

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

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M. Meyer zu Hörste, K. Lemmer, A. Urech and M. Jose



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

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

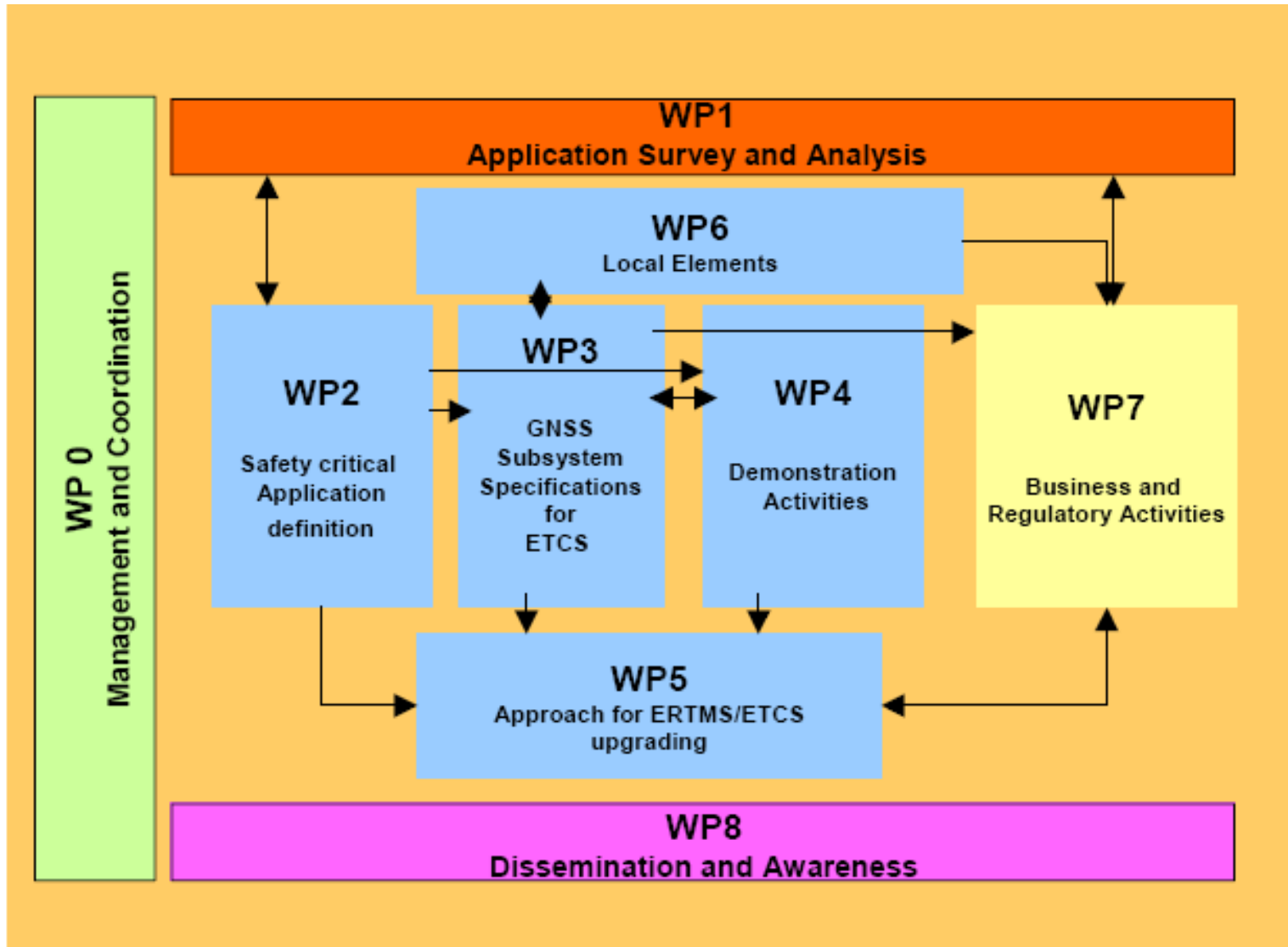
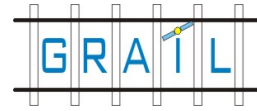
2. To develop and test a prototype of the **GNSS subsystem** for the **Enhanced Odometry** and the **Enhanced ETCS applications**

- ▶ 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



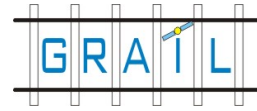
Current Status



- ▶ 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



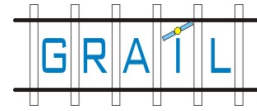
- ▶ System Requirement Specification (first draft)
 - Functional description
 - System architecture
 - Requirements at system level (functional, performance)

- ▶ 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)

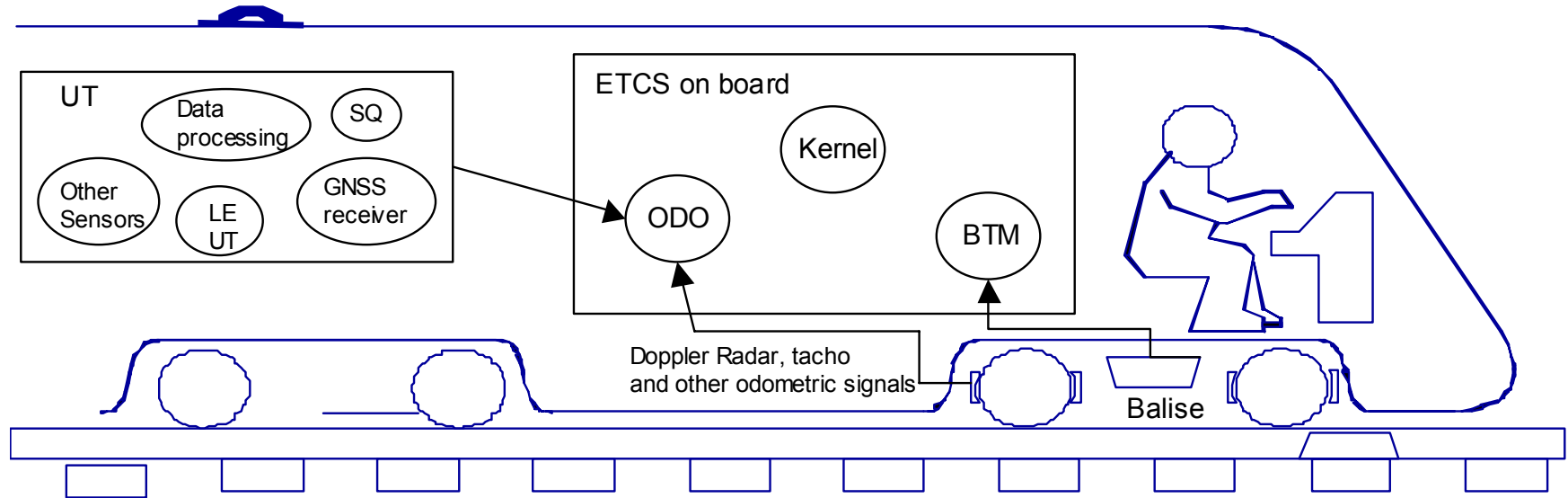
Enhanced Odometry - Functions



- **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



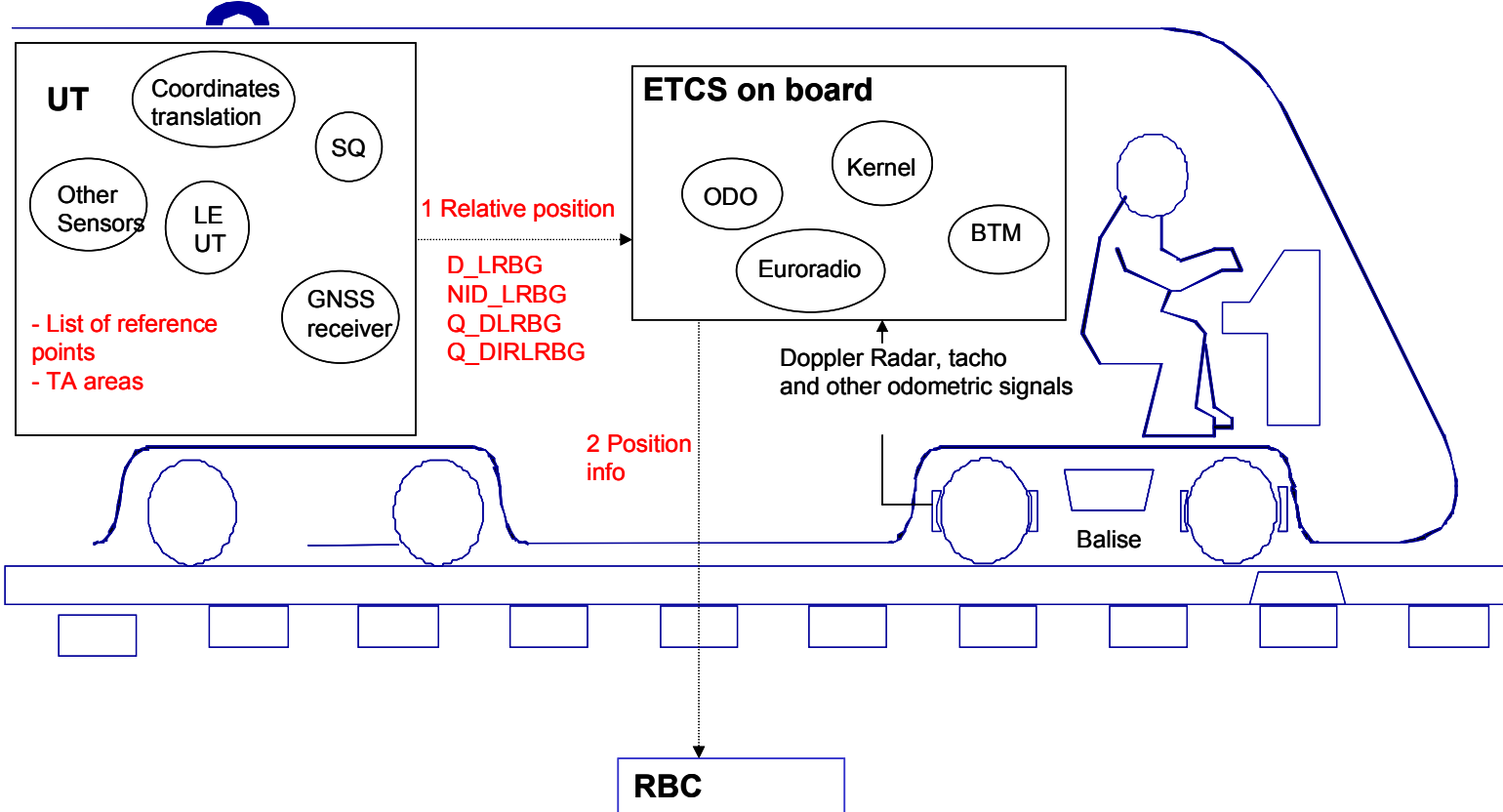
Cold Movement Detection:

- 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

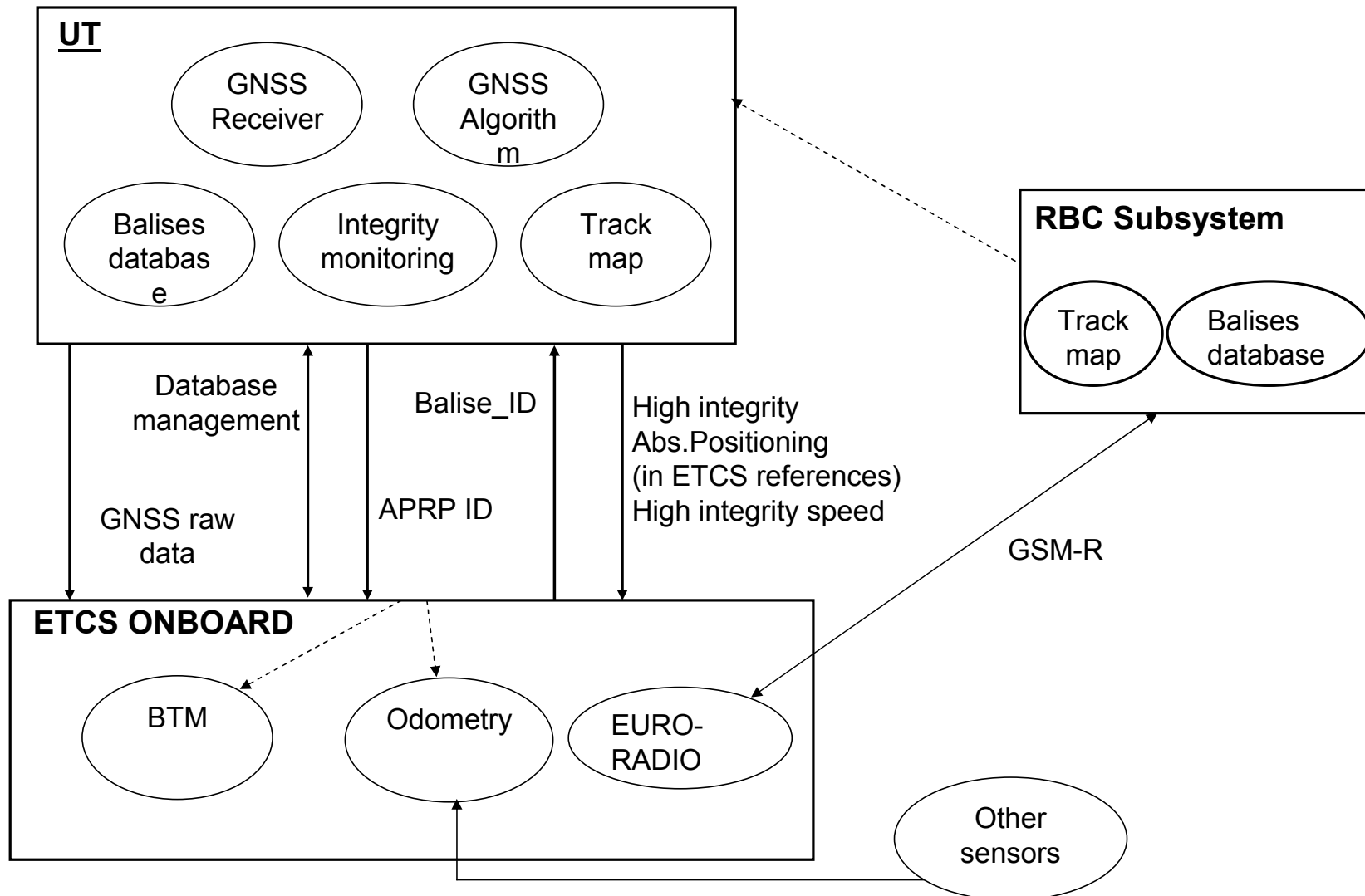
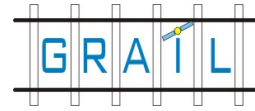


Approaches: position input to ETCS odometry and input to ETCS on board

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

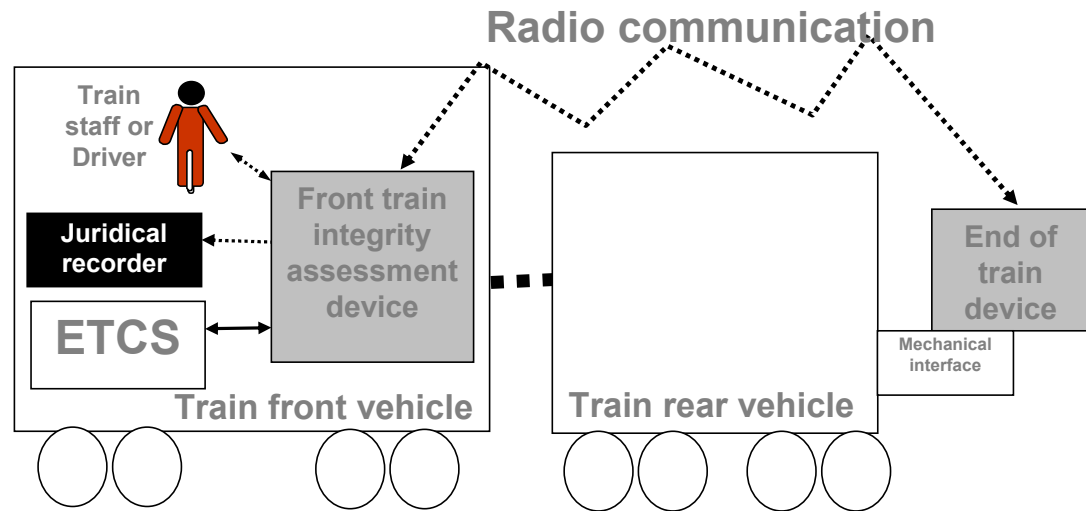
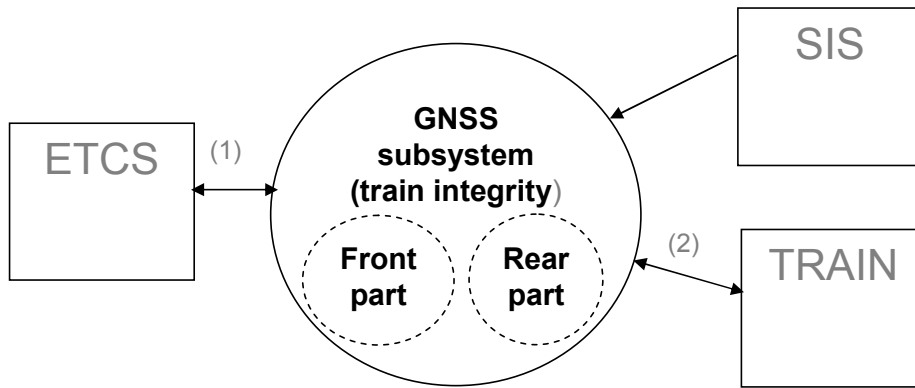
Inputs (ETCS subsystem to GNSS subsystem):

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

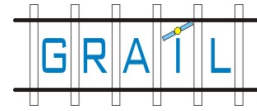
Outputs (GNSS subsystem to ETCS subsystem):

- 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!