Institute of
Automatic Control

RWTH AACHEN UNIVERSITY

Potential of a Galileo Test Environment for Rail Applications

ENC GNSS 2010, Braunschweig

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Outline

railGATE – Introduction

railGATE

- is a test environment for Galileo-based railway applications
- is currently being built and will be operational in autumn 2011
- complements four other GATEs
- is located at the Siemens Test- and Validation Center

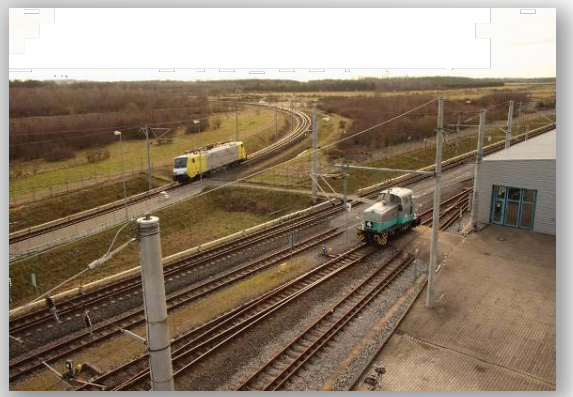
GATEs in Germany © DLR

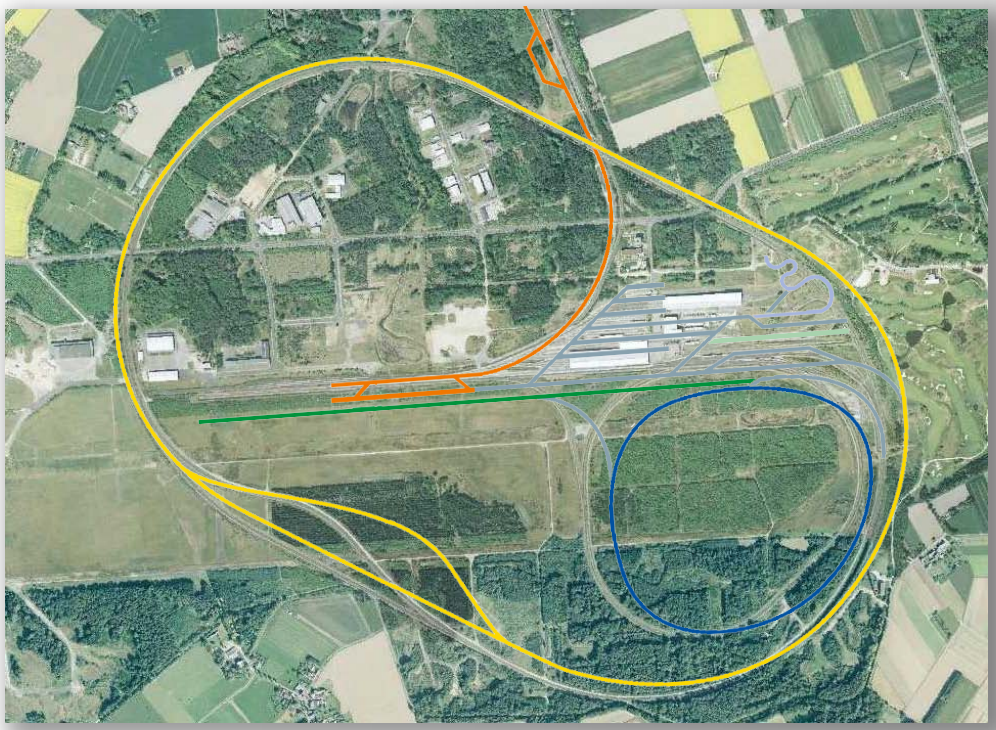
Siemens Test and Validation Center © Siemens

Sponsored by the Space Agency of the German Aerospace Centre (DLR) with funding by the Federal Ministry of Economics and Technology, in compliance with a resolution of the German Parliament (project/grant no. 50 NA 0902).

railGATE – Test- and Validationcenter

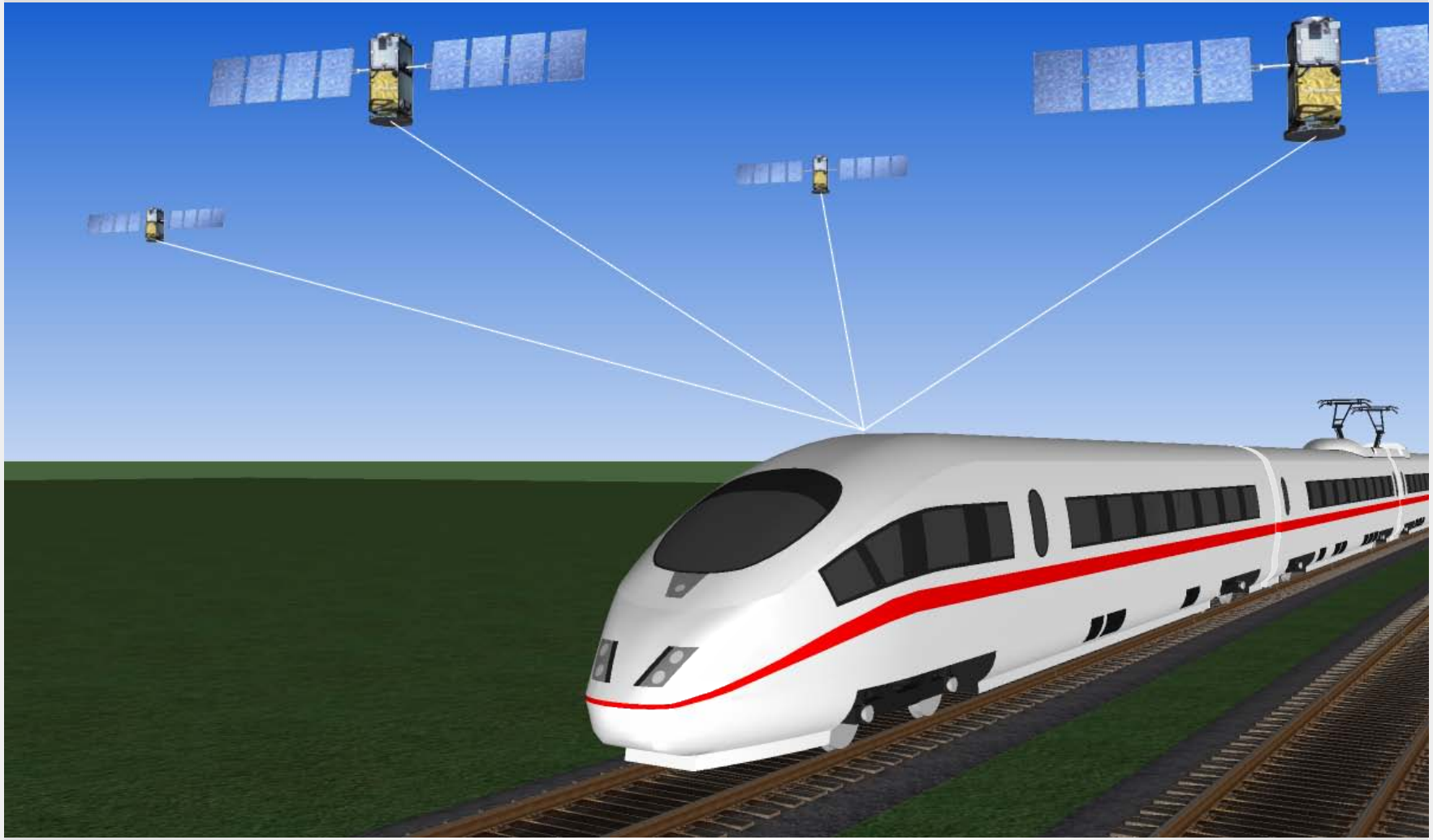
- in Wegberg-Wildenrath near Aachen
- close cooperation between RWTH Aachen University and Siemens
- test center for railways, railway systems and components
- ideal environment for tests
- 28 km of rails



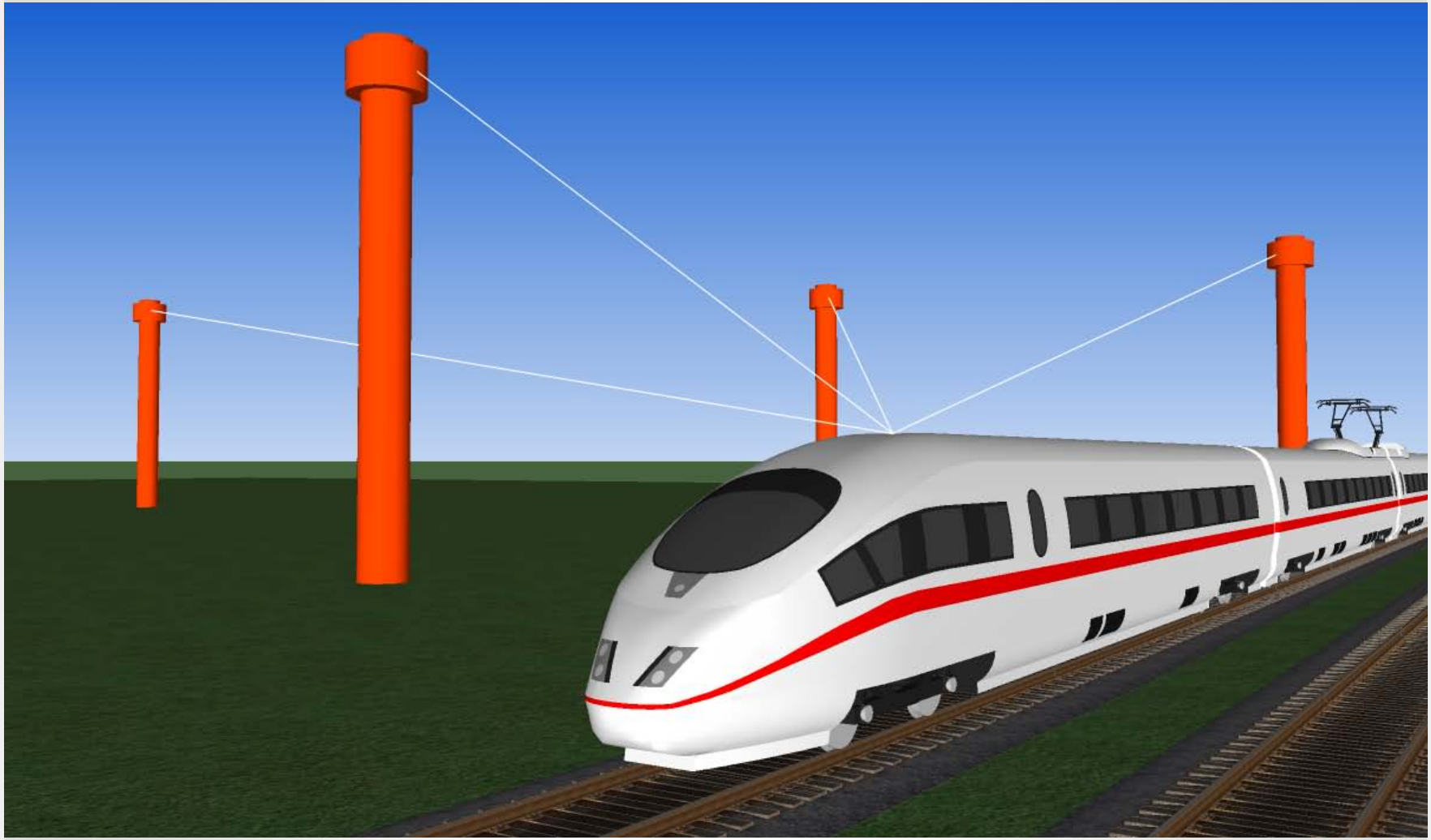


Sources: Siemens, tim-online.nrw.de

railGATE – Pseudolite working principle



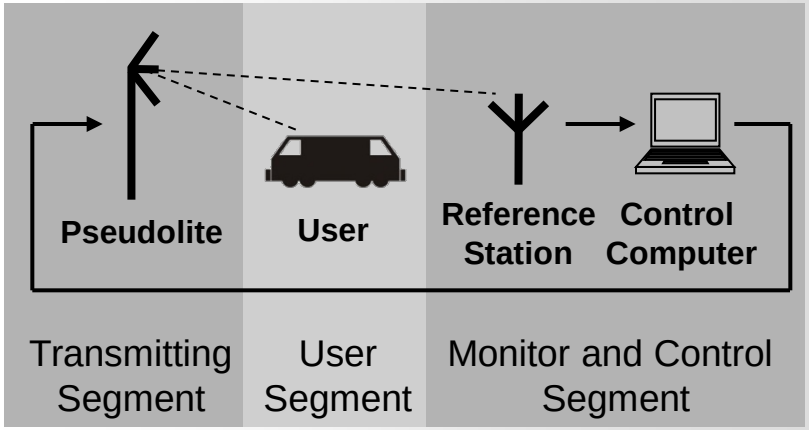
railGATE – Pseudolite working principle



railGATE

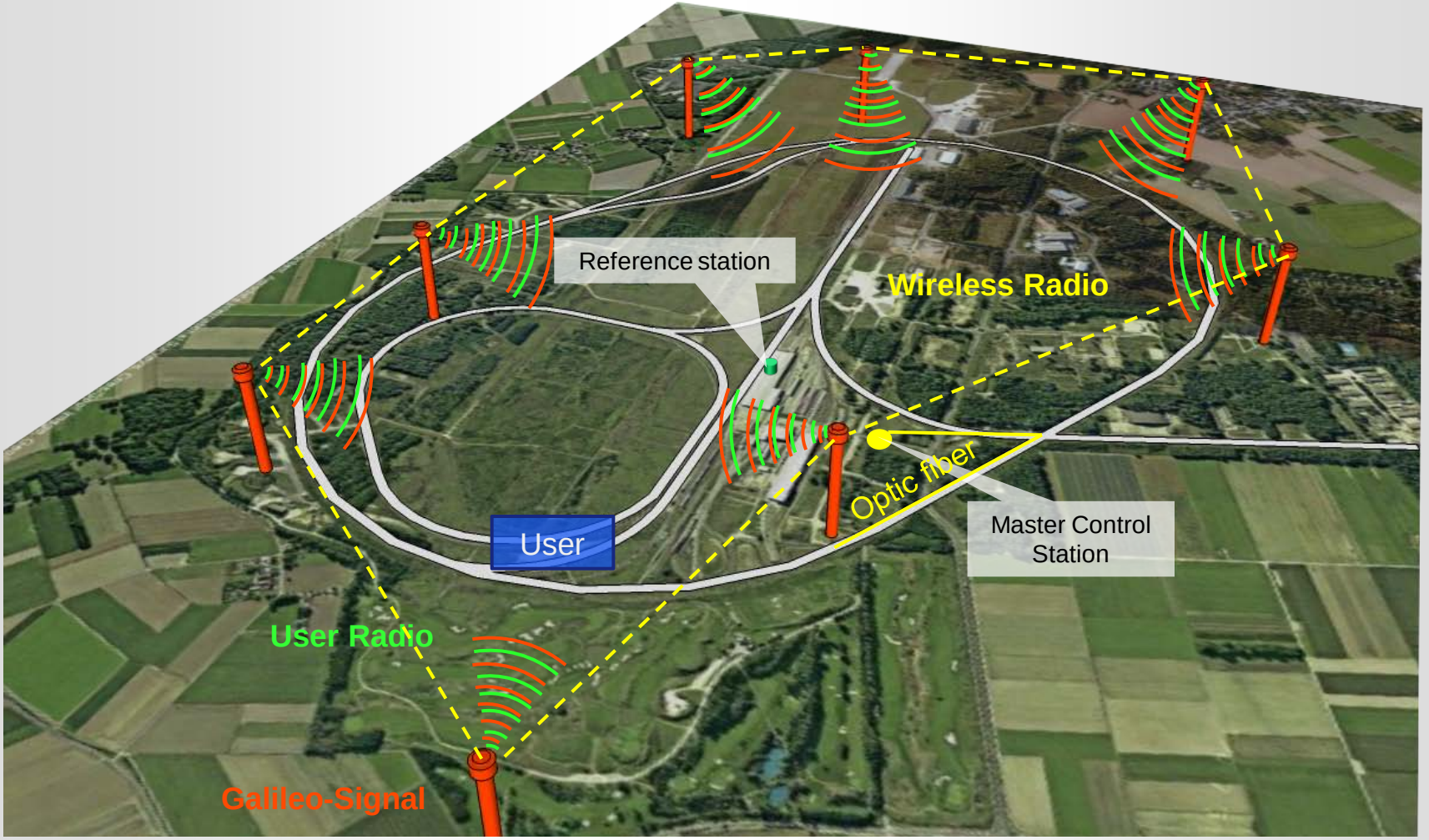
- uses eight pseudolites to emulate Galileo signals
- allows the precise positioning in the user segment
- allows the transmission of arbitrary signal content
- allows extensive data recording and analysis in the monitor and control segment
- allows the reproducible generation of various usage scenarios

Testbed with pseudolites



System components

railGATE – System components



railGATE – Projected system properties

Modes of Operation

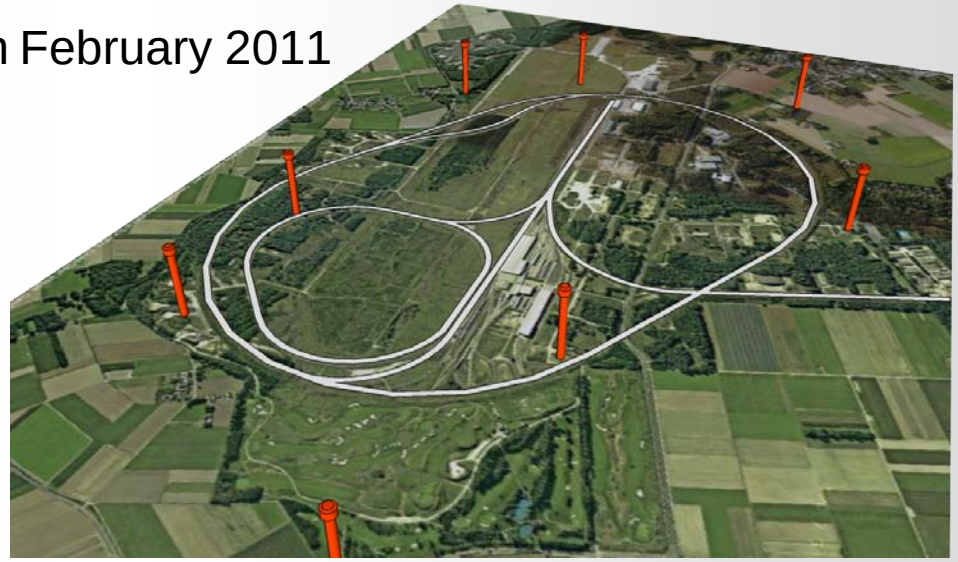
- Base Mode: exclusive use of pseudolite signals
  → Accuracy at least 2.7 m
- Assisted Mode: Data of the reference station via a data link
  → Accuracy at least 0.8 m

Constellations

- Pseudolites only (2D only)
- Pseudolites + Galileo
- Pseudolites + Galileo + EGNOS
- Pseudoliten + GPS
- Pseudoliten + GPS + EGNOS
- Pseudoliten + GPS + Galileo
- Pseudoliten + GPS + Galileo + EGNOS

Construction of railGATE

- Construction of poles
- Start of system implementation February 2011
- First test in July 2011
- Full Operation Capability
  autumn 2011



Automatic train formation

Goal

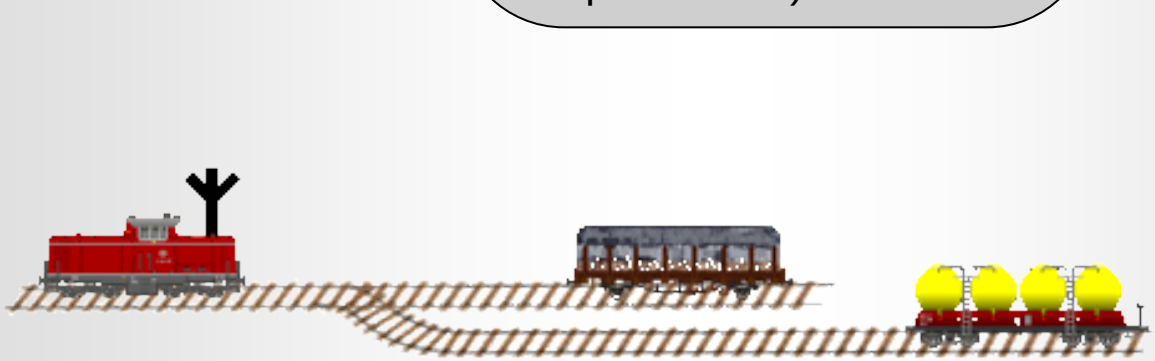
- automatic train marshalling
- time efficiency
- improved safety
- horizontal marshalling yards

Technical realization

- Disposition system
- Onboard-unit on the locomotive
- Galileo-based positioning and digital map
- additional sensors (INS, wheel incremental encoder, speed radar)

Consequence

System which needs comprehensive validation



Validation using railGATE

validation of regular functionality

- GNSS-based positioning works correctly

validation of fail safe functionality in case of malfunction of GNSS-based positioning

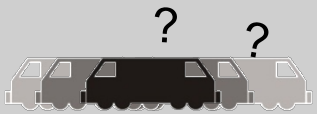
Use-cases simulating errors:

- **Deterioration of positioning accuracy** (2D Gaussian distribution e.g.)
- **„Tunnel Simulation“**
- **Real Shadowing scenartio** – caused by infrastructure or natural obstacles

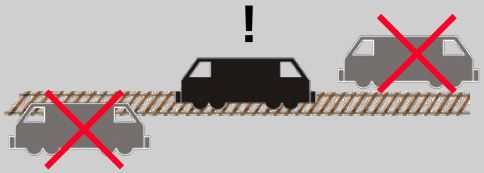
Validation of automated train formation – Examples

Use case 1

The satellite-based accuracy deteriorates…



… but the error is estimated based on the digital map and compensated.



Use case 2

Failure of acceleration sensor: An actual buffer contact is not detected, the locomotive keeps pushing …

The error is detected by comparsion of GNSS-based calculated vehicle speed and wheel incremental encoder based vehicle speed.

Summary

railGATE

- provide an environment for tests of system functions
- testing GNSS-based systems from ideal to worst-case conditions
- offer efficient validation of complex systems

Automated train formation

- automation of standard manoeuvres
- test of the functionality with railGATE

Outlook

- Build up in progress
- Test operation starts in July 2011
- Full operation capability end of 2011
- offer a platform for industrial or academic interested parties
- offer a reference environment for the certification of applications

Thank you for your attention!

www.railgate.de