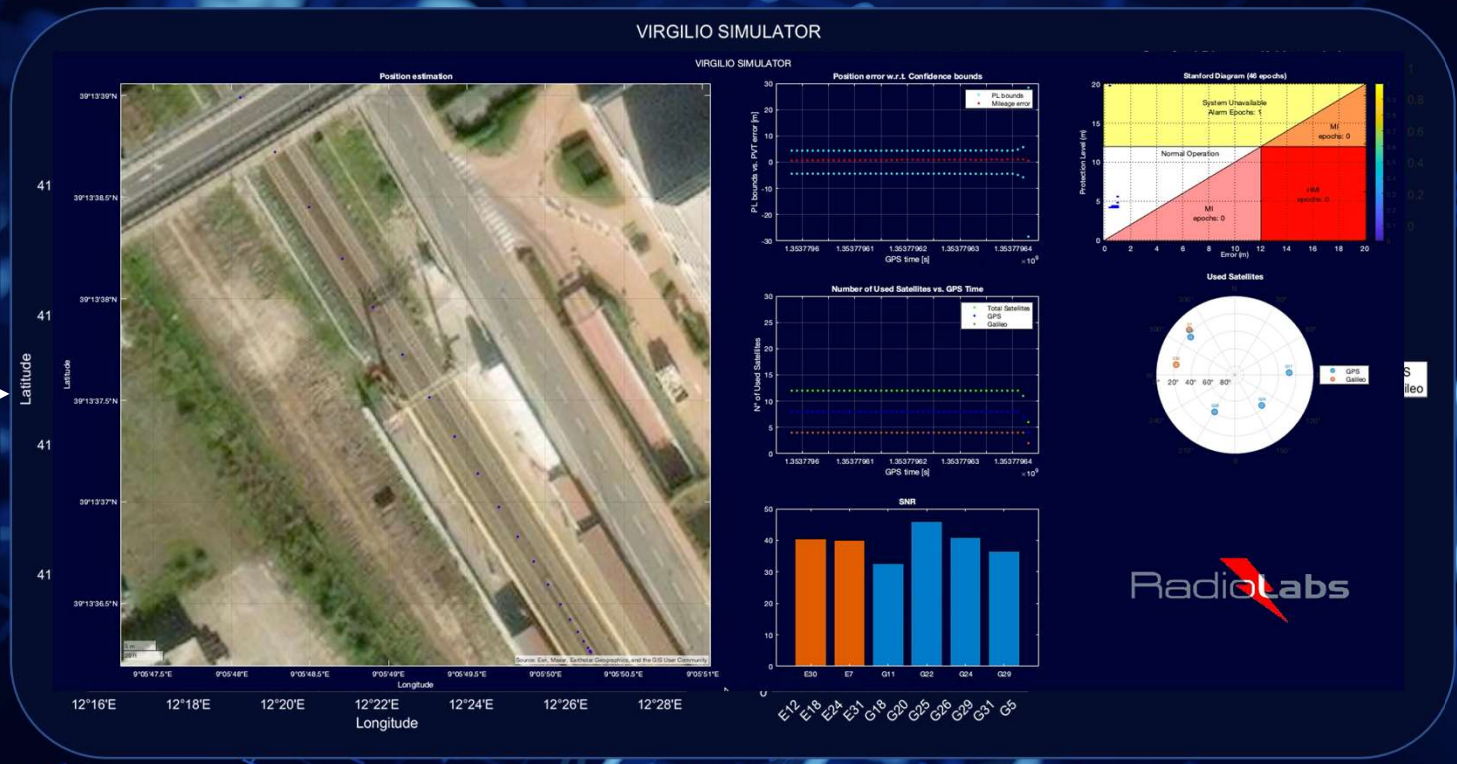
CAPABILITIES

- Simulate **rare events**
- Simulate various **configurations** encountered in the railway operational environment
- Assess the safety level of a solution with a far **larger data sets** than what could not be obtained by field tests
- Use methods and tools for test environment accounting for a **set of common requirements for notified body approval**

The Zero on-Site Test Approach

VIRGILIO SIMULATOR





GNSS positioning: State of the Art

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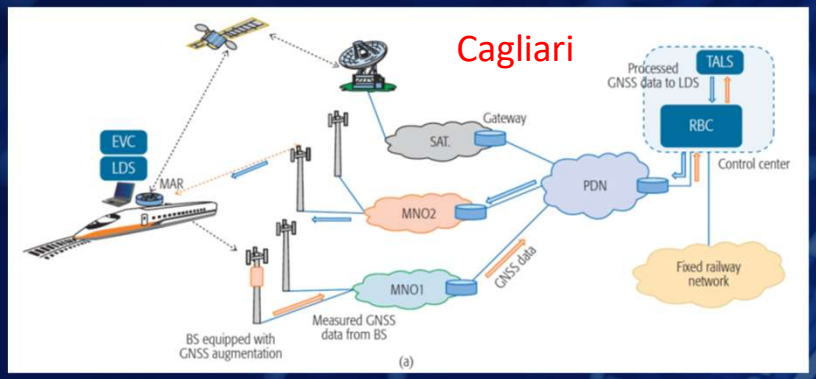
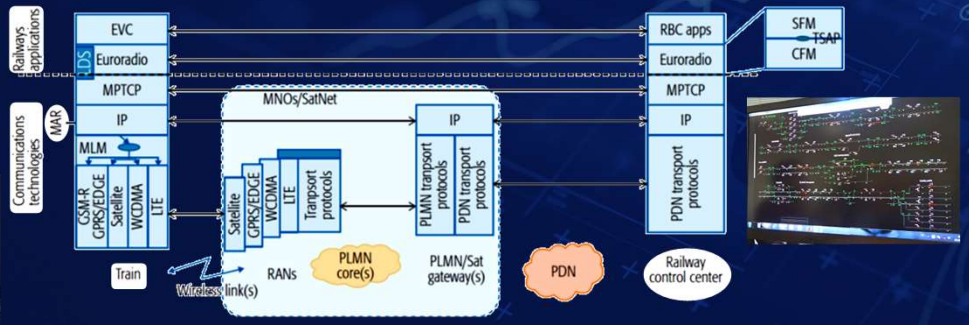
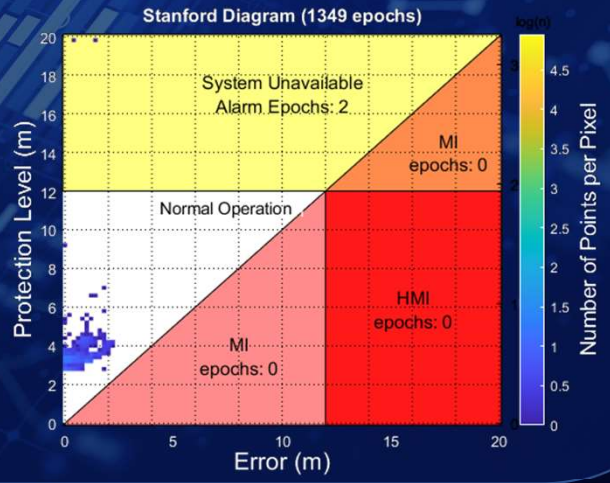
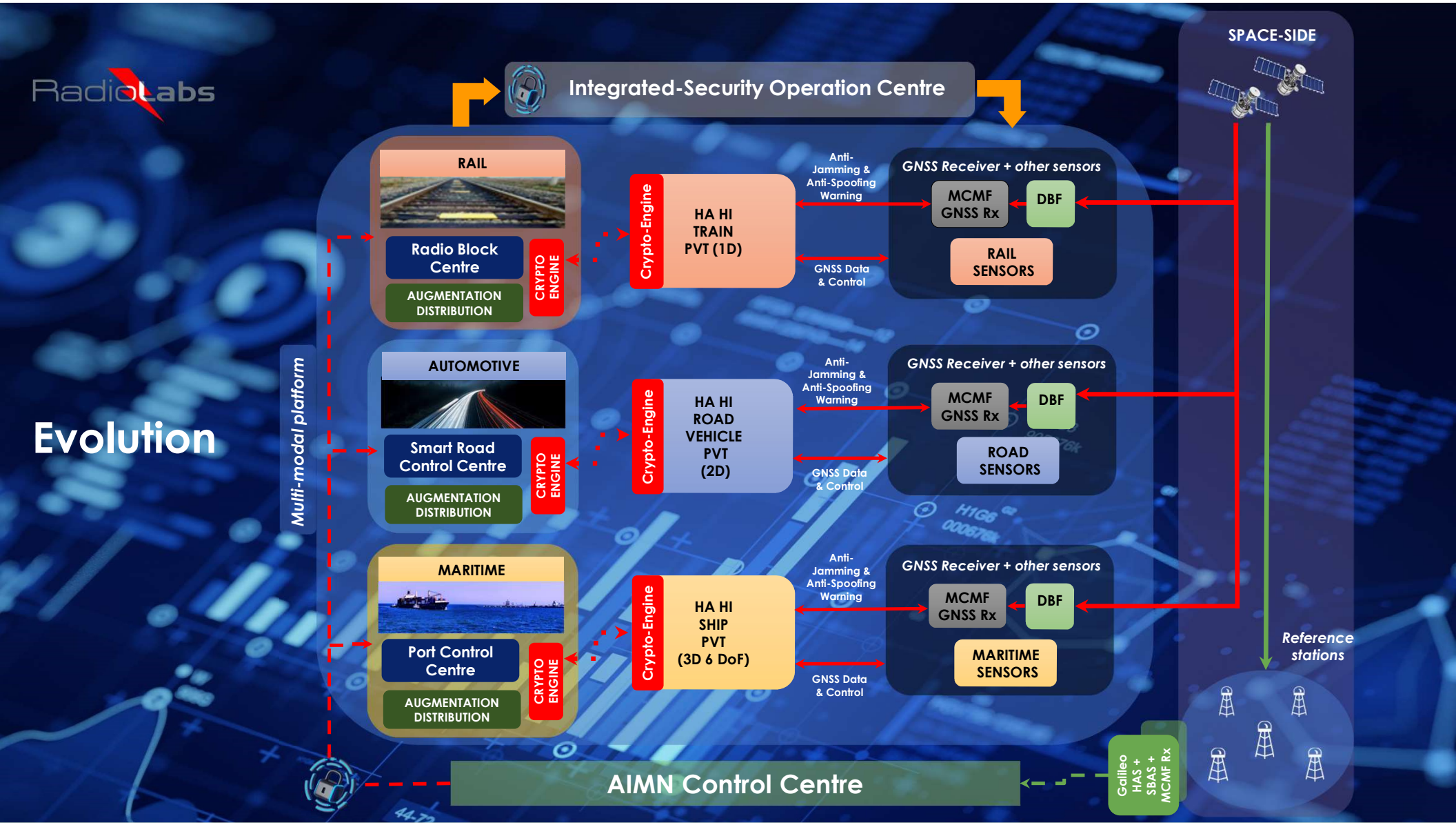
RFI SARDINIA TESTBED





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Evolution
Integrated-Security Operation Centre
SPACE-SIDE
Multi-modal platform
RAIL
Radio Block Centre
AUGMENTATION DISTRIBUTION
CRYPTO ENGINE
Crypto-Engine
HA HI TRAIN PVT (1D)
Anti-Jamming & Anti-Spoofing Warning
GNSS Data & Control
GNSS Receiver + other sensors
MCMF GNSS Rx
DBF
RAIL SENSORS
AUTOMOTIVE
Smart Road Control Centre
AUGMENTATION DISTRIBUTION
CRYPTO ENGINE
Crypto-Engine
HA HI ROAD VEHICLE PVT (2D)
Anti-Jamming & Anti-Spoofing Warning
GNSS Data & Control
GNSS Receiver + other sensors
MCMF GNSS Rx
DBF
ROAD SENSORS
MARITIME
Port Control Centre
AUGMENTATION DISTRIBUTION
CRYPTO ENGINE
Crypto-Engine
HA HI SHIP PVT (3D 6 DoF)
Anti-Jamming & Anti-Spoofing Warning
GNSS Data & Control
GNSS Receiver + other sensors
MCMF GNSS Rx
DBF
MARITIME SENSORS
Reference stations
AIMN Control Centre
Galileo HAS + SBAS + MCMF Rx

THANK YOU FOR YOUR ATTENTION

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