

Safe GNSS/Inertial Positioning for Highly Automated Driving

Michael Baus, Project Director,
Vehicle Motion and Position Sensor (VMPS)
Chassis Systems Control, Robert Bosch GmbH

Driving is ...



Freedom



Independence



Fun to drive



Mobility



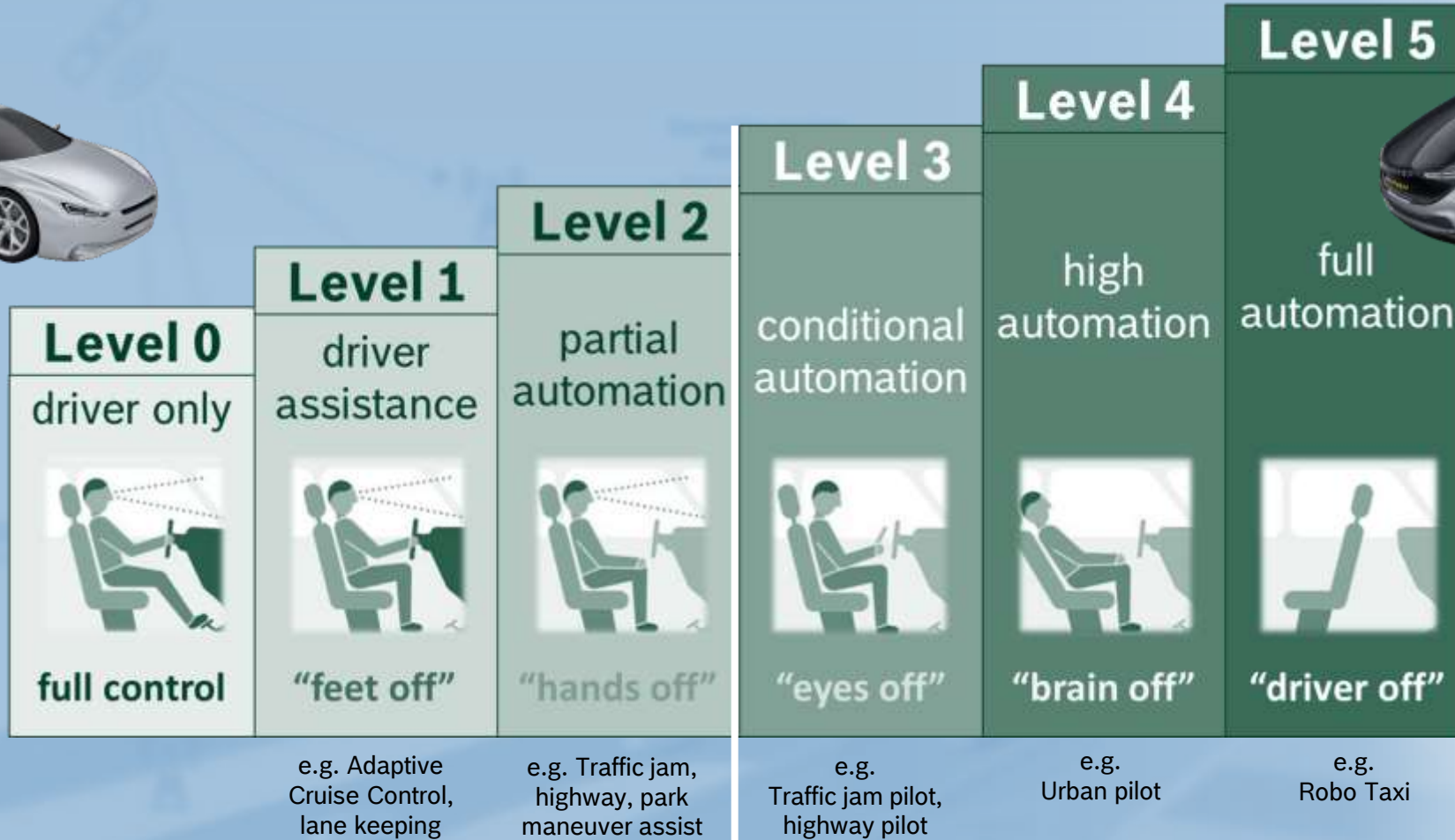
Infinite space

Are you really sure



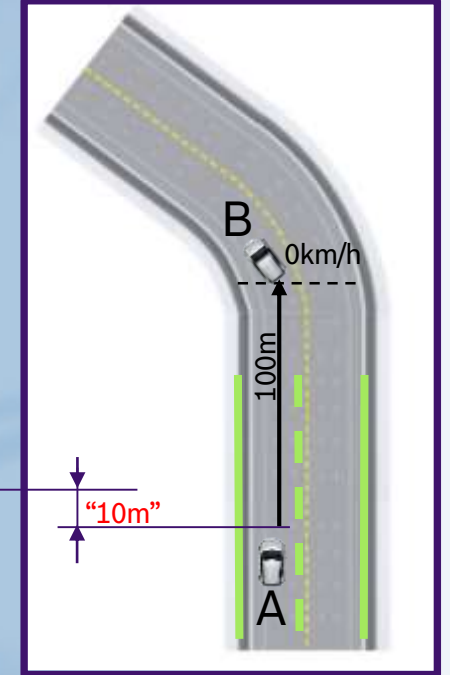
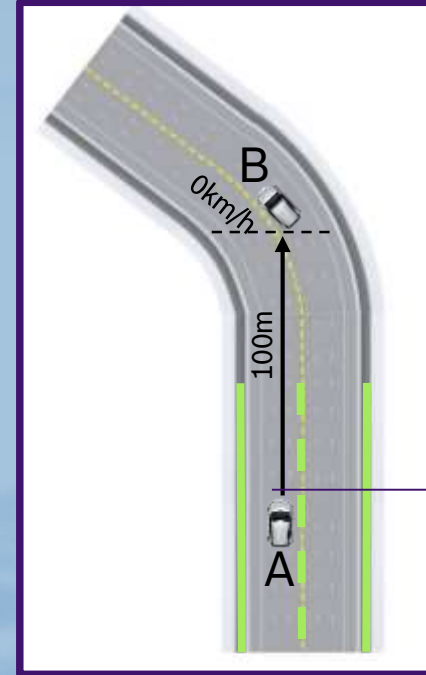
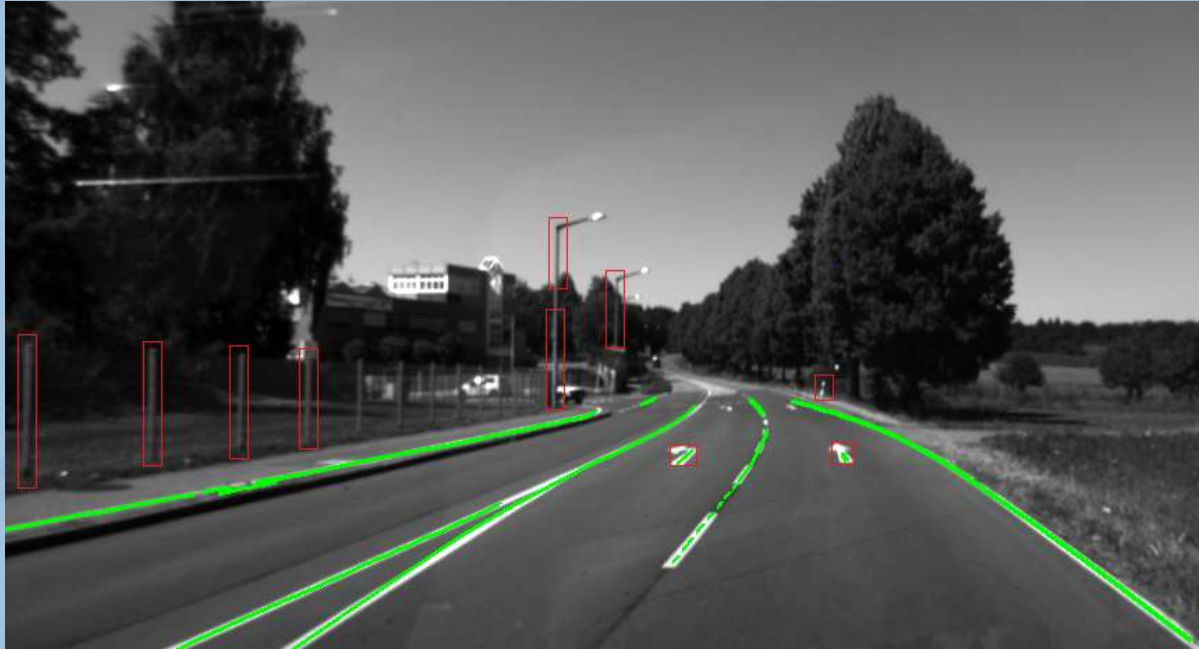
... that you **ALWAYS** want to drive on your own?

Automation levels



> L3 makes the difference

WHY DO WE NEED PRECISE LOCALIZATION?

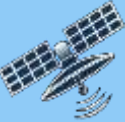


... hopefully your localization was right!

LOCALIZATION TECHNOLOGIES

Vehicle localization

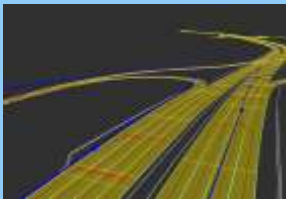
Satellite-based localization



positioning absolute to map



planning layer

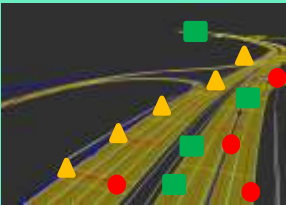


map

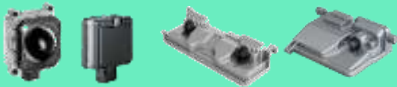
Landmark-based localization



feature layer



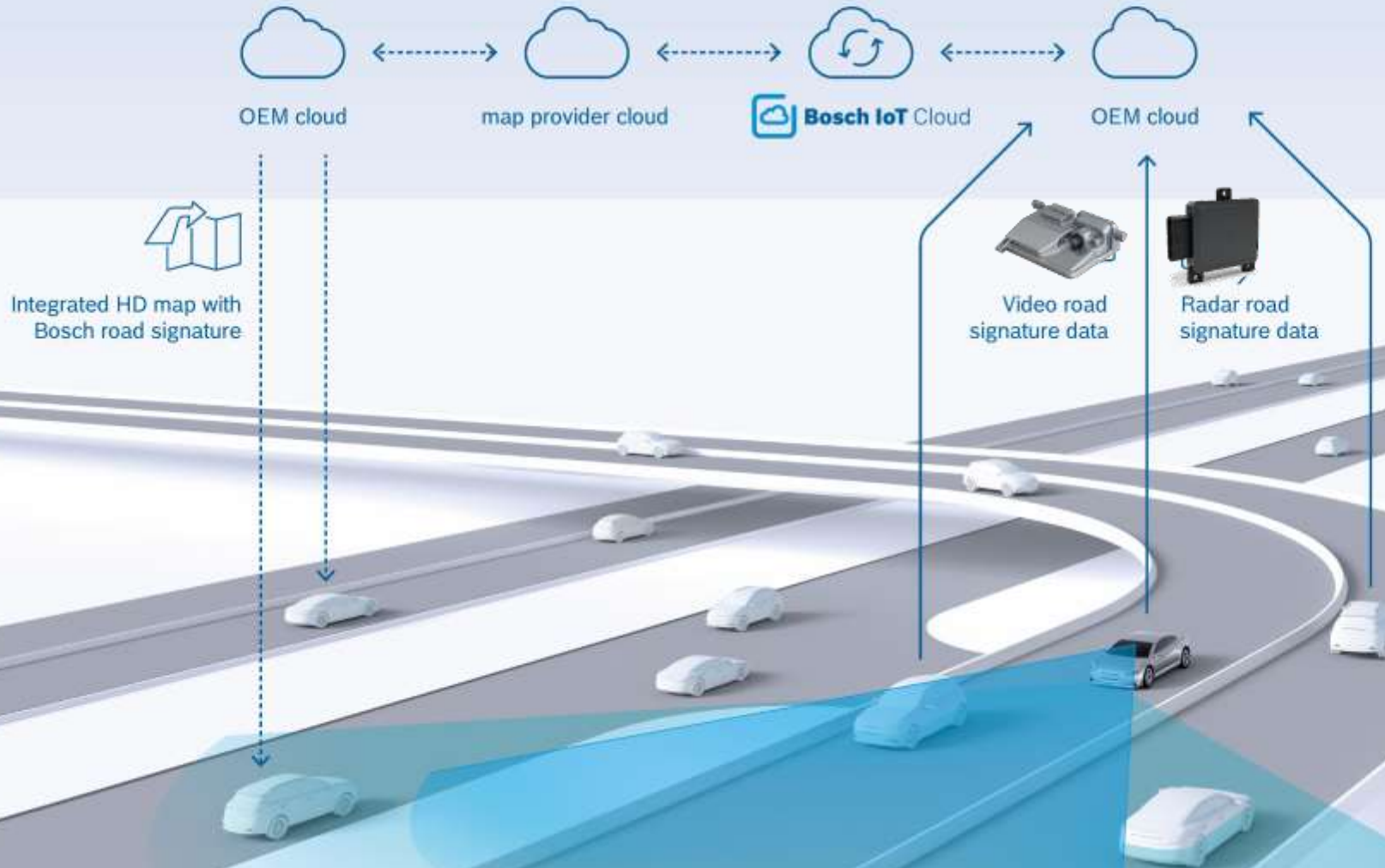
positioning relative to map



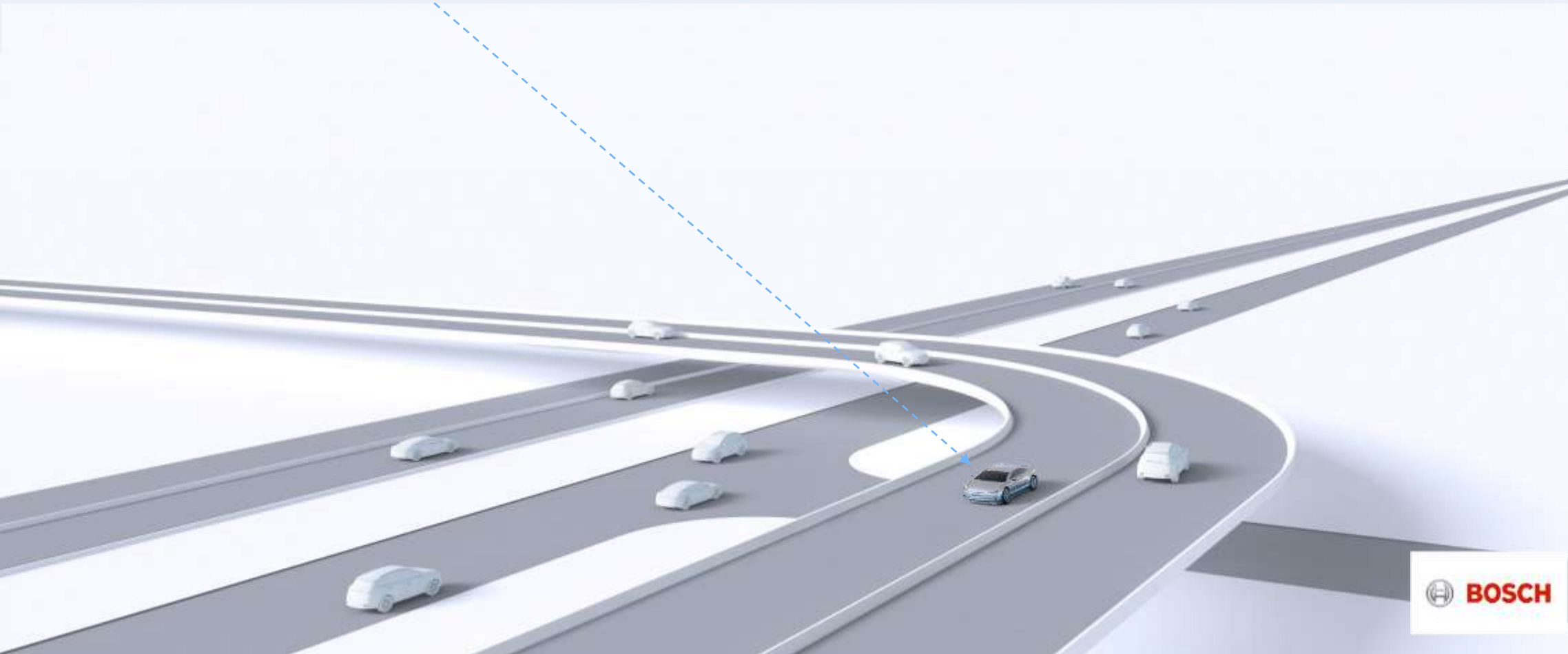
Radars

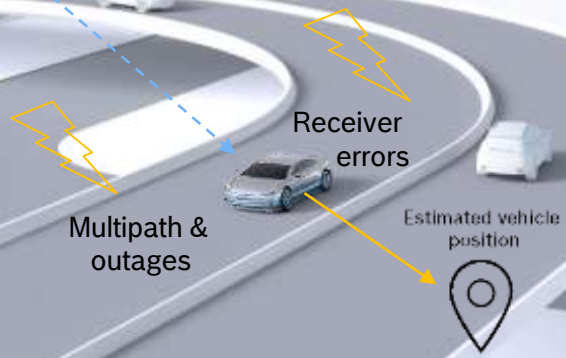
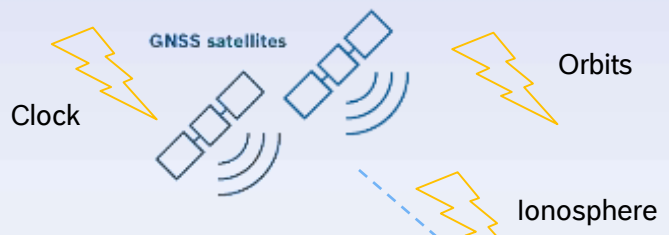
Cameras

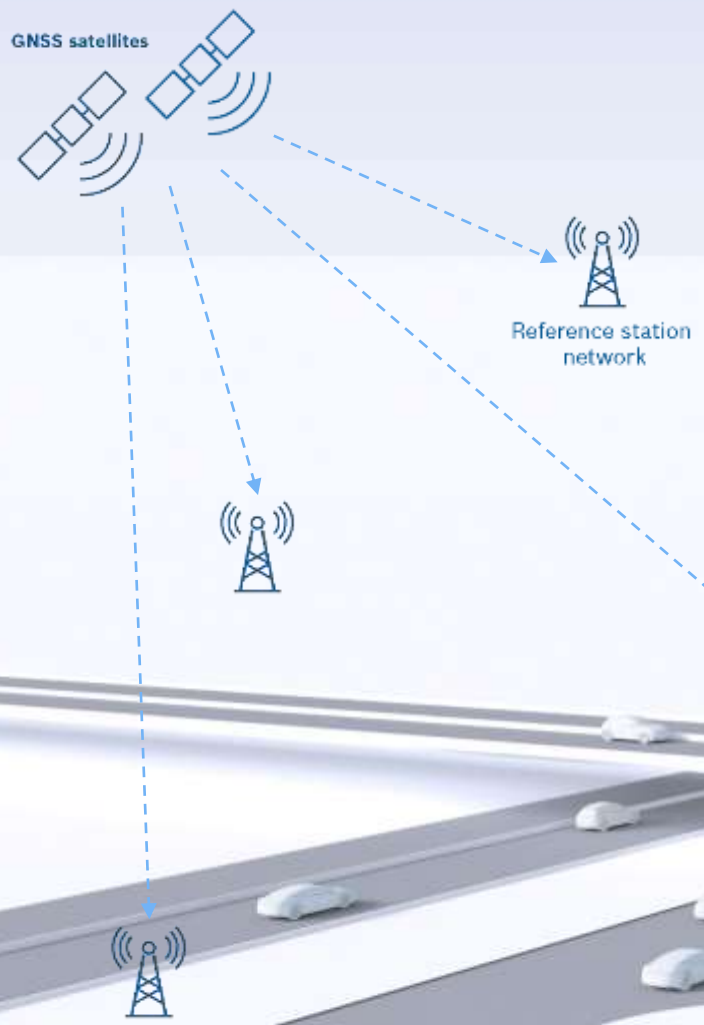
Road Signature

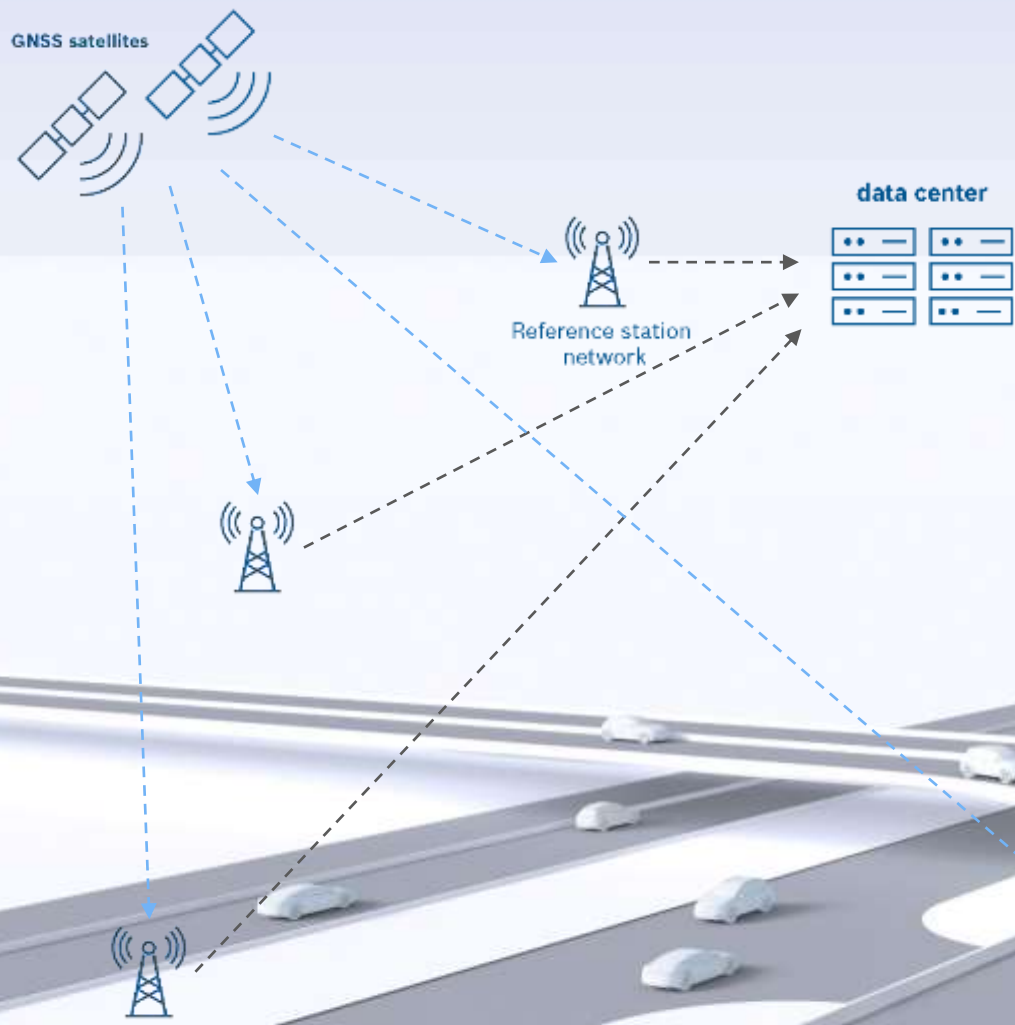


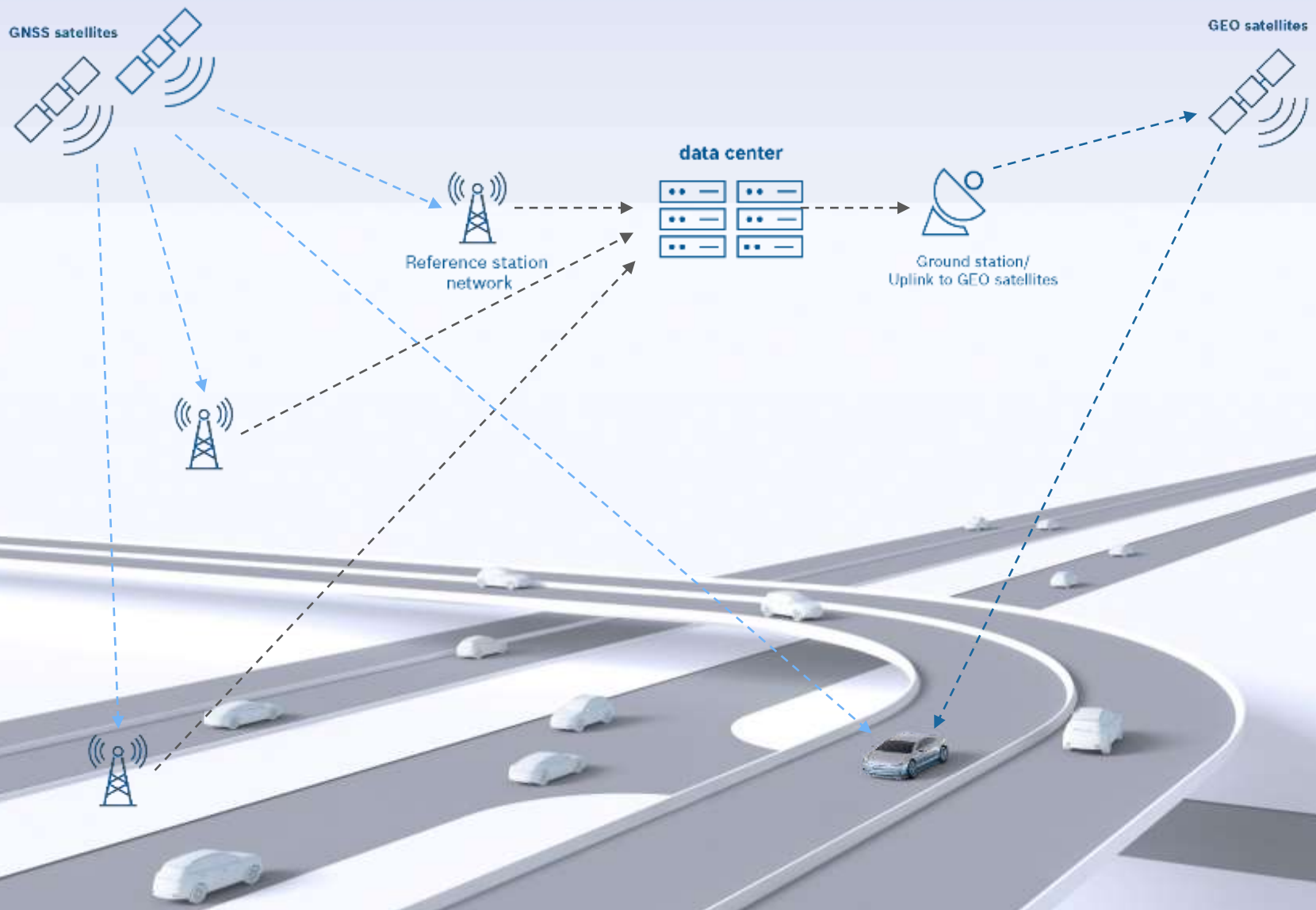
GNSS satellites

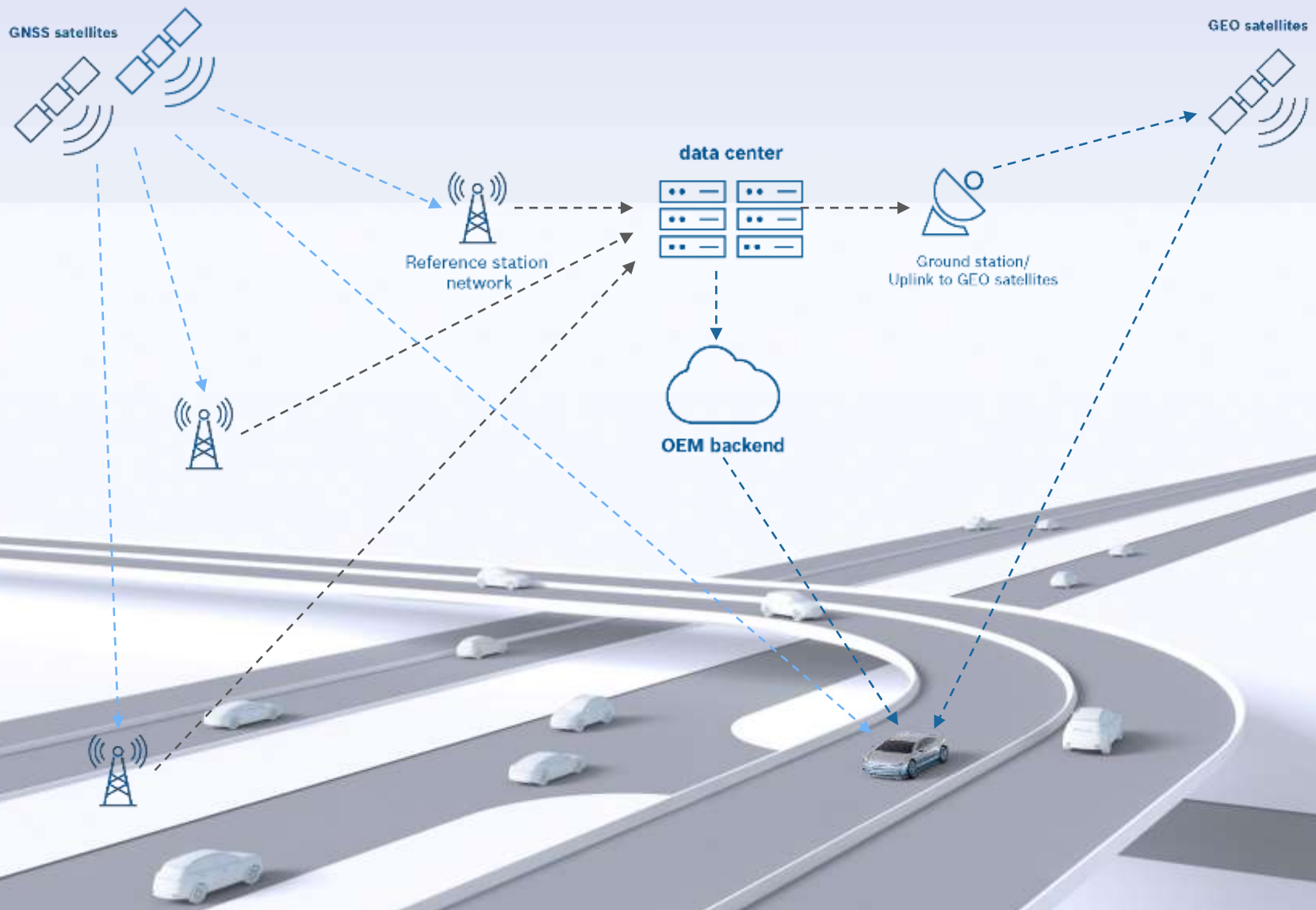


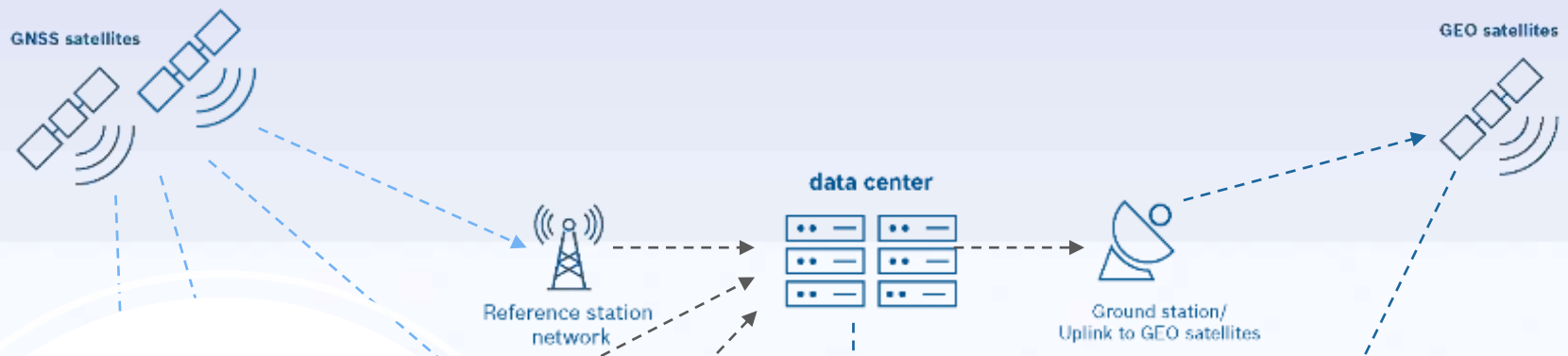












Vehicle motion and position sensor



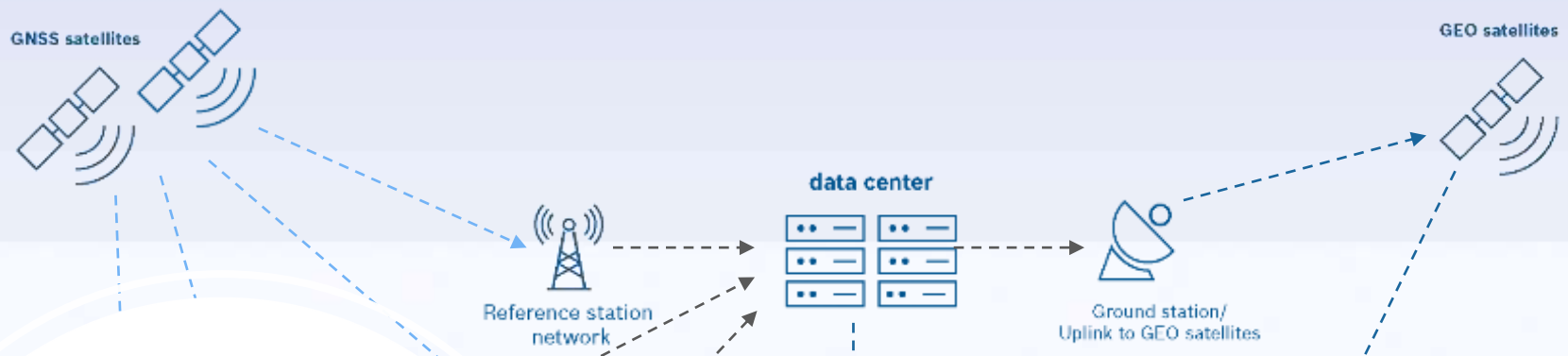
GNSS receiver

Microcontroller

Correction data receiver

Fusion and integrity algorithms

6D inertial measurement unit

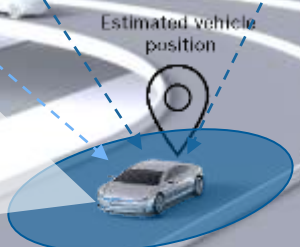


Vehicle motion and position sensor



GNSS receiver	Microcontroller
Correction data receiver	
6D inertial measurement unit	
Fusion and integrity algorithms	

Precise localization for highly automated driving using the vehicle motion and position sensor.



SERVICE COVERAGE

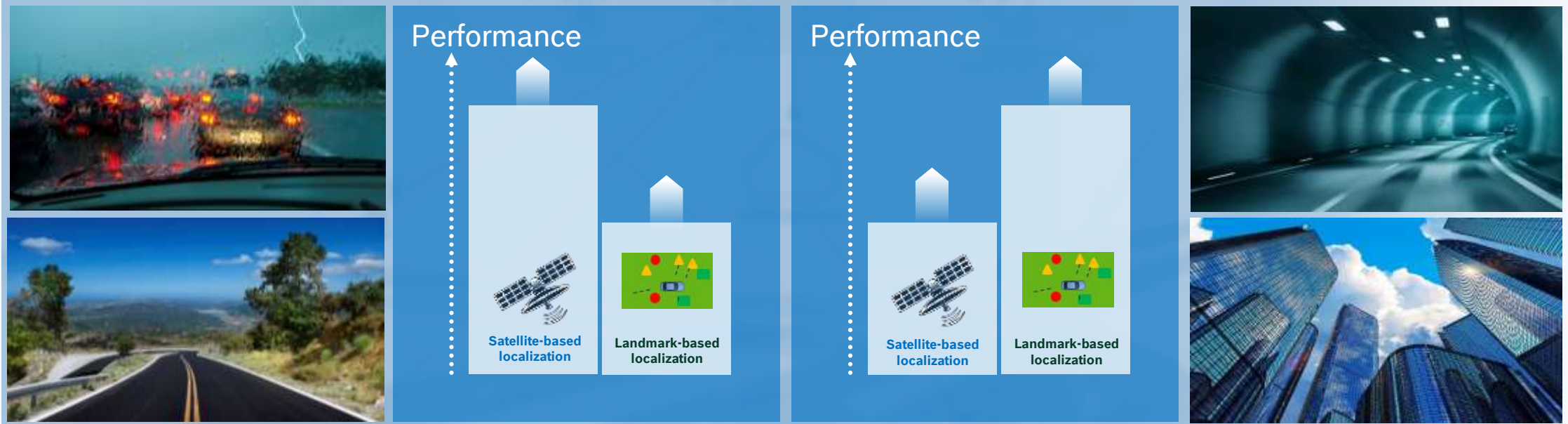


... location dependent service
needs world wide ramp up.

LOCALIZATION TECHNOLOGIES

Satellite-based localization

Landmark-based localization



... optimal localization portfolio
out of one hand ...

Key challenges for GNSS systems

PERFORMANCE

- ▶ **Guaranteed** sub-meter range
- ▶ **Everywhere** (worldwide) and **always**

Automated driving

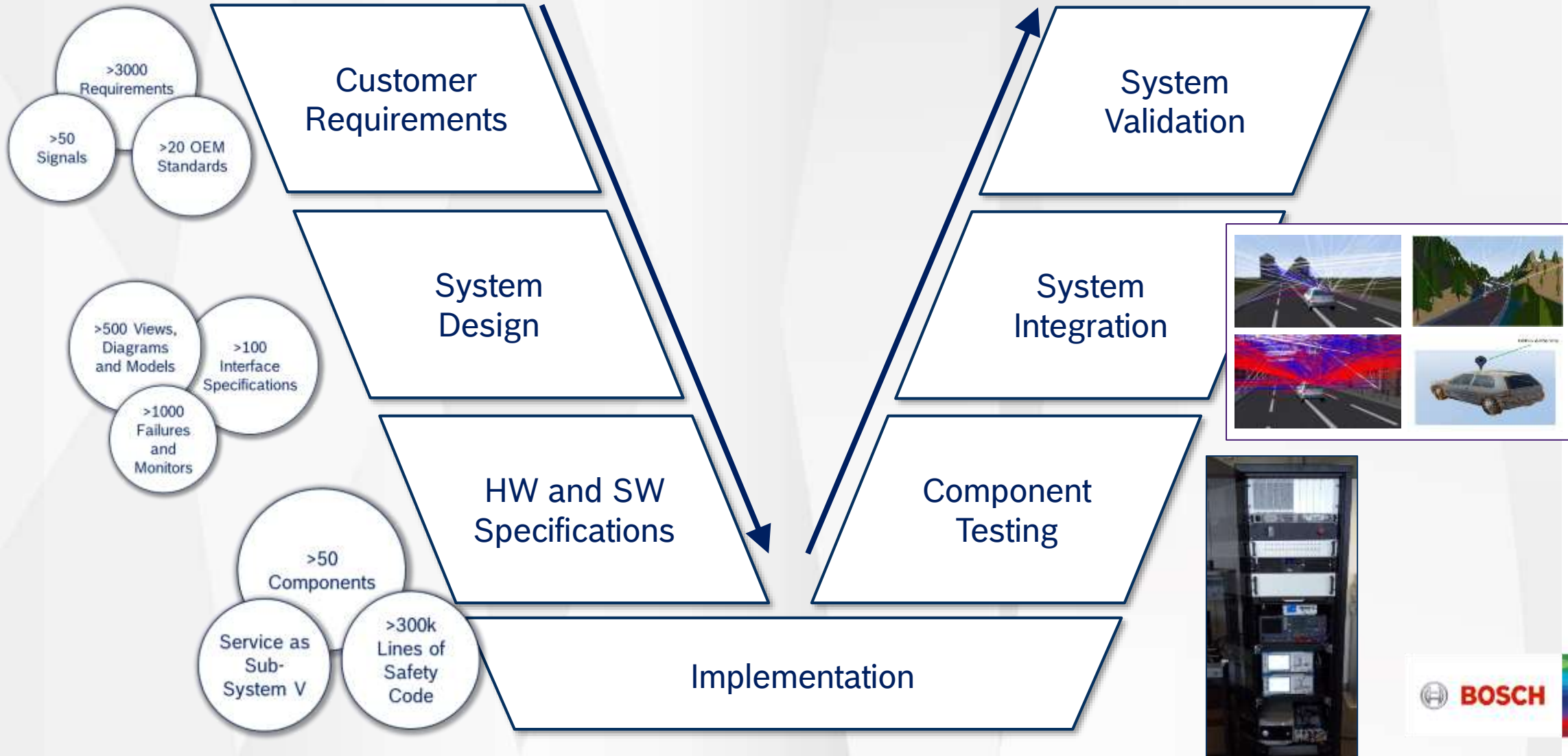
SAFETY

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

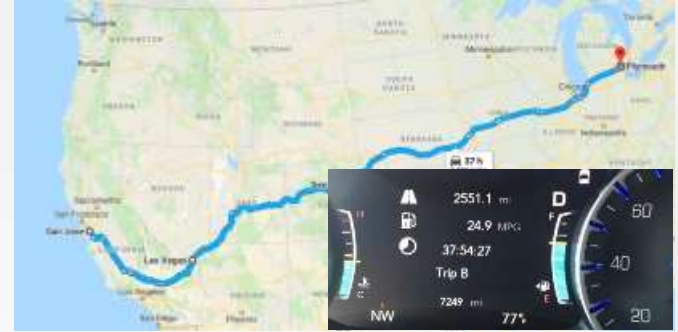
- ▶ **0 faults** policy
- ▶ **100% uptime** in
- ▶ Scalable and c

AUTO-MOTIVE

A HOLISTIC DEVELOPMENT APPROACH



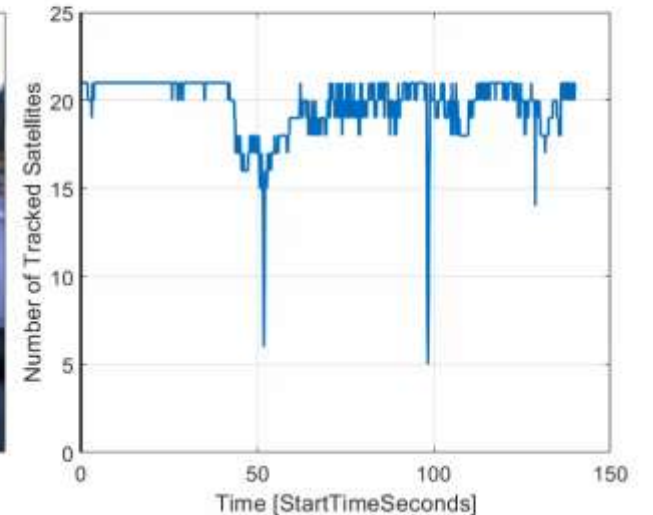
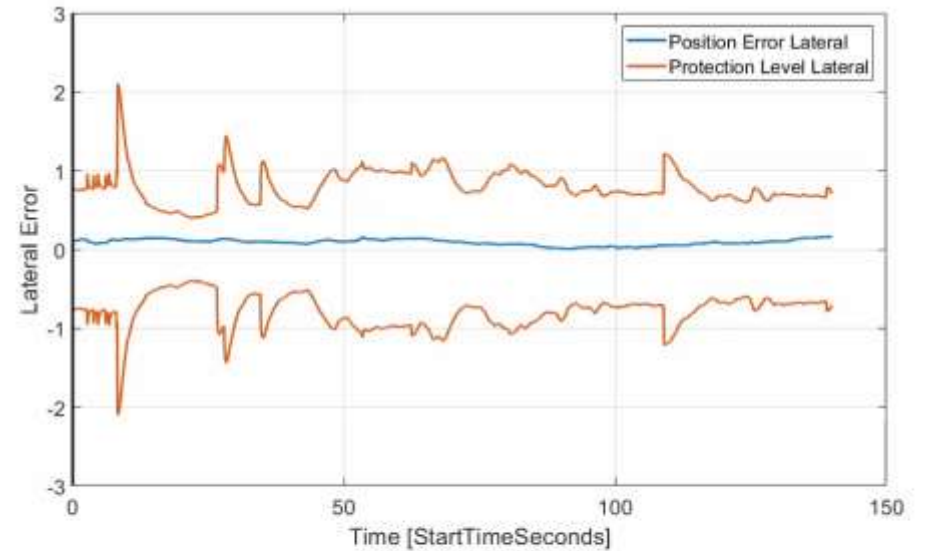
WORLDWIDE VEHICLE TESTING



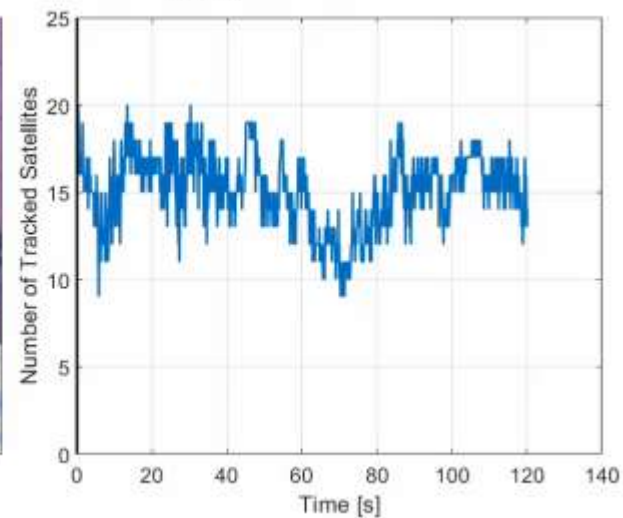
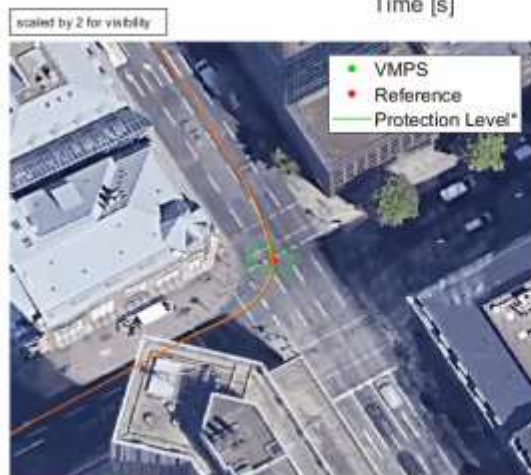
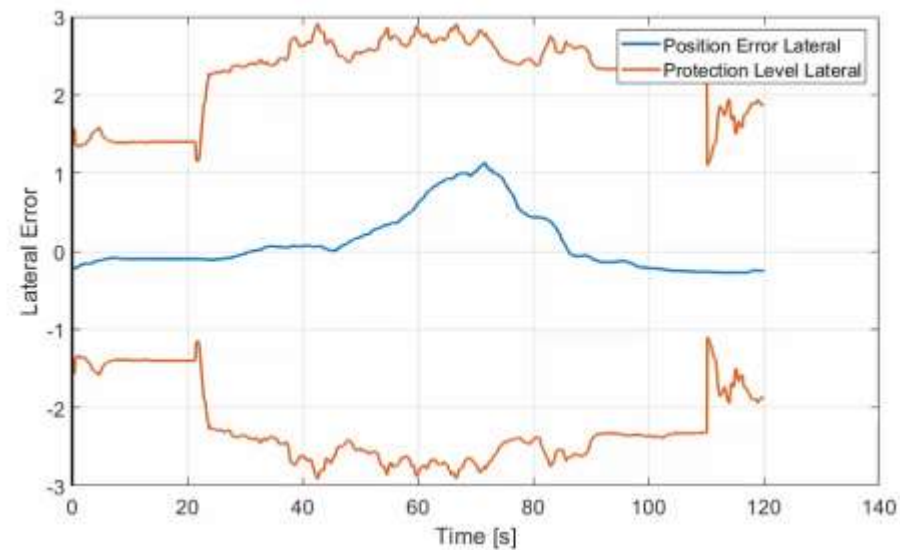
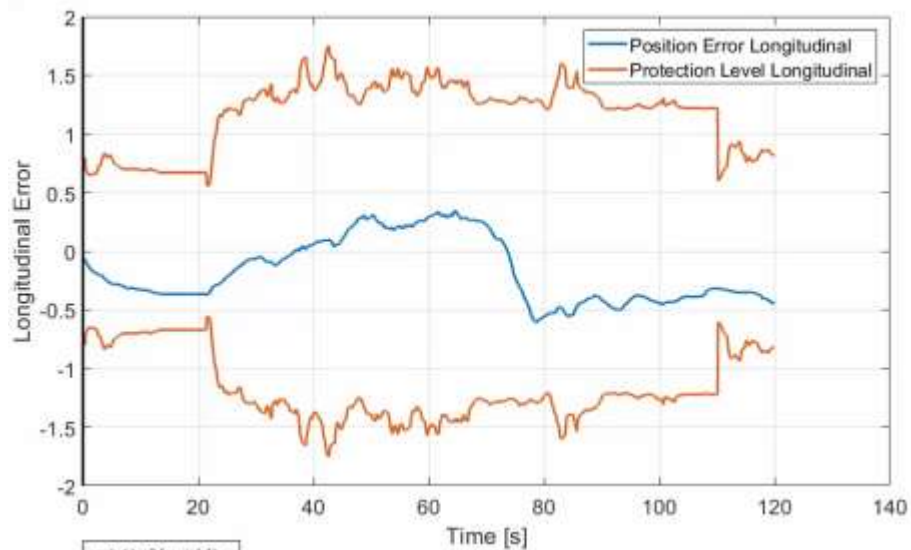
Systematically
derived and linked

Thousands of driving hours
Hundreds of different test cases

HIGHWAY DRIVE ABSTATT-LEONBERG



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