The GRAIL project: Galileo Localisation for the European Train Control System

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Galileo 6th Framework Programme

Structure

- The GRAIL Project:
  - Context
  - Consortium
  - Objectives
  - Status
- WP 3: Specification and Safety Analysis
  - Enhances Odometry
  - Support of Train Awakening and Cold Movement Detection
  - Absolute Positioning
  - Train Integrity Monitoring
  - Safety Analysis
- Conclusion and Perspective

Context

GRAIL: GNSS Introduction in the RAIL sector

- Project objective:
  - Define applications as well as roadmap to support the introduction of GNSS in the Rail market
  - Specification and Test of applications to support ERTMS/ETCS.
- Managed by the GJU/GSA
- Duration:
  - From 1st-Sep-05 to 30st-May-08
- Budget: 6.627.191 Euro (estimated cost)
- Co-financed by the GJU/GSA (50%)

GRAIL Consortium

Project objectives

1. **To achieve a common specification agreed by Users and Industry for the GNSS subsystem for the**

   - Enhanced Odometry application
   - Enhaced ETCS applications (absolute positioning, train integrity, train awakening and cold movement detector)

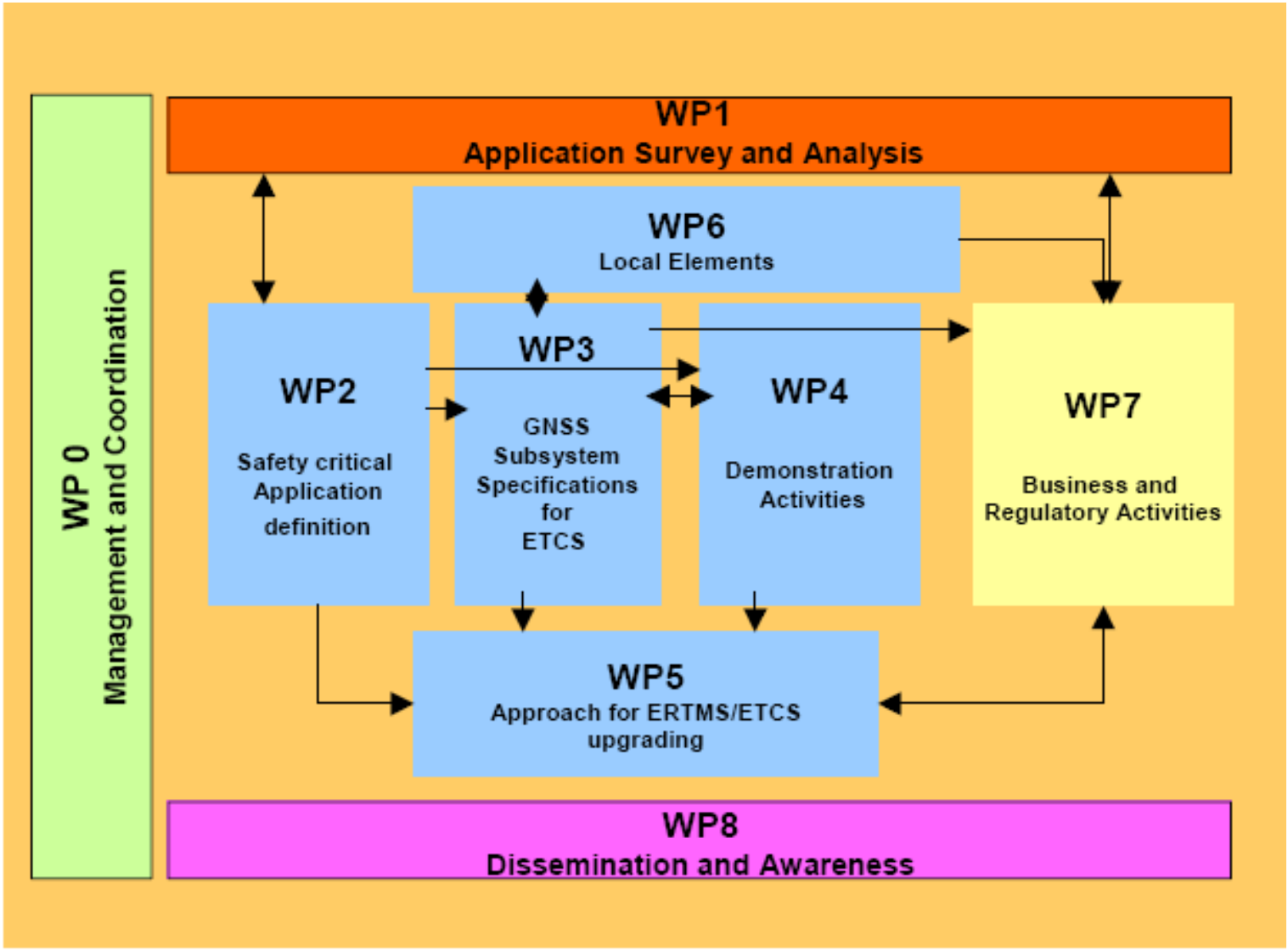
2. **To develop and test a prototype of the GNSS subsystem for the Enhaced Odometry and the Enhanced ETCS applications**

   - Tests in a lab environment (CEDEX)
   - Test in a real ERTMS/ETCS line (MAD-LLE)

3. **To study the complementary aspects**

   - economical issues
   - legal issues
   - development of GNSS local elements specific for railways

Project logic



Current Status

- Achievements
  - Application Survey and Analysis. WP1.1
  - Service Enablers. WP1.2
  - Action Plan. WP1.3
  - Acceptance criteria and Safety Requirements - HAZOPs WP2
  - Legal and Regulatory analysis. WP7.2
  - Definition of a GNSS based **System Requirement Specification**, **Interface Specification** and **Test Specification** for enhanced odometry, train awakening, absolute positioning and train integrity. WP3
  - Review of the specifications.WP3
  - Cost-benefit analysis WP7.1
  - Demonstration test plan. WP4
  - Migration strategies & User's workshops. WP5
  - Local elements. WP6

- On-going activities
  - Safety analysis. WP3.4
  - Demonstration test activities. WP4
  - Legal and Regulatory recommendations. WP7.2
  - Dissemination and awareness. WP8

GNSS Subsystem Specifications

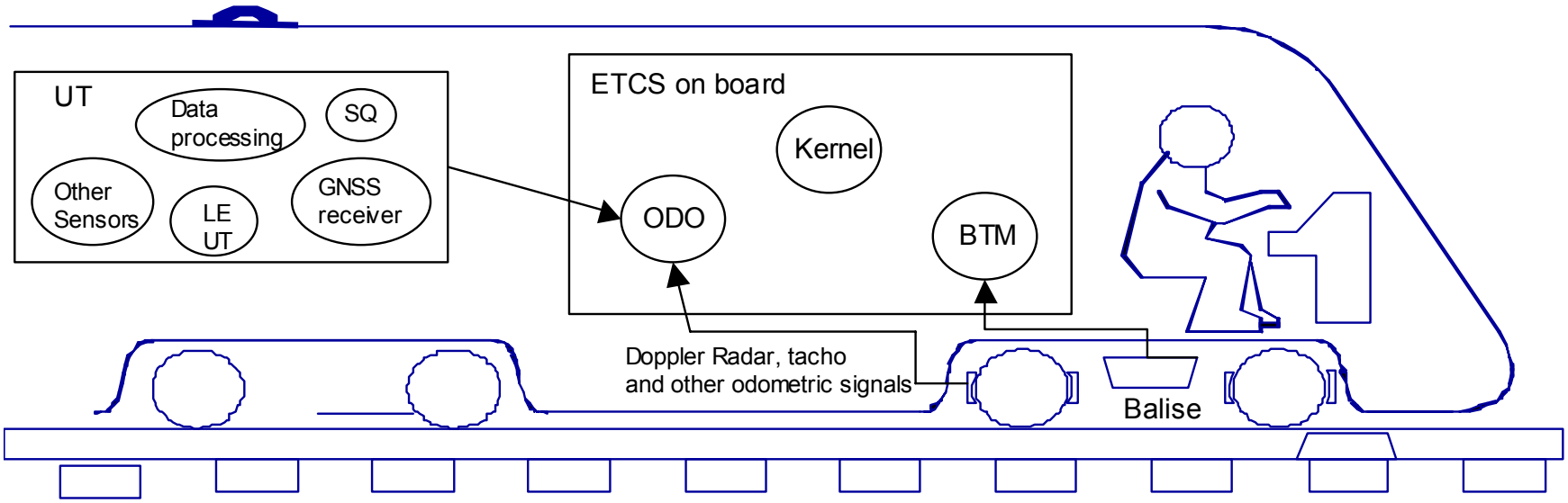
- System Requirement Specification (first draft)
  - Functional description
  - System architecture
  - Requirements at system level (functional, performance)
- ETCS-GNSS Interface specification (first draft)
  - Logical and Physical levels
- Test specification (first draft)
  - Functional and performance tests (in operation)
  - Test tools and reference test architecture (in operation)
- Safety requirements for the GNSS subsystem to allocate SIL to the different modules (on-going)

Enhanced Odometry - Functions

- **Measure position and speed** (along track)
  - To acquire the navigation data
  - To implement a real time data fusion in order to generate odometric information in a common format.
  - To prepare information to be sent in the appropriate format and timing.
  - Time stamping the data from GNSS receiver

- **Data processing and error estimation**:
  - Data fusion (sensor output elaboration, translation of coordinates, etc.)
  - Status determination: Diagnostic and self-test
  - Integrity monitoring of SIS (including Local effects)
  - Compute confidence interval

Enhanced Odometry - Architecture



→ external to the ETCS on-board system
→ used as another sensor
→ independently management from the other sensors information
→ Data fusion from different sensors carried out in ETCS odometry function

The use of other sensors remains optional for the EVC suppliers

Train Awakening and CMD - Functions

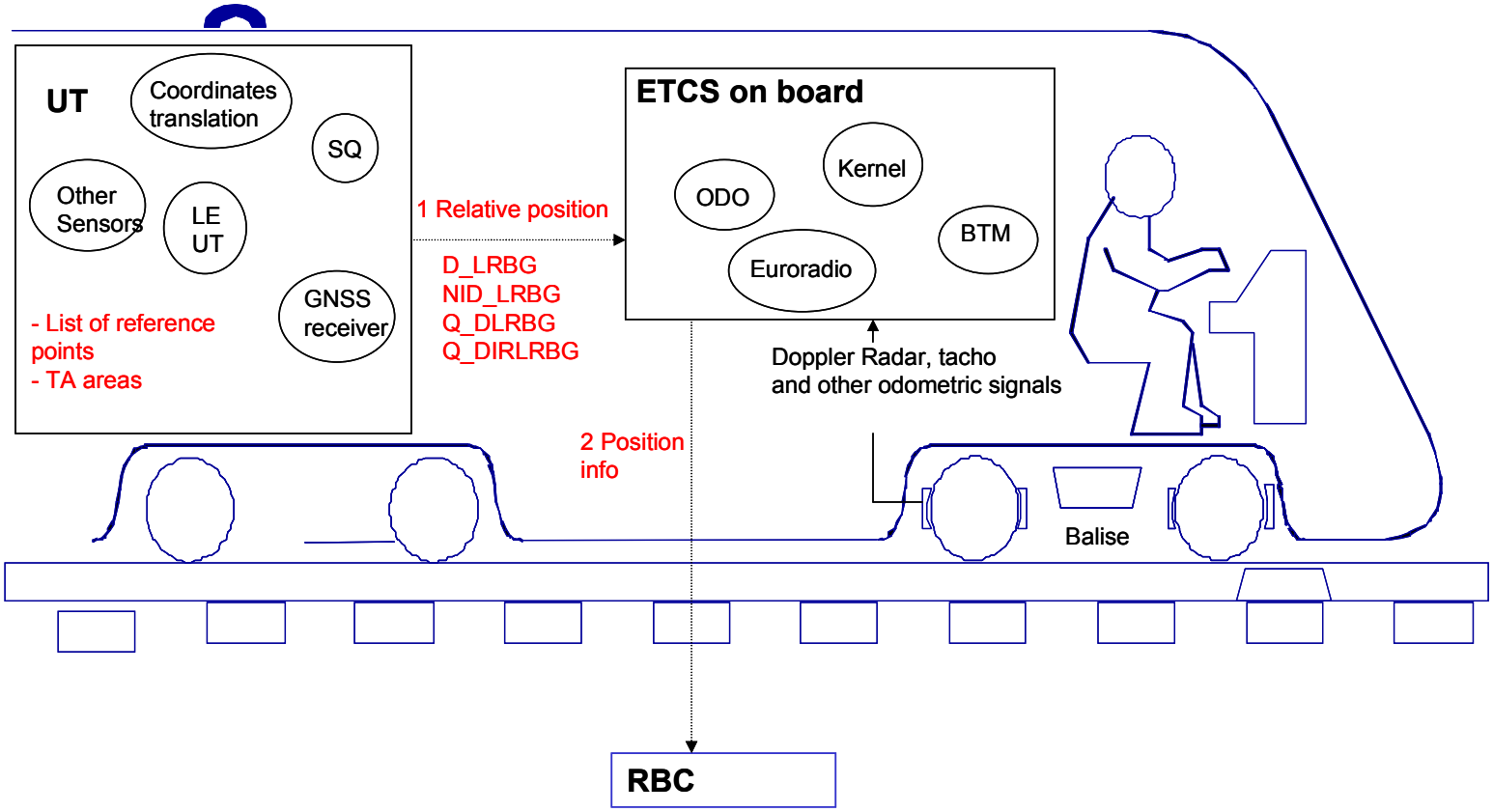
Cold Movement Detection:

- Detection of **train movement** during **No Power** mode (based in the comparison of two absolute positions)
- **Validation of stored data**: During switch-on process, stored data, if any, are validated or not depending whether cold movement has been detected.

Train Awakening:

- Providing valid **RBC ID/telephone number** under request by ERTMS/ETCS on-board equipment (when in L2 and RBC ID/phone no. are unknown or invalid)
- Providing **valid position** under request by ERTMS/ETCS on-board equipment (when location variables are unknown or invalid). These include:
  - Identification of a reference point: It is a reference balise to be used as LRBG for the distance
  - Position of train: This information shall be provided as a distance along the track from LRBG and orientation of position of train with regard to orientation of LRBG
  - Orientation of train: Orientation of train with regard to orientation of LRBG

Train Awakening and CMD - Architecture



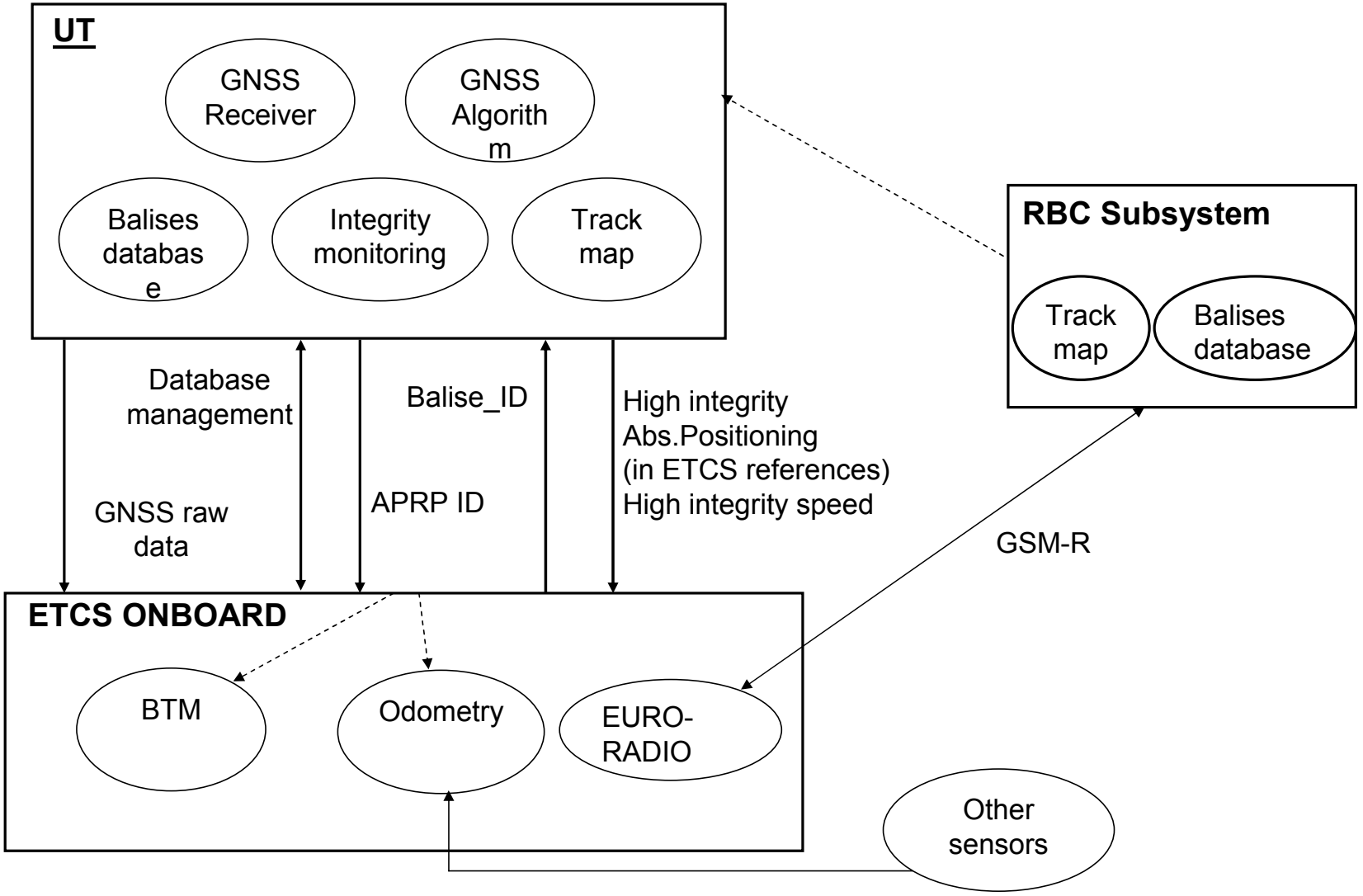
Absolute Positioning - Functions

Approaches: position input to ETCS odometry and input to ETCS on board

Functions:

- **Compute train position:** in terms of travelled distance from the last LRBG or the last APRP and determine the confidence interval on the position corresponding to the required high integrity level.
- **Data translation in ETCS reference:** The positioning data obtained in the GNSS referential will be translated into a travelled distance from the LRBG or the last APRP.
- **Compute train speed:** two level of safety integrity have been defined for speed
- **Compute time:** This function takes SIS in input and provides the Universal Time Coordinated (UTC) in output.
- **Provide position information to ETCS:** sending position code to the ETCS on-board subsystem so that the odometry will make fusion.
- **Integrity Monitoring function:** of the SIS as well as the integrity of the UT itself.
- **Data base management:** monitors the integrity of the database internal to the UT.

Absolute Positioning - Architecture



Train Integrity - Functions

Functions:

- Train integrity assessment
  - Elaborate the TI status (TI ok , TI lost, TI unknown) and safe train length confidence interval
  - Displaying status and providing alarms to train staff (maintenance or info for the driver).
  - Computing and managing Juridical data
  - Providing train's tail red light indication
- Train length confirmation at SoM

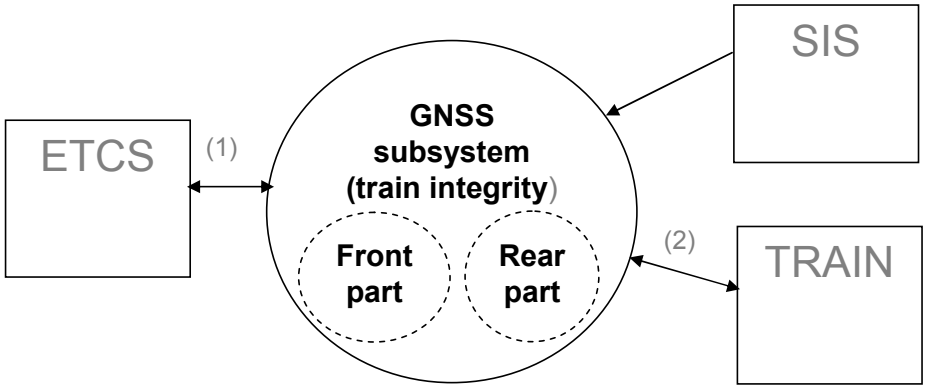
Inputs (ETCS subsystem to GNSS subsystem):

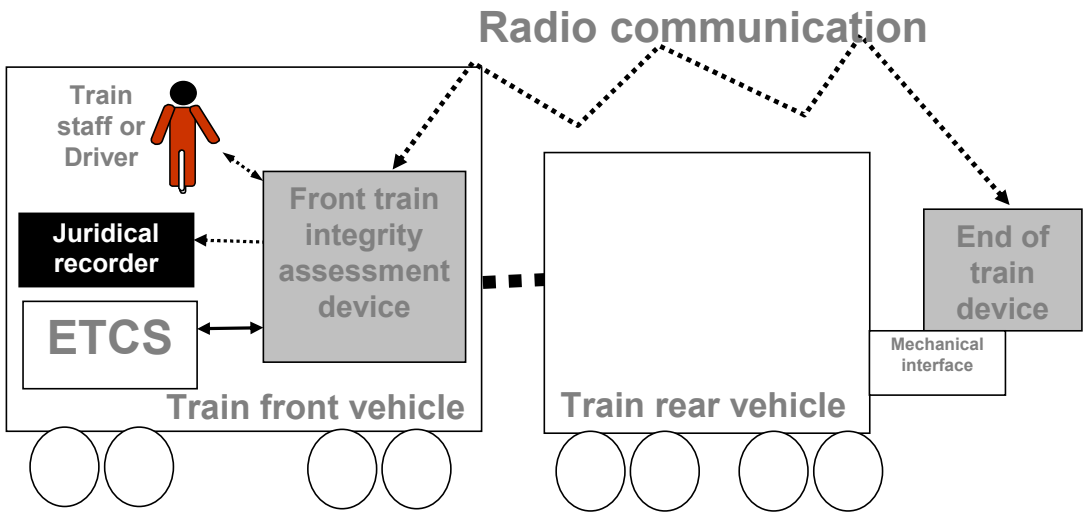
- Trigger to update TI info (if TI is event-driven) or parameters (cycle information,...) – [See output rate requirement] and configurable (TBC)
- Train length

Outputs (GNSS subsystem to ETCS subsystem):

- TI status (ok-train complete, lost-train not complete, Failure state/unknown, TI info unknown)
- Train length confidence interval (referred to the position of the rear of the train)
- Train length confirmation
- Info for the juridical recorder and for train staff

Train Integrity - Architecture





WP3.4 Safety Analysis Activities

- According to CEN/CENELEC and UNISIG ERTMS/ETCS Subset 091
- PHA Specification oriented
- PHA content:
  - Establish for the purpose of the analysis the boundaries of the application system and those to which it interfaces
  - Establish the overall system structure, functions.
  - Obtain the hazards from the earlier HAZOP and complementary analyses, e.g. FTA and FMEA
  - Apply rational systematic and random probability targets
  - Set out safety barriers and SILs

Conclusion and Perspective

- GRAIL is progressing well
- Both railway signalling (all UNISIG companies) and GNSS industry have proved a good co-operation towards a common interest.
- Main on-going activities:
  - Test and Demonstration
  - Finalisation of the Safety Analysis
  - Digital map: Structure and Processes

Thank you!