STARS
SATELLITE TECHNOLOGY FOR ADVANCED RAILWAY SIGNALLING

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InnoTrans

STARS: Satellite Technology for Advanced Railway Signalling

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Bernhard Stamm – Technical Leader (SIEMENS)

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European
Global Navigation
Satellite Systems
Agency

SATELLITE NAVIGATION IN RAIL

Daniel Lopour
Market Development Officer

This presentation can be interpreted only together with the oral comments accompanying it

European GNSS Agency (GSA) mission

Support European Union objectives and achieve the highest return on European GNSS (Global navigation satellite systems) investment, in terms of benefits to users and economic growth and competitiveness

- Staff: c.a. **135**
- Nationalities: **21**
- Headquarters: **Prague**
- Other Locations:
  - St Germain en Laye
  - Swanwick
  - Torrejon

What is Europen GNSS?

‘It’s there, use it’

Where we want to be
how to get there

Where we want to be

How to get there

EGNSS adopted as a part of future evolutions of **ERTMS and for train positioning subsystem**

Support UNISIG in their effort to define industry requirements

Coordinate relevant R&D activities together with key funding and standardization bodies (ERA, Shift2Rail, ESA)

Cooperate with railway associations and EC to **foster the role of EGNSS in the evolutions of ERTMS standard and in the standardization and certification of EGNSS receivers**

Multi-constellation use of GNSS for multimodal logistics applications

Support the establishment of EGNSS enabled asset and cargo tracking solutions

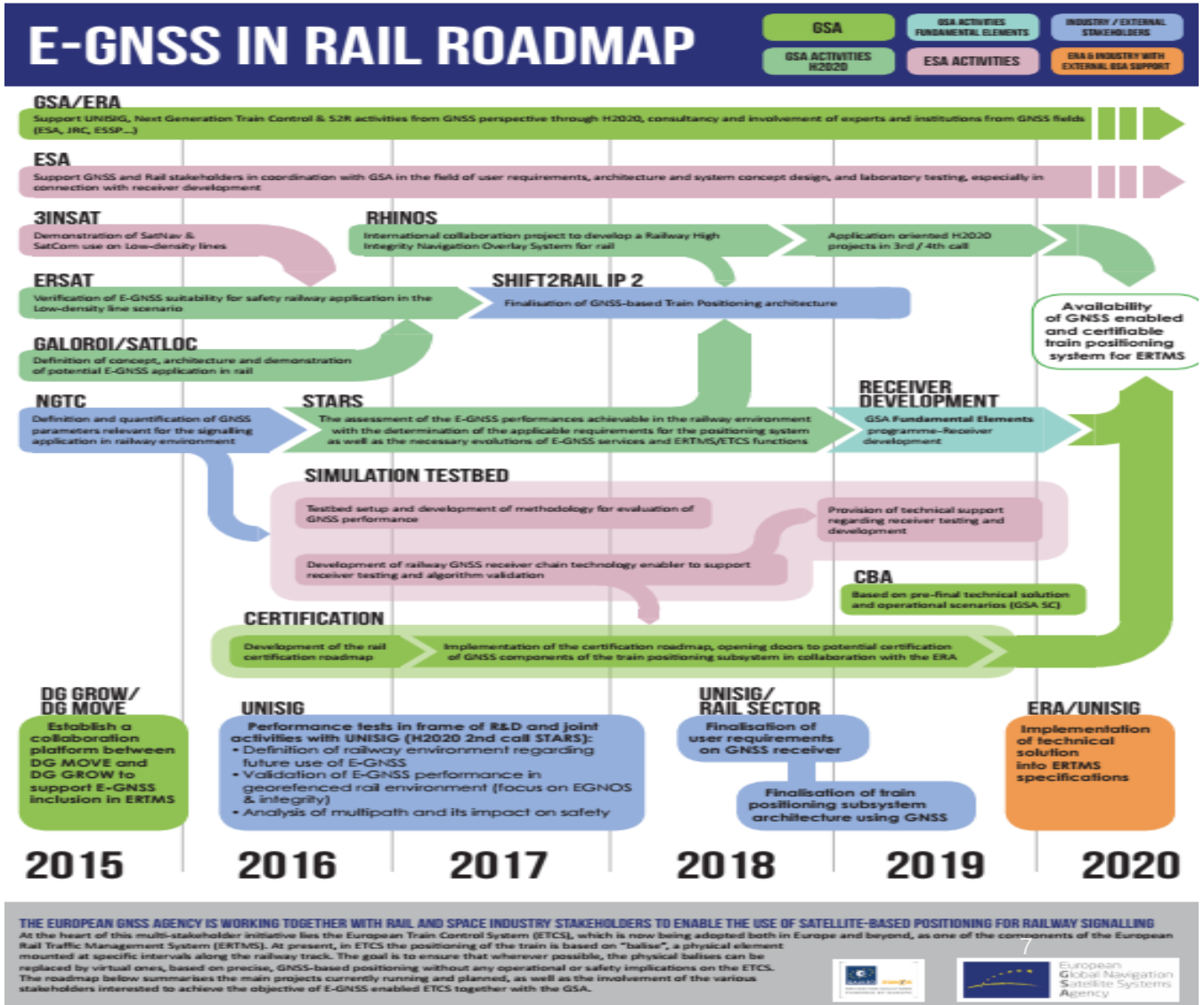
E-GNSS in Rail – Roadmap

Roadmap was developed with active involvement of main stakeholders interested in European GNSS potential in railway signalling applications is leading towards inclusion of E-GNSS into ERTMS

Stakeholders currently involved in the process are:

- EC (DG MOVE, DG GROW)
- ERA
- UNIFE
- UNISIG
- CER
- ESA
- ESSP

Roadmap is available for download at the GSA Rail segment website



The GSA's managed funding mechanisms promote the development of EGNSS solutions

Aims to foster adoption of Galileo and EGNOS mostly via content and application development

Fundamental Elements projects focus on fostering the development of innovative Galileo- and EGNOS-enabled receivers, antennas and chipsets technologies.

Collaboration and information exchange between projects in H2020 and Shift2Rail is a prerequisite to speed up the delivery of necessary R&D results leading to real applications

http://www.gsa.europa.eu/r-d/gnss-r-d-programmes

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Thank you

Introductory remarks

GNSS applications in Railways are become more and more frequent, but so far the **highest growth** has been in **non-safety related applications** such as:

- Passenger information systems
- Freight logistic
- Infrastructure data collection

GNSS has a long history of safety critical applications in aviation, but this cannot be used as a basis for similar applications in the railway domain:

- **The railway environment for GNSS is significantly more challenging**
- **Certification procedures and related requirements are totally different**

To push GNSS applications into safety applications, a much **better understanding of GNSS behavior in the railway environment** is needed:

- This is especially true for standardized applications, such as ERTMS

Key project objectives

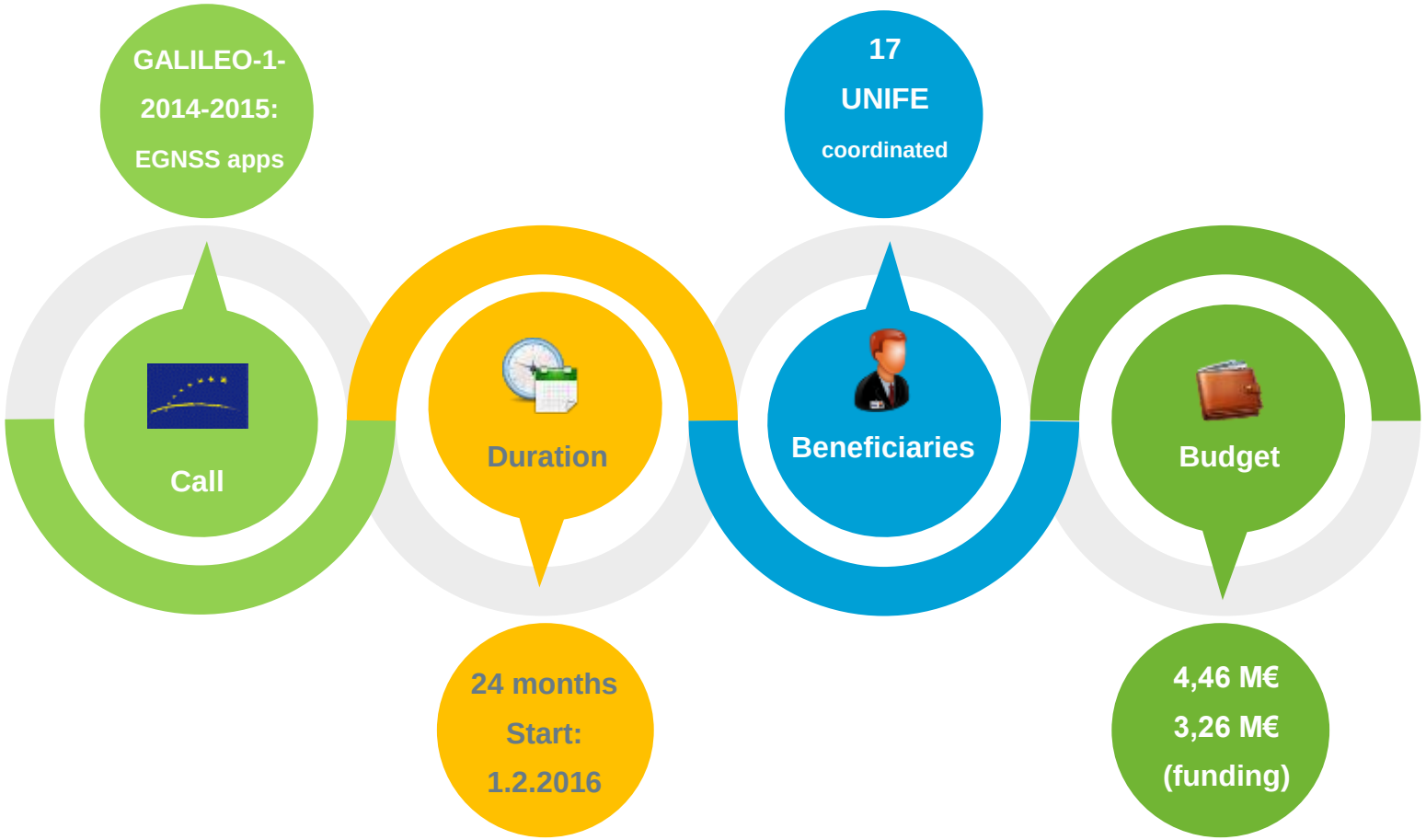
To develop a **universal approach to predict the achievable GNSS performance in a railway environment**, especially for safety critical applications within ERTMS and to determine the necessary evolution of ETCS to include GNSS services

To **quantify the economic benefits** through reduction of cost, which will increase market appeal of ERTMS

Expected results

- **To predict performance** in the railway environment in terms of accuracy, availability and safety
- **To achieve interoperability** between equipment of different suppliers
- To **allow inclusion of GNSS into ERTMS**

Basic figures about the STARS project



STARS Project Consortium

STARS Coordinator

unife
THE EUROPEAN RAIL INDUSTRY

Signaling Companies

SIEMENS
Ansaldo STS
A Hitachi Group Company
ALSTOM
THALES
BOMBARDIER
the evolution of mobility
AŽD
PRAHA

Space Industry

ThalesAlenia
A Thales / Finmeccanica Company
Space
TELESPAZIO
A Finmeccanica / Thales Company

Consultancy & Specific Expertise

ineco
RadioLabs
D'APPOLONIA

Research Centers

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CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES - INVESTIGACION + DESARROLLO
Technische Universität Braunschweig
Università Commerciale Luigi Bocconi
UNIVERSITY OF WEST BOHEMIA

Overall structure of the STARS work-plan

GNSS Measurement Campaign

- Preparation of campaign
  - Methodology, Procedures, Identification of the suitable lines
- Field measurement, data collection

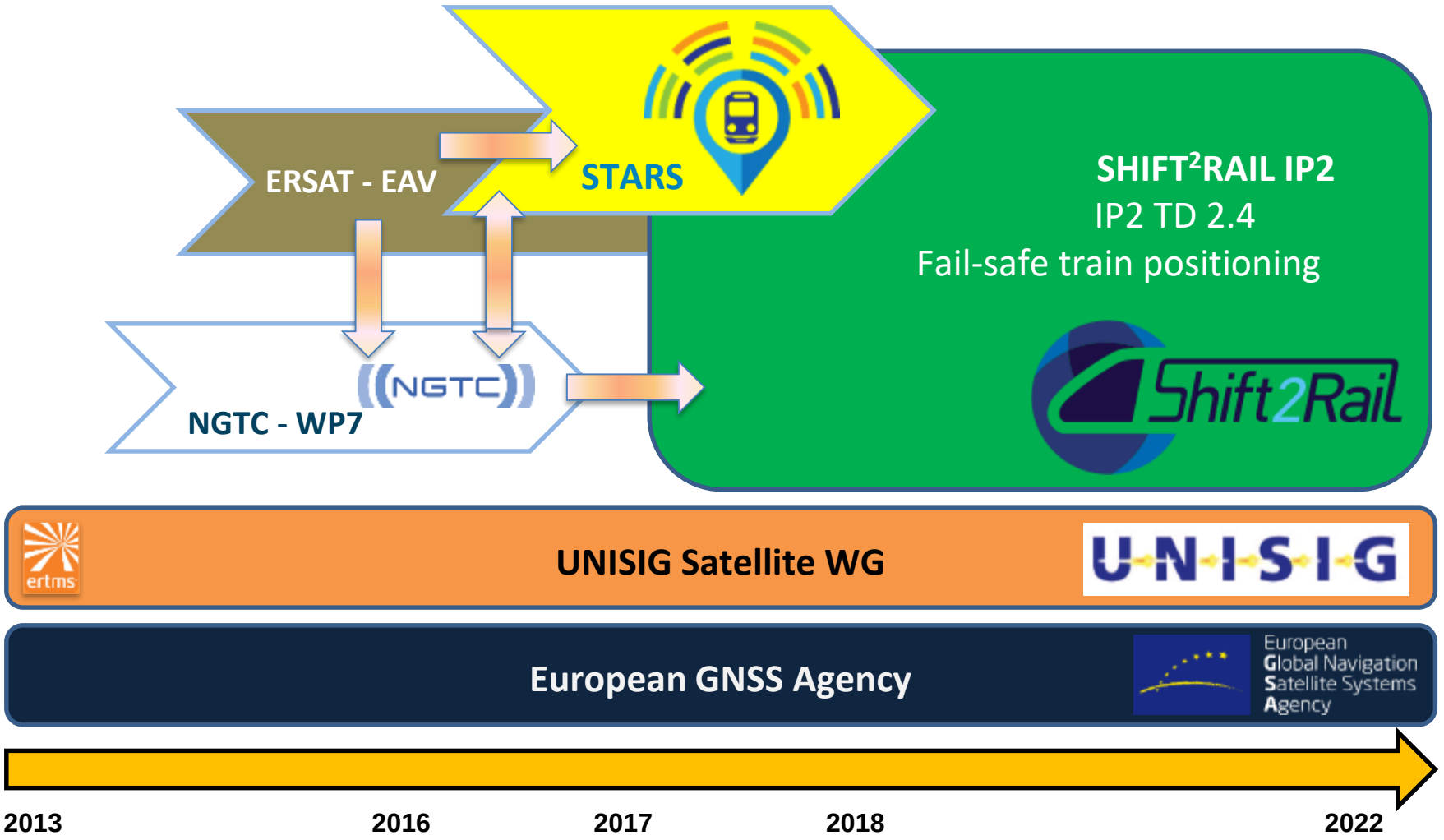
GNSS Data Analyses and Performance Evaluation

- Data post-processing, Railway environment characterization
- EGNSS services evolution, EGNSS performances assessment in rail environment

GNSS Economic Evaluation

- Cost Benefit & Impact Assessment
- EGNSS / ERTMS evolution roadmap
- Implementation plan

Major links between STARS and other projects / initiatives



Why use GNSS with ETCS

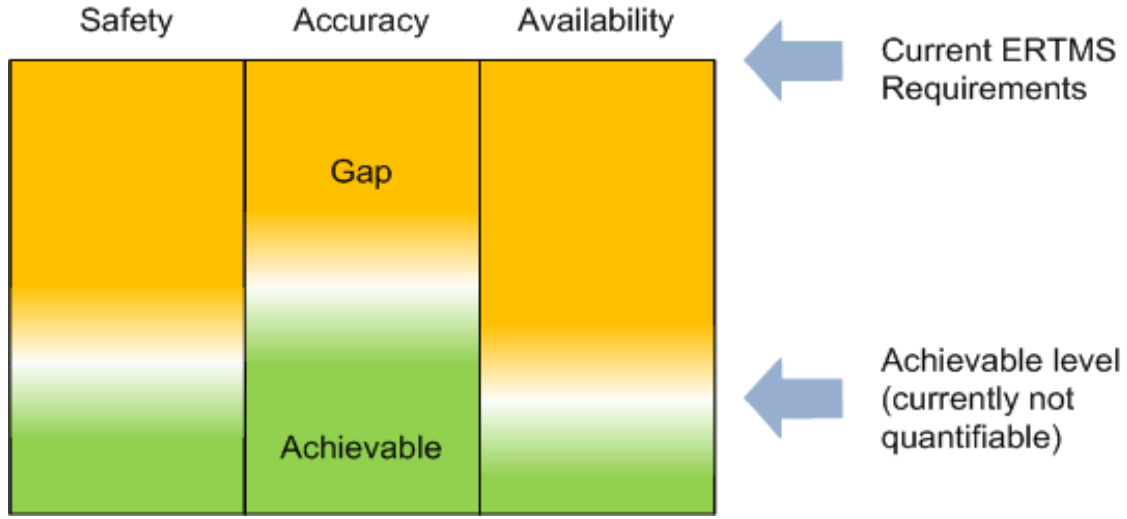
- ETCS is a train control system which provides the driver with information on how fast and until where he is allowed to drive
- ETCS also supervises the movement of the train and prevents the driver from exceeding the indicated limits
- ETCS uses balises in the track as location references for the safe localisation of trains and for communicating movement authorities
- Eliminating those balises would be beneficial in many applications, not only in lowering the cost of signalling systems, but also to increases flexibility, availability, improve maintainability and reduce exposure to theft, vandalism etc.
- Higher accuracy might be achieved, as repositioning with balises is only possible every 1-2 km if cost shall be reasonable

Challenges of using GNSS on Railway Lines

- The main technical challenges for using GNSS on railway lines lie in the environment, which differs significantly from the one in aviation and marine applications
- Major differenced are
  - limited and continuously changing visibility of satellite
  - signal attenuation due to e.g. foliage
  - electromagnetic interference, especially from traction systems but also from nearby sources
  - significant multipath signals
- In some locations, such as in urban areas, multiple of these effects might appear at the same time

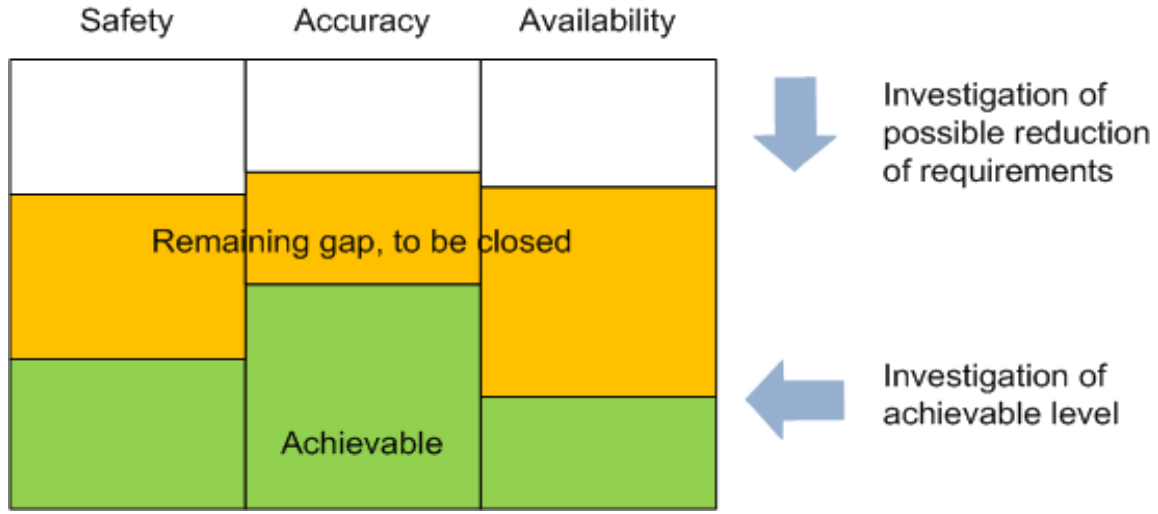
Performance Requirements

- The requirements on train positioning in ETCS are well defined. It is also understood that these requirements can not be met by GNSS alone at every location along railway lines
- It is however not clear how big the gap is in regards to safety, accuracy and coverage between what GNSS can provide and what is required by the ETCS application
- It is also not fully understood in detail in which environments performance is degraded to which extent
- Whatever gap will have to be closed by other means, such as e.g. other sensors or also route maps
- Also predictability is essential, in order to decide where GNSS can be used and where other means need to be applied for safe train localisation



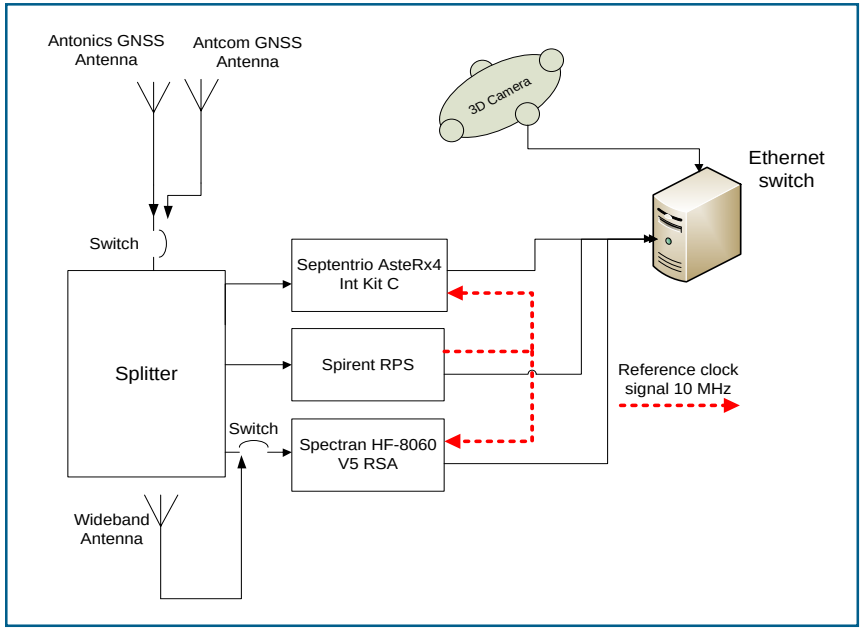
Performance Requirements

- UNISIG is currently investigating to which extent the overall requirements can be reduced, e.g. by better analysis of individual operating scenarios or by limiting the use of satellite positioning to certain applications
- The question remains however how much can be contributed by a satellite navigation system to fulfill the application requirements
- For that purpose the STARS project has been set up. It's field measurement campaign and subsequent data analysis are set up to close this gap
- The contribution of EGNOS is also being investigated, including how it is best integrated into ETCS



Measurement campaign

- Key element of the STARS project is a field measurement campaign to collect GNSS data, which is then being analysed to identify and quantify possible local effects which have an influence on GNSS performance, such as:
  - Multipath signal propagation
  - Electromagnetic Interference
  - Reduced satellite visibility
- Prior to the campaign techniques have been assessed how to identified these phenomena, which resulted in a measurement setup that collects the necessary signals
- A so called Ground Truth has also been defined, to achieve a very accurate train position to which GNSS can be compared



Measurement campaign

- Measurements will be performed in the Czech Republic, in Italy and in Switzerland in order to get data from different environments
- Measurements will be performed with identical equipment and setups, to make the results from the three sites comparable
- Analysis of the collected data from all three sites will be performed in a joint work package
- Measurements are scheduled to start later in 2016 and to last through most of 2017

Next steps in the project

- Parallel to the preparation of the measurement campaign the data analysis procedures and tools are being prepared
- Large volumes of data will be collected, which will have to be managed during analysis
- Data analysis is scheduled to start as soon as field data is available
- In parallel the possible contributions of EGNOS are being studied, both in regards to accuracy and safety
- An economical analysis of the benefits of GNSS usage is also being performed

Achieving the key project objectives

Expected results

- ✓ **To predict performance** in the railway environment in terms of accuracy, availability and safety
- ✓ **To achieve interoperability** between equipment of different suppliers
- ✓ To **allow inclusion of GNSS into ERTMS**

- Preparation of measurement ongoing, with measurements to start still in 2016
- Analysing of data under preparation, to start early 2017 as soon as data is available
- Investigation of inclusion of EGNOS started
- Quantification of the economic benefits started
- Project on track to deliver promised results

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Thank you for your attention!

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European Global Navigation Satellite Systems Agency

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