Testing of Rail Applications for the European Satellite Navigation System GALILEO at the DLR – Coupling of Static and Dynamic Testing

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Outline

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➤ The Railway Specific Laboratory RailSiTe®
➤ The Road-Rail-Vehicle RailDriVE®
➤ Combination of RailSiTe® and RailDriVE®
➤ Conclusion
Introduction and Motivation

- Galileo: important solution for rail applications, esp. safety-critical ones

- Before setting the Galileo-system into operation a certification process is necessary
  - Validation of the overall system and parts of it
  - Easiest way of testing: validation by a static test-period in a laboratory, e.g. in the railway specific laboratory of the DLR (RailSiTe®)

- Dynamic position information cannot be provided by the RailSiTe® but e.g. by a road-rail vehicle which is coupled to the RailSiTe®
RailSiTe® – Rail Simulation and Testing
Railway Specific Laboratory

- Realization of a modular concept for railway simulation environments

- Ability to analyse, test and validate systems, subsystems and components of train control equipment

- Simulation of the complete chain from the interlocking via the trackside, the onboard system and the involved train control system up to the driver interaction
Architecture of the RailSiTe®

- Track side
- Distributed real time simulation
- Air gap
- Onboard
RailDriVE®
Extension of the Principle of the RailSiTe®

- For some sensors the simulation in a lab is possible

- For others a reasonable realistic representation in the lab using simulation would be much more complex

- Therefore a suitable extension of the RailSiTe® is a test bed which
  - moves on real tracks and
  - captures data flows from real sensors in a real environment

- This experimental vehicle is called RailDriVE®
RailDriVE®
Rail Driving and Validation Environment

- GSM
- GPS / Galileo
- Video Camera
- Data Logger
- Fusion Rack
- Preprocessing Rack
- Inertial System
- RFID-Antenna
- Radar Sensor
- Odometer
- Eddy-current-sensor
### RailDriVE®
Some of the Sensors for Position Determination

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Measurement Parameters</th>
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<tbody>
<tr>
<td>GPS / Galileo</td>
<td>Abs. position, time, velocity</td>
</tr>
<tr>
<td>Eddy current sensor</td>
<td>Abs. position at discrete points, distance, driving direction</td>
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<tr>
<td>Doppler radar</td>
<td>Velocity, driving direction</td>
</tr>
<tr>
<td>Rotational Speed Sensor/Odometer</td>
<td>Number of wheel rotations, distance</td>
</tr>
<tr>
<td>Inertial measurement unit</td>
<td>Acceleration, angular speed</td>
</tr>
<tr>
<td>Other sensors may be installed</td>
<td>if required</td>
</tr>
</tbody>
</table>
Combination of RailSiTe® and RailDriVE®
Features of static and mobile laboratory equipment

RailSiTe®:
+ can deliver perfectly reproducible test conditions
– cannot generate dynamic position information

RailDriVE®:
+ dynamic position information is available
– cannot perform reproducible tests

Coupling of the two labs seems appropriate for performing certification tests of applications of the Galileo system for the railways

Real-time input of the data into the RailSiTe® is planned
Combination of RailSiTe® and RailDriVE®
Equipment Setup for Application Tests

Distributed real time simulation
Air gap
Track side
Onboard
Galileo application under test

Position Information

RailDriVE®
RailSiTe®
Combination of RailSiTe® and RailDriVE®

- Tests under ideal laboratory conditions with real dynamic position information and Galileo signals

- Compatibility of the application with the Galileo specifications and regulations

- Further tests with generic test sequences for the certification process of different applications
Combination of RailSiTe® and RailDriVE®
Testing of Several Features of Galileo Applications

- Reaction of the application

- Time to alarm in the case of
  - Divergences between real and estimated position of the vehicle (caused by shading or mirroring)
  - Faulty integrity of the signal in space
  - Loss of the signal in space or
  - An insufficient number of satellites
Conclusion

- A method for the validation and certification of different railway applications using the new Galileo system is presented.

- The combination of a static and a dynamic laboratory:
  - allows ideal conditions for reproducible, static laboratory tests
  - offers the real dynamic position information necessary for navigational tests

- The test equipment can be used for validation and certification of different railway applications using the new Galileo system.

- First attempts will take place in the second half of this year by running the RailDriVE® on tracks in and near Braunschweig.
Thank you for your attention!