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User Needs for the Development of New Methodologies and R&D Tools for Building a Railway Digital Map and for the Experimental Performance Evaluation of On-Board Subsystems

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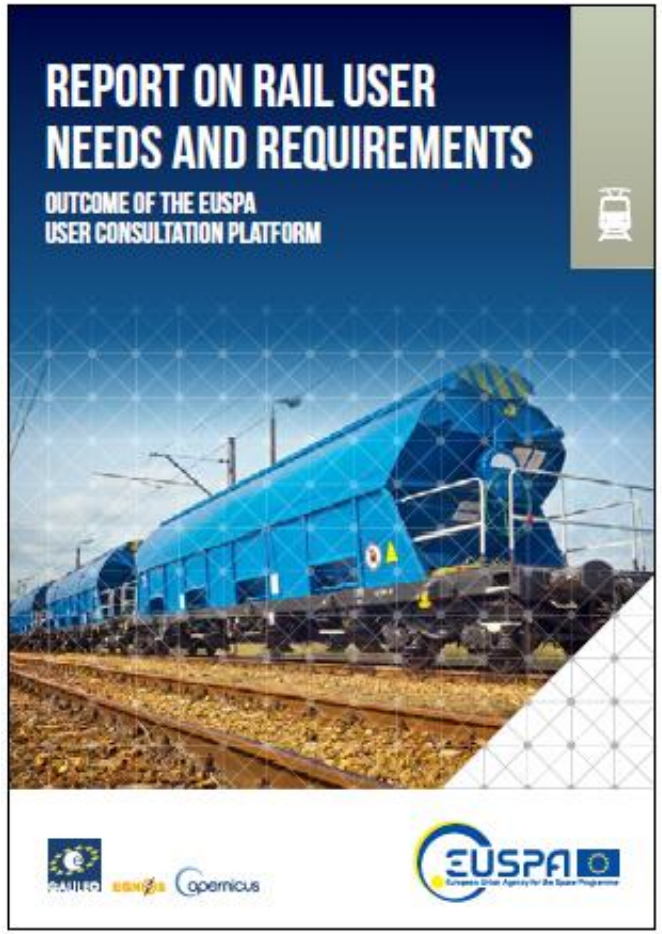
RFI RETE FERROVIARIA ITALIANA
GRUPPO FERROVIE DELLO STATO ITALIANE

RAILGAP

GNSS-based localisation systems

- GNSS introduction in the railways – Why? What for?

	Non safety-critical applications			Safety-critical applications
Applications	**Asset management**	**Passenger Information**	**Trackside personnel protection**	**Signalling and train control applications**
Key GNSS requirements	Accuracy (10 metres) Availability (High)	Accuracy (5 to 100 metres) Availability (95%)	Accuracy (1 to 10 metres and track discrimination) Availability (95%)	Accuracy (1 to 20 metres) Availability (High) Integrity Robustness
Other requirements	Connectivity Power Consumption	Connectivity (communication link)	Connectivity (communication link)	Interoperability



- GNSS as a game changer for ERTMS
- in July 2021: EU Parliament calls for fast adoption of satellite-based train localization in railway signaling https://www.euspa.europa.eu/newsroom/news/eu-parliament-calls-fast-adoption-satellite-based-train-localization-railway

GNSS-based solutions to be evaluated

- We need to evaluate the new localisation solutions
  - How?

  We need to compare the new solution with a reference.
    - Position accuracy
    - Velocity accuracy
    - Acceleration Accuracy

  Comparative analysis requires the use of coherent Reference and Evaluation data

- What is missing?
  - The need for a Ground Truth in space and time
  - This is the justification for (reason to have) the RAILGAP project

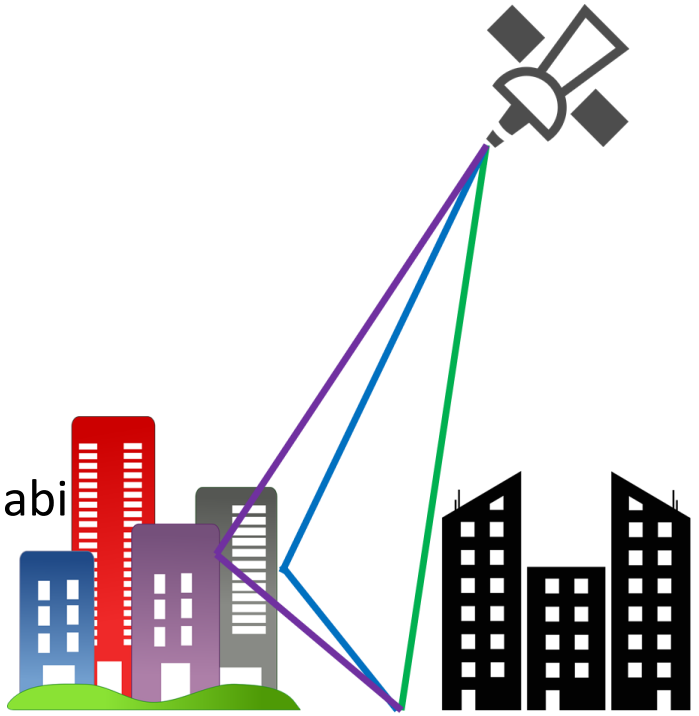
  Moreoveor, as new GNSS-based train localization subsystems are exploring the use of a digital map
    - We need Digital Maps. This is another reason for having the RAILGAP project

The Railway Environemnt is hostile

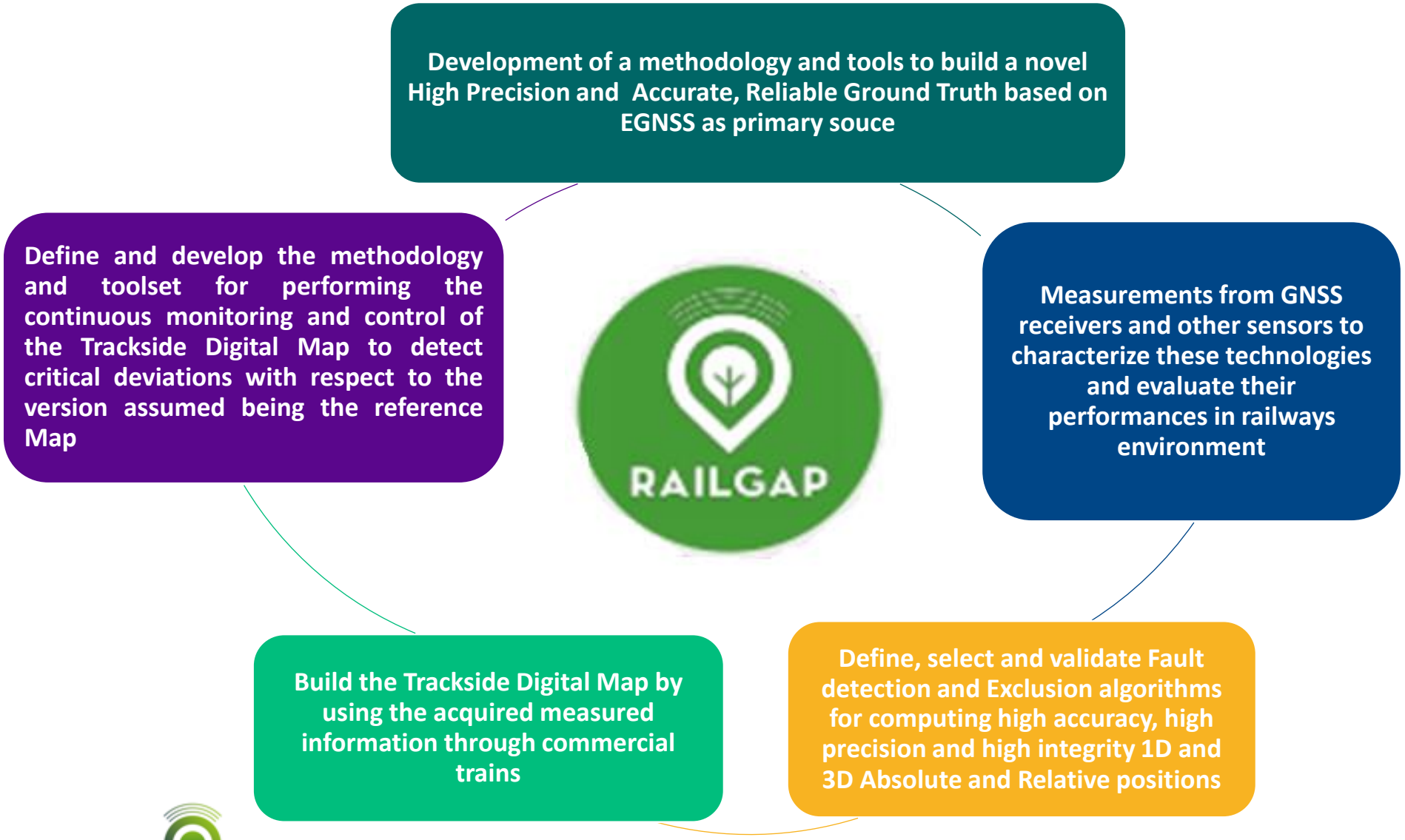
The environnement has impact on

- Accuracy and Precision
- Availability
- Integrity

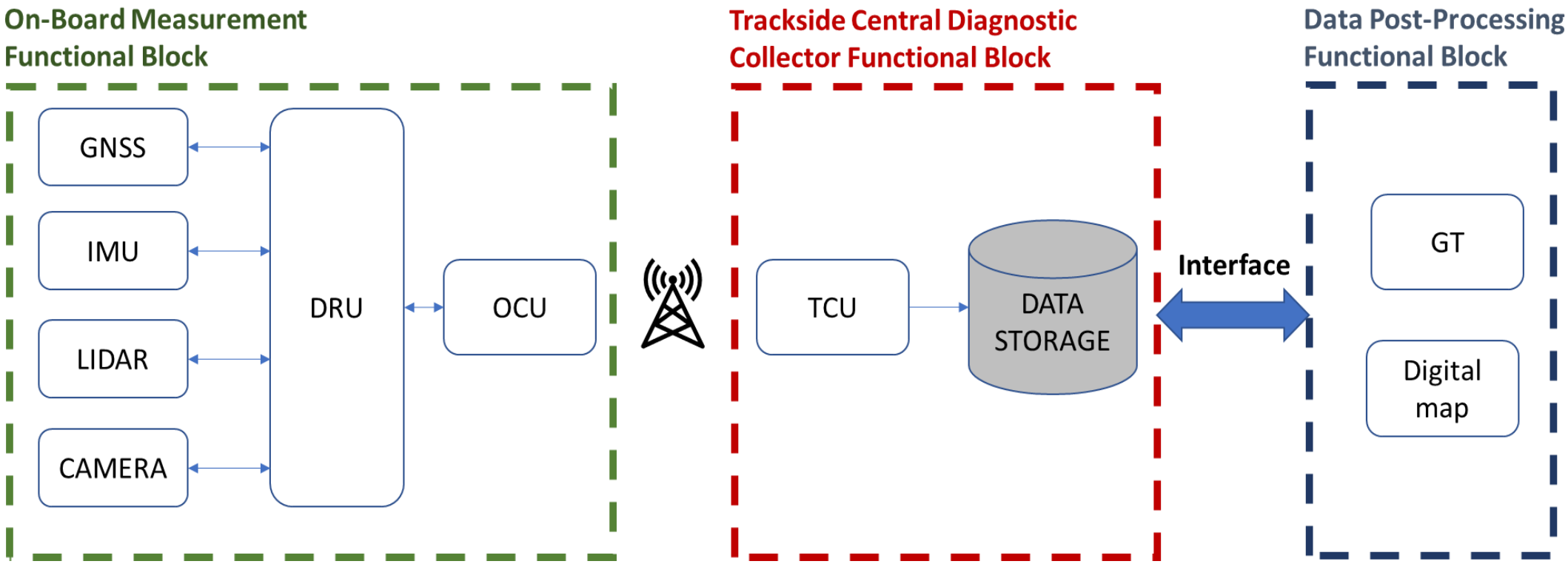
- GNSS for absolute position
  - But lack of high accuracy
  - Suffers from local effects
- Complementary sensors for more and predictable accuracy, ensure availabi
  - IMU for higher rate, availability
  - Lidar and Camera for track discrimination and map maching



The main objectives of RAILGAP



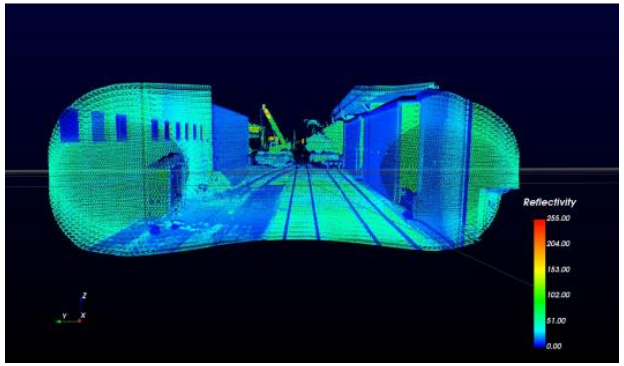
Measurement environment to acquire data for both GTs and DMs



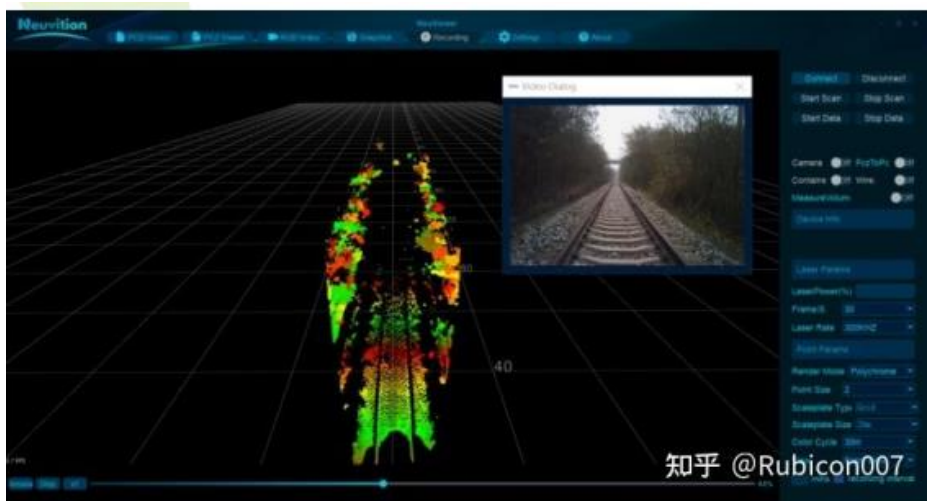
Measurement environment to acquire data for both GTs and DMs

GNSS receiver

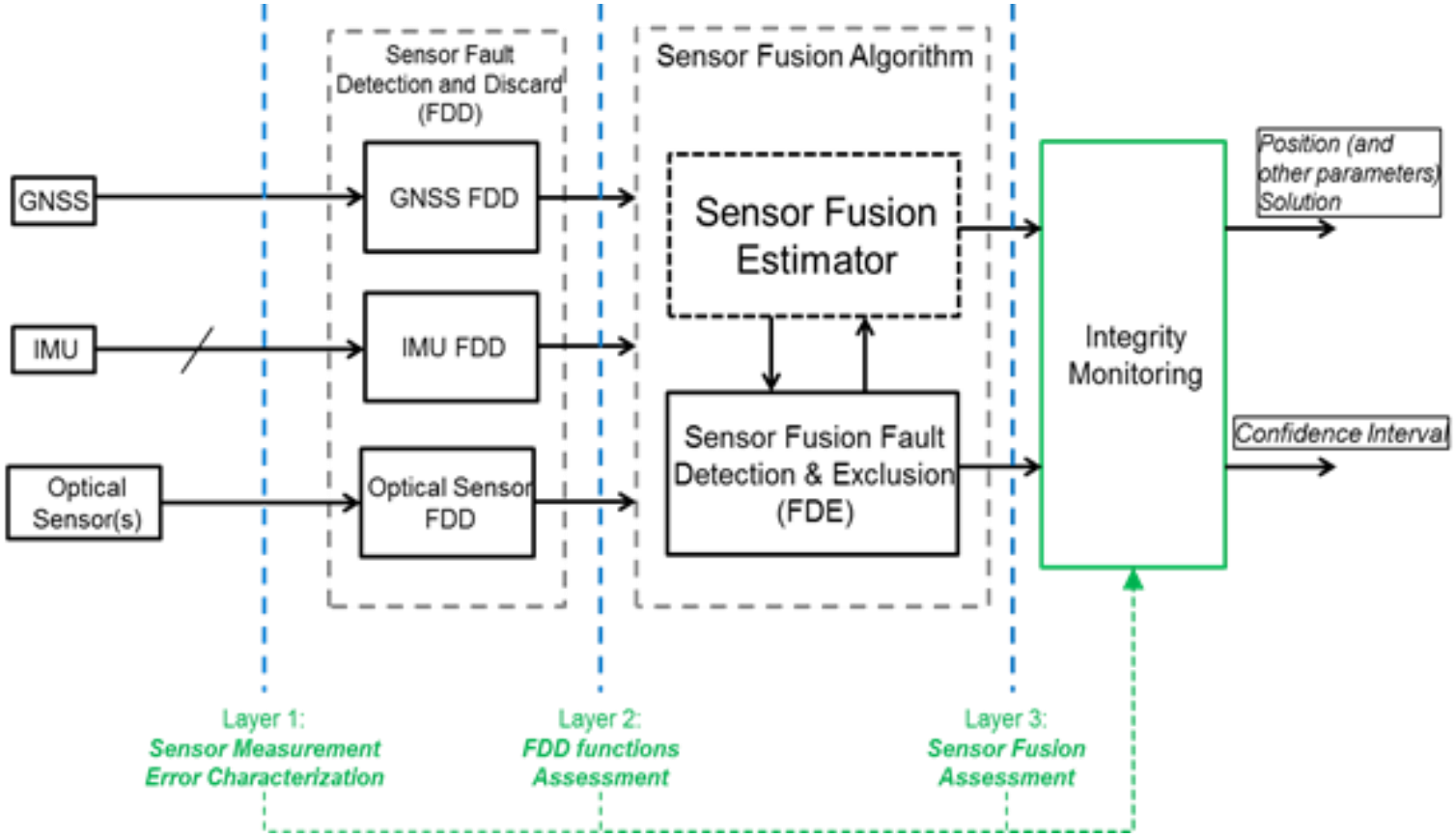
Lidar



Point cloud

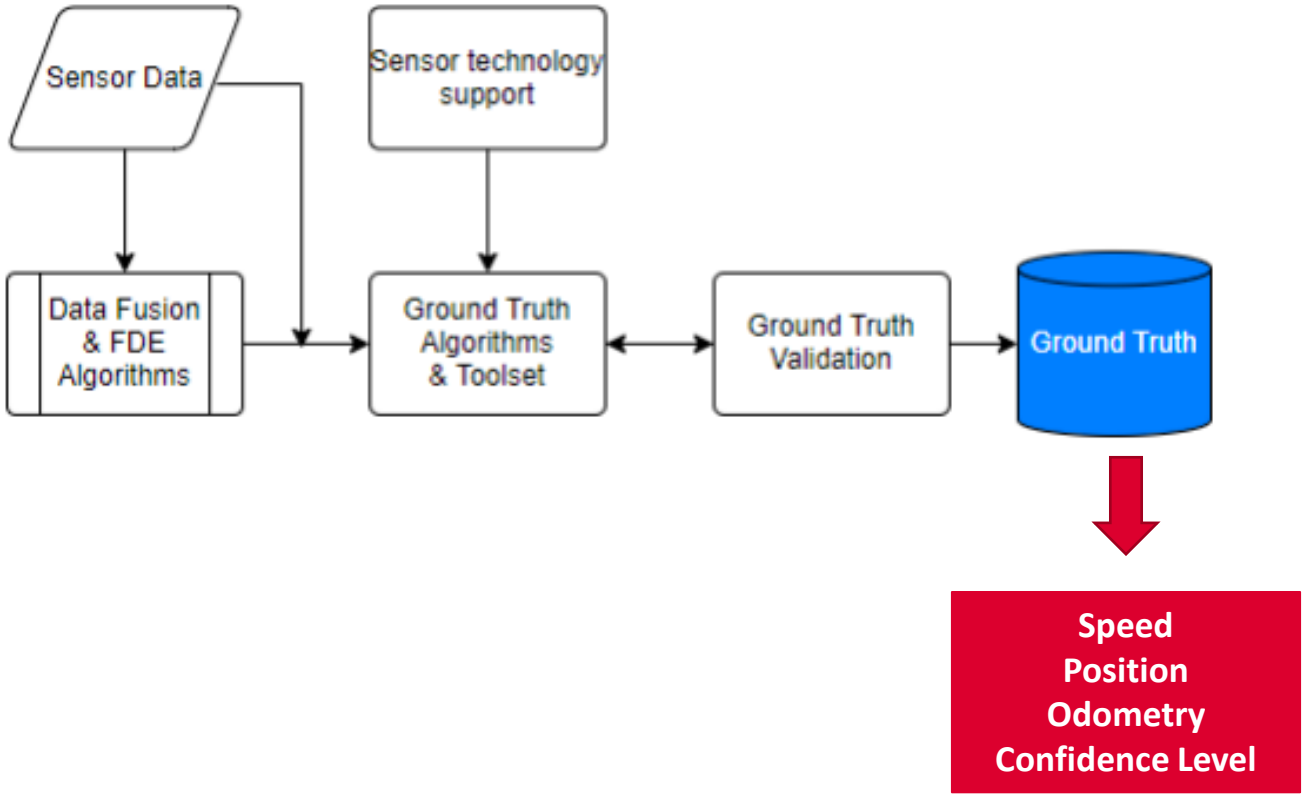


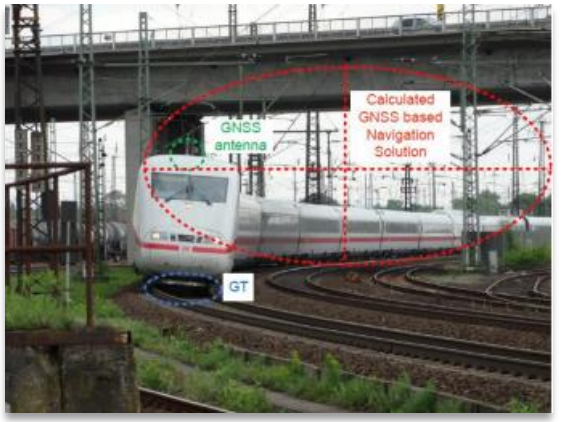
Characterization for Railway Ground Truth and Digital Map Generation

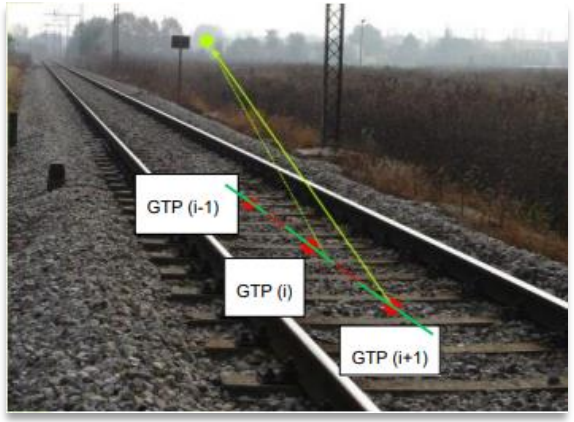


Ground Truth: definition

Ground Truth constitutes a novel **High Precision** and **Accurate**, **Reliable** Ground Truth reference for **train positioning** based on EGNSS as primary souce

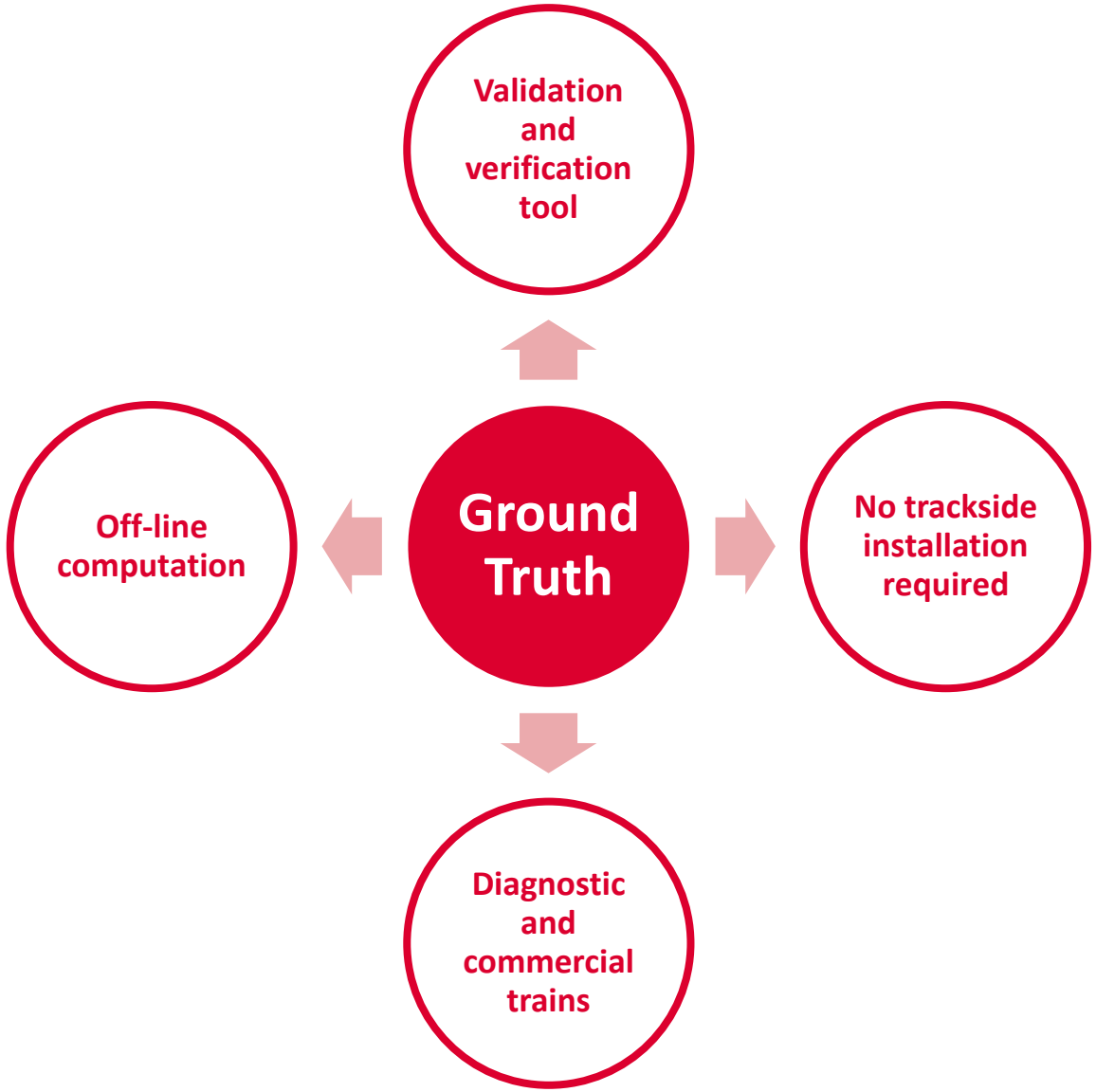






Ground Truth: differentiators

- ✓ High accuracy and integrity Validation and Verification tool for EGNSS-based train position
- ✓ No trackside installation required for GT computation
- ✓ Data acquisition from diagnostic and commercial trains
- ✓ Off-line computation from on-board measurements

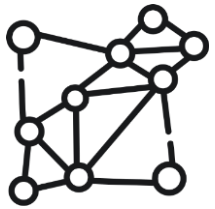


Digital Map: Definition

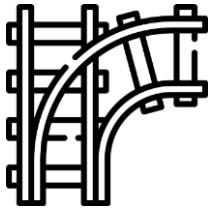
The **rail digital map** is one of the **key points** for supporting the **GNSS uptake into rail signaling and control systems.**

Digital map refers to the **absolute coordinates** and the **static description** of the **track** and its **elements**

The railML® infrastructure schema [1] includes

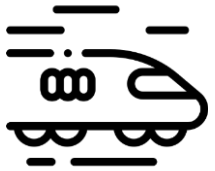


Topology



Geometry

Infrastructur
e elements

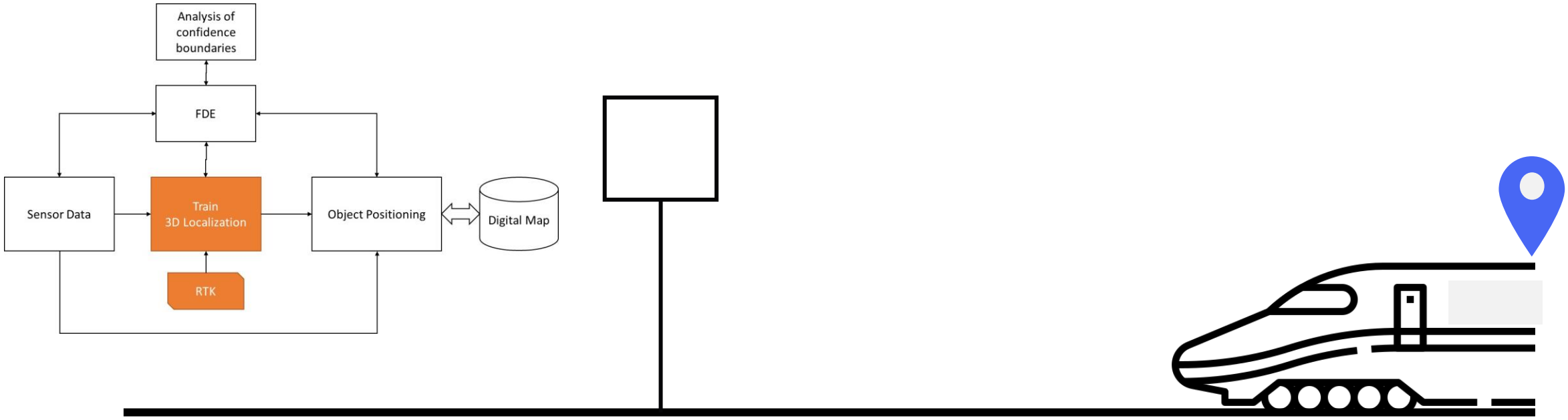


Immaterial
objects

[1] “RAILML,” [Available at: www.railml.org - accessed 03-November-2021].

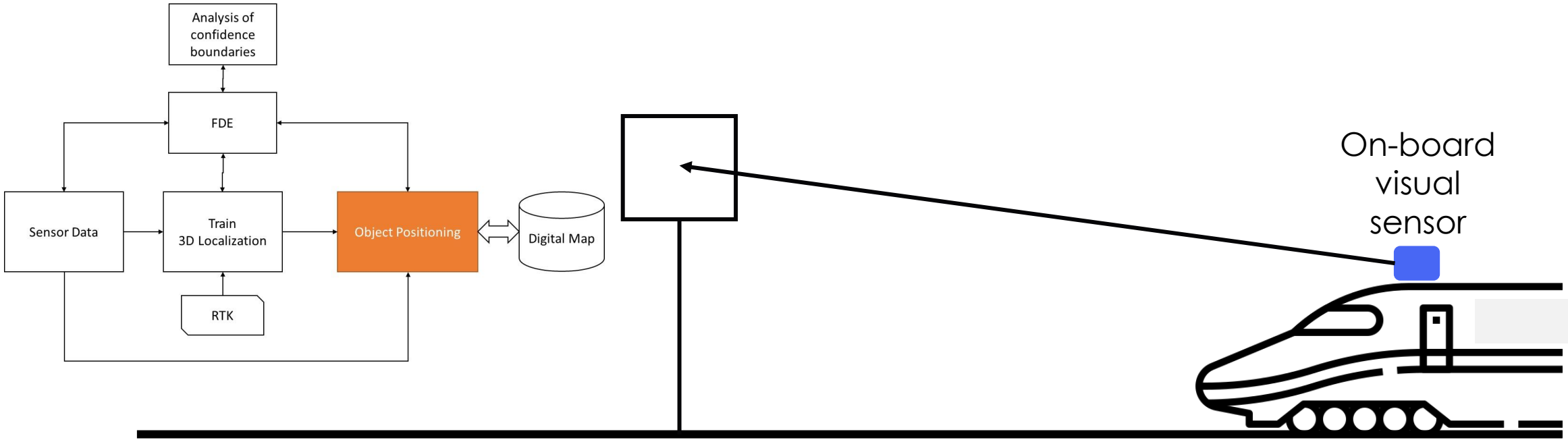
Digital Map - Approach

1 The train location is estimated based on high accuracy GNSS-based techniques (e.g., RTK).



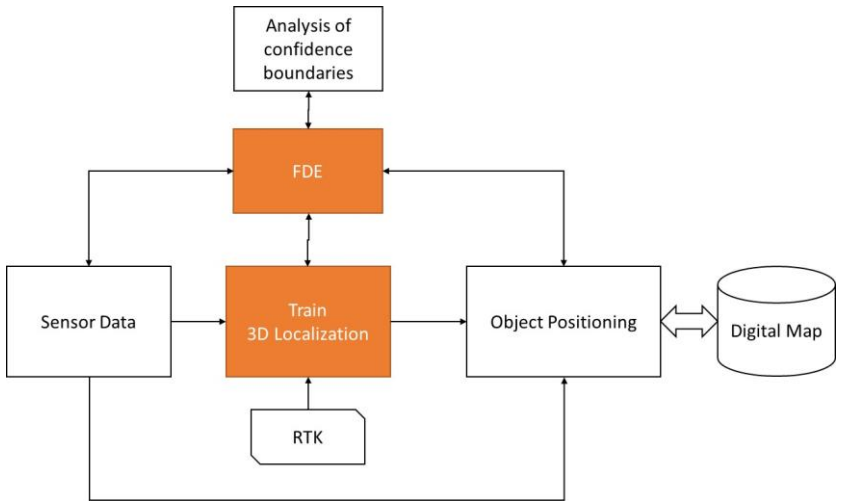
Digital Map - Approach

2 The relative position of Infrastructure Elements (IE) with respect to the train is computed.



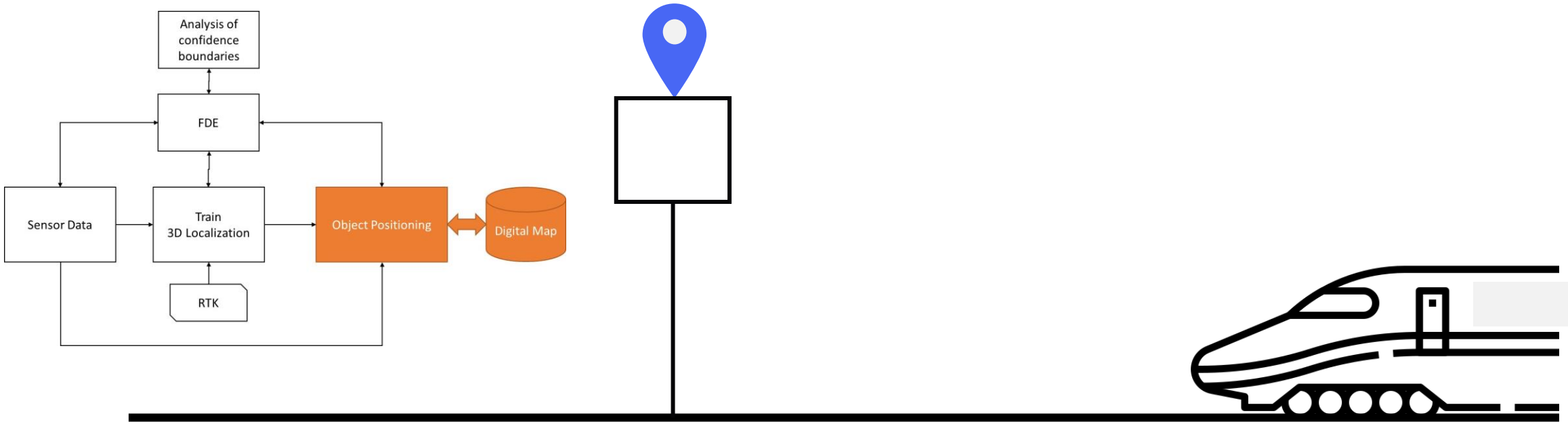
Digital Map - Approach

3 GNSS records are post-processed to exclude outliers due to local phenomena (e.g., multipath, interferences) that may impair the estimation of the location of the train.



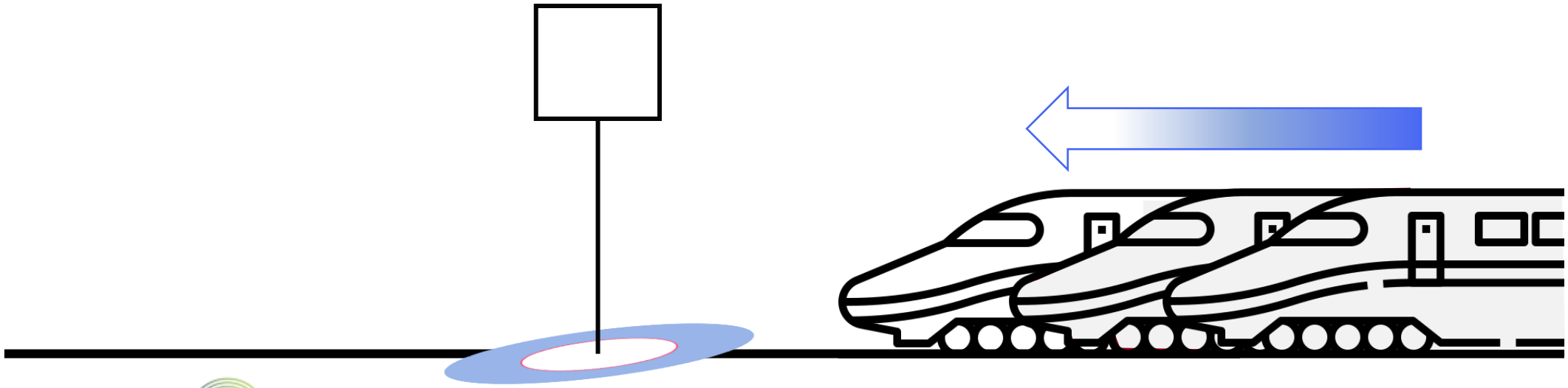
Digital Map - Approach

4 The GNSS-based train location, the IE's relative position, and the information previously stored in the digital map are combined to set/update the absolute position of the IE.



Digital Map - Approach

5 The process of building the digital map is incremental and the accuracy of the location of each landmark improves by increasing the number of successive detections and runs.



Conclusions

The RAILGAP project aims at providing the **characterizations** of the LIDAR, IMU and EGNSS technologies in railway environment and the definitions of the **methodologies** for building the **Ground Truth** and the **Digital Map** to the R&D communities.

The RAILGAP **Ground Truth** provides “reference data along with their accuracy” for different types of quantities to be monitored (i.e. **position**, **speed** and **acceleration**) and **does not require installation of trackside equipment and the a priori knowledge of the database of the lines**.

The RAILGAP methodologies for executing accurate and precise **railway surveys** and building **Digital Maps** use measured data collected with **commercial trains**.

Thank you

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