Safe GNSS/Inertial Positioning for Highly Automated Driving

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Driving is ...

- Freedom
- Independence
- Fun to drive
- Mobility
- Infinite space
Are you really sure ....

... that you ALWAYS want to drive on your own?
Automation levels

- **Level 0**: Driver only
  - full control
  - e.g. Adaptive Cruise Control, lane keeping

- **Level 1**: Driver assistance
  - “feet off”
  - partial automation
  - e.g. Traffic jam, highway, park maneuver assist

- **Level 2**: Partial automation
  - “hands off”
  - conditional automation
  - e.g. Traffic jam pilot, highway pilot

- **Level 3**: High automation
  - “eyes off”
  - “brain off”
  - e.g. Urban pilot

- **Level 4**: Full automation
  - “driver off”
  - e.g. Robo Taxi

> L3 makes the difference
WHY DO WE NEED PRECISE LOCALIZATION?

... hopefully your localization was right!
LOCALIZATION TECHNOLOGIES

Vehicle localization

Satellite-based localization
- positioning absolute to map
- planning layer

Landmark-based localization
- positioning relative to map
  - Radars
  - Cameras
- feature layer

map
Vehicle motion and position sensor

- GNSS receiver
- Correction data receiver
- 6D inertial measurement unit

Microcontroller
- Fusion and integrity algorithms

Protection level

Precise localization for highly automated driving using the vehicle motion and position sensor.
... location dependent service needs world wide ramp up.
LOCALIZATION TECHNOLOGIES

Satellite-based localization

Performance

Satellite-based localization

Landmark-based localization

Performance

Landmark-based localization

... optimal localization portfolio out of one hand ...
Key challenges for GNSS systems

- **Guaranteed sub-meter range**
- **Everywhere** (worldwide) and **always**
- **0 faults** policy
- **100% uptime in 24/7**
- **Scalable and cost-sensitive**

**PERFORMANCE**

**SAFETY**

- **ISO26262** compliant
- **Integrity** with hardware and functional safety metrics
- **Cyber Security** proof

**AUTOMOTIVE**

Automated driving
Three decades of GNSS and service operation stability required!
A HOLISTIC DEVELOPMENT APPROACH

Customer Requirements

System Design

HW and SW Specifications

Implementation

System Validation

System Integration

Component Testing

> 3000 Requirements

> 50 Signals

> 20 OEM Standards

> 500 Views, Diagrams, and Models

> 100 Interface Specifications

> 1000 Failures and Monitors

> 50 Components

Service as Sub-System V

> 300k Lines of Safety Code
WORLDWIDE VEHICLE TESTING

Systematically derived and linked

Thousands of driving hours
Hundreds of different test cases
CITY DRIVE FRANKFURT
CONCLUSION

VMPS (Vehicle Motion and Position Sensor)

- GNSS for Highly Automated Driving
- Sophisticated System Design
- Comprehensive Engineering Methods

accurate, safe and reliable for highly automated driving