The Future of Automotive Navigation Systems

Dr.-Ing. Stefan Döbrich

Dresden, 20.10.2016

- Company Presentation
- State-of-the-Art of IVI Navigation Systems
- Digital Navigation Maps
- Future Trends & Development
  - Hybrid Navigation
  - Augmented Reality
- Questions

Milestones

1997 — Automotive business is established

1998 — „Werra 1“, first car radio from TechniSat, hits the market

2002 — Started delivery of the Ultra Low Radio into Volkswagen serial production

2007 — „NAVI-DRESDEN 1“, the first in-car-navigation system, hits the market

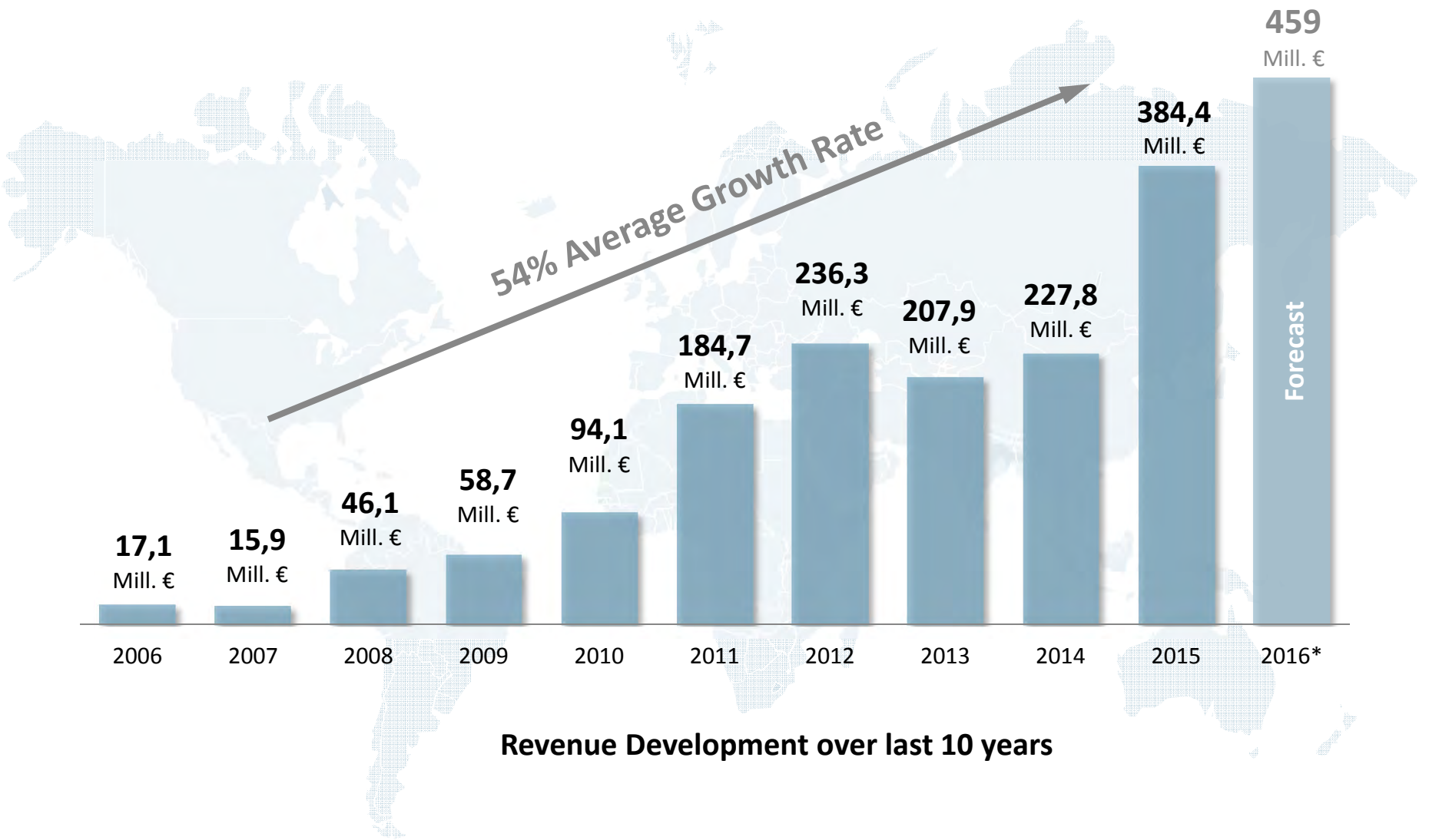
2010 — Started serial production of RNS 315 - navigation systems for Volkswagen Group

2012 — Volkswagen Group Award for TechniSat Automotive

2014 — Started serial production of Volkswagen MIB2

2016 — Strategic realignment with Joyson and Preh

Company development



Revenue Development over last 10 years

Note: until end of 2015 no official Automotive profit and loss account as well as balance sheet available.

Legal Entity structure (as per May 2016)

Preh Car Connect GmbH
Dresden, Germany
- Headquarter and R&D -

Preh Car Connect Thüringen GmbH
Dippach, Germany
- Production -

Preh Car Connect Polska Sp. Z o.o.
Oborniki, Poland
- Production -

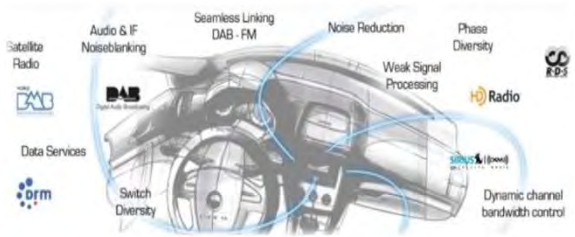
Preh Car Connect China Co. Ltd.
Shanghai, China
- R&D and Test Center -

Preh Car Connect USA, Inc.
San Carlos, USA
- Innovation Center -

4 Core Competencies in Research & Development

Navigation & Driver Assistance

Tuner & Multimedia



Connectivity

Telematics & Data Services

Audio

- Audio Management includes
  - Audio Source Control
  - Sound Parameter Management
- Signal processing includes
  - Signal routing
  - Filter design

Media

- Supports all common Codecs
  - Audio (MP3, …)
  - Video (MPEG, …)
  - Pictures (JPG, …)
- Supports new media
  - Streaming (Spotify,…)
  - UPNP (Rear Seat Entertainment)
  - Online-Storage (Dropbox)

Radio

- Radio Application and Services
  - AM/FM
  - DAB (EU), SDARS
  - HD-Radio, DRM (India)
  - Online radio
- Radio Base Functions
  - Software Defined Radio
  - Seamless Linking

Apple CarPlay

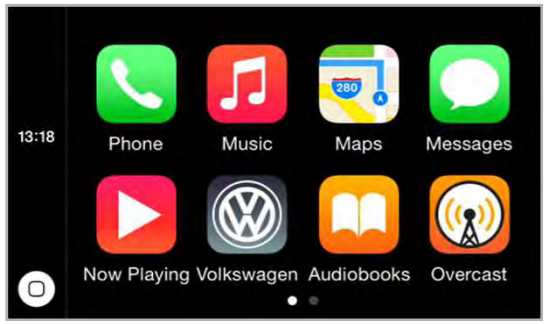
- Main Features
  - Puts the iPhone right on the car's built-in display
  - Voice control (Siri)
  - Maps is available
  - Listening to Messages and dictating Messages while driving
  - Access to whole iTunes-Content

Android Auto

- Main Features
  - Integrated steering wheel controls
  - Minimizes distraction
  - Information appears just when needed
  - Access to favorite apps and content

Baidu CarLife

- Main Features
  - Supporting both Android and iOS
  - Connecting via USB or WiFi
  - Picking various Apps suit for driving
  - Maps, Music, Phone
  - Voice Control & Apps Platform



Integration of Cluster Instrument and Infotainment

Key Benefits

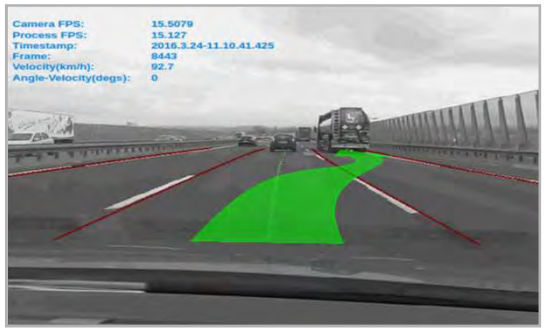
- Shared Resources
  - Lower Redundancy
- Fewer Interfaces
  - Lower Complexity
- One seamless HMI
- Less cost for OEM

Key Challenges

- Major change in vehicle architecture
- Cluster instrument know-how
- Safety aspects (e.g.: ISO 26262)
- SOP 2019

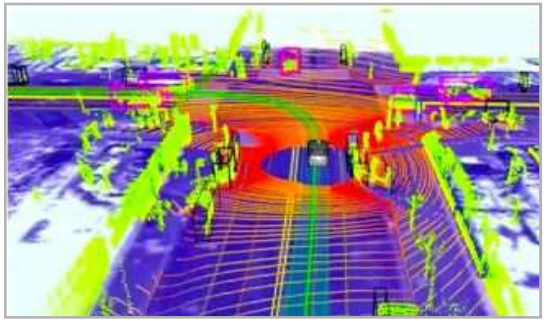
Current Project Forward Engineering

- Augmented Reality
  - Head-Tracking
  - Eye-Tracking
  - Gesture Control



- Personal Profile
  - Car Sharing via Smartphone
  - Keyless Entry
  - Face Recognition

- High Precision Positioning
  - Real time lane change
  - Prerequisite for autonomous driving
  - More accurate maneuver announcements



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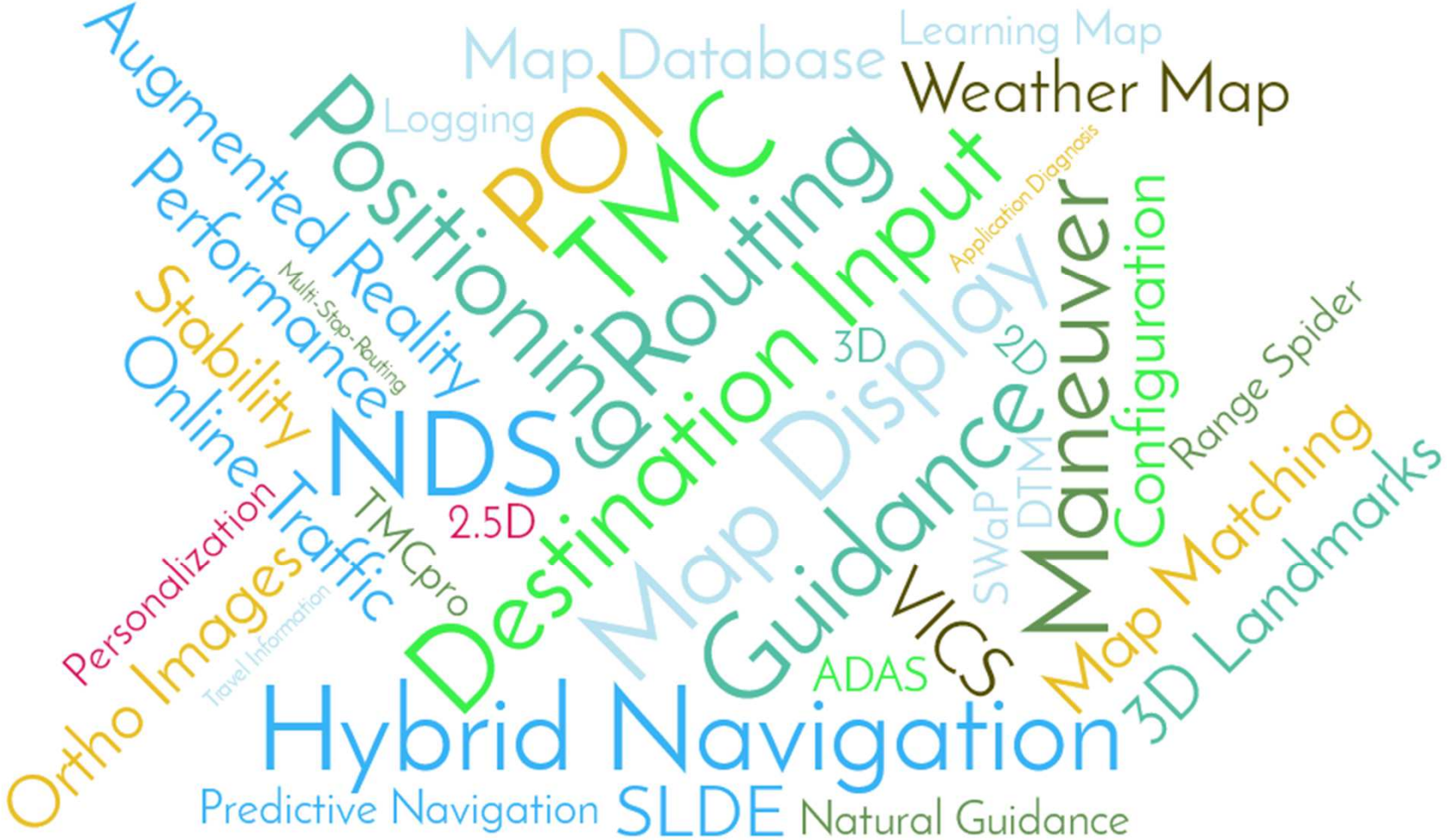
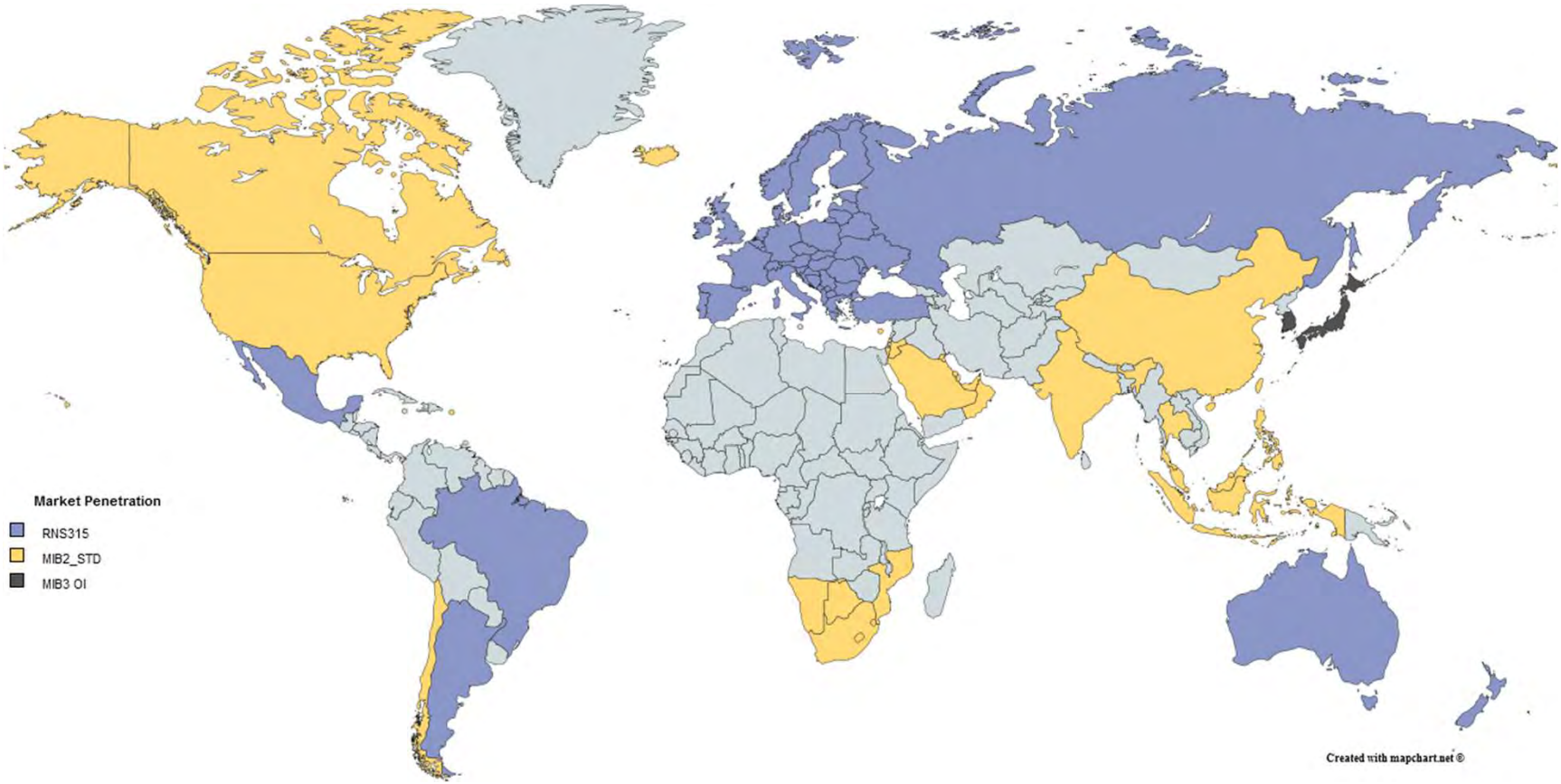

Map Database
Learning Map
Weather Map
Logging
POI
TMC
Augmented Reality
Positioning
Routing
Destination Input
Application Diagnosis
Performance
Multi-Stop-Routing
Stability
Online
3D
2D
Map Display
Guidance
Maneuver
Configuration
Range Spider
NDS
Personalization
Traffic
TMCpro
2.5D
SWaP
DTM
VICS
Map Matching
Ortho Images
Travel Information
ADAS
3D Landmarks
Hybrid Navigation
Predictive Navigation
SLDE
Natural Guidance

➲ Availablity of Preh Car Connect Navigation increases steadily



Q: Why is it so hard to develop a global in-vehicle navigation core?

A: Because there is no global understanding of a „good navigation“.

- OpenLR
- Left-hand driving in some countries

- National Security Act
- DMB

- SiriusXM
- Housenumber first DI
- Driver Distraction

- Writing right to left
- Patriarchy

- Encoded Map
- Elevated Roads
- Governmental cencorship

- VICS & ETC
- Left-hand driving
- Different address system

Global Navigation Core (3) - Crossplatform and Compatibility Aspects

Fully Supported




Partly Supported


Not Supported (Yet)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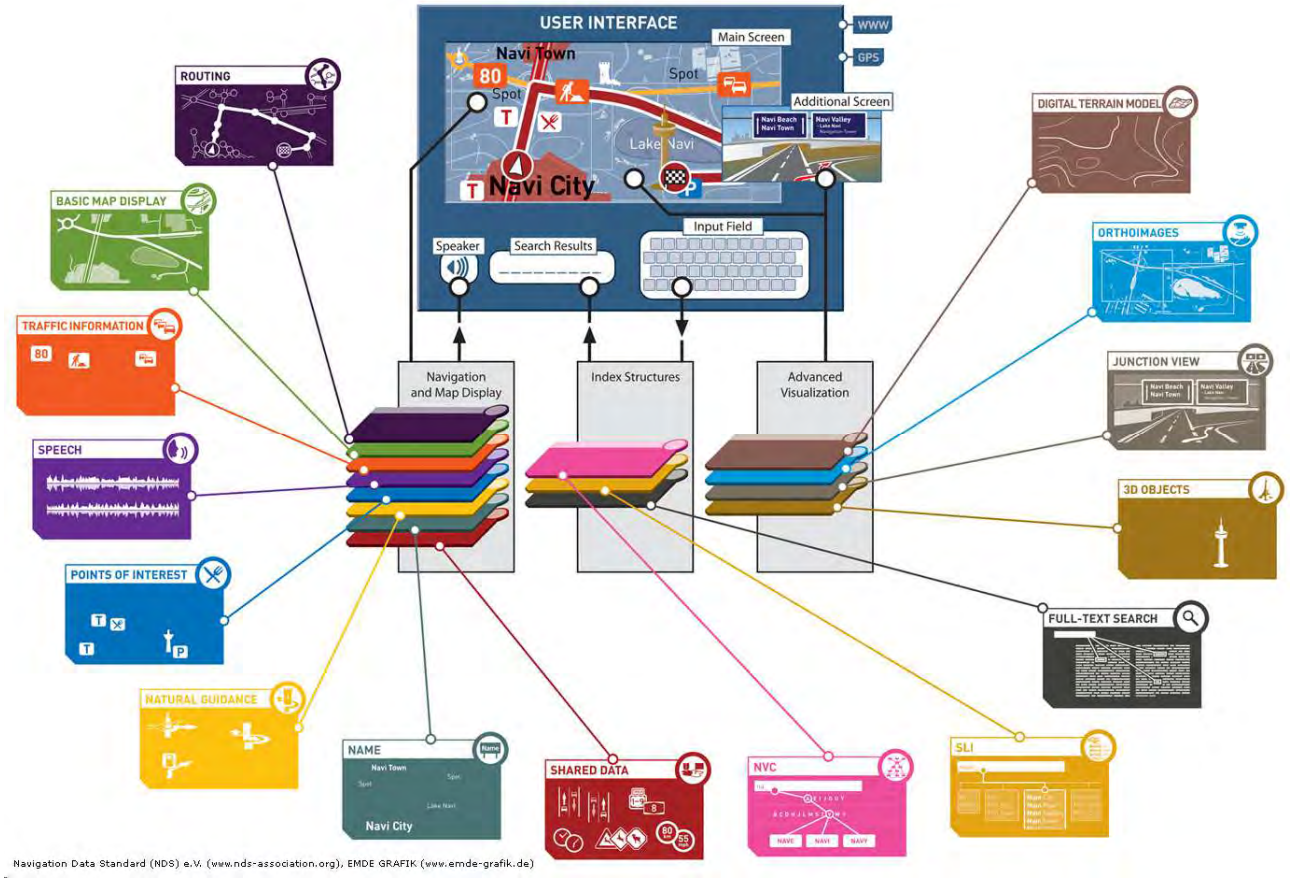
Navigation Data Standard
PSF Physical Storage Format

➲ Map consists of update regions and building blocks



Navigation Data Standard (NDS) e.V. (www.nds-association.org), EMDE GRAFIK (www.emde-grafik.de)

- **Map updates and the required compiler toolchain are a significant enabler for a powerful navigation.**

Map Update

Regular update of the map database in the car over SD card or USB stick.

OTA Update

Over the air update of the map. Requires less user interaction.

Partial Update

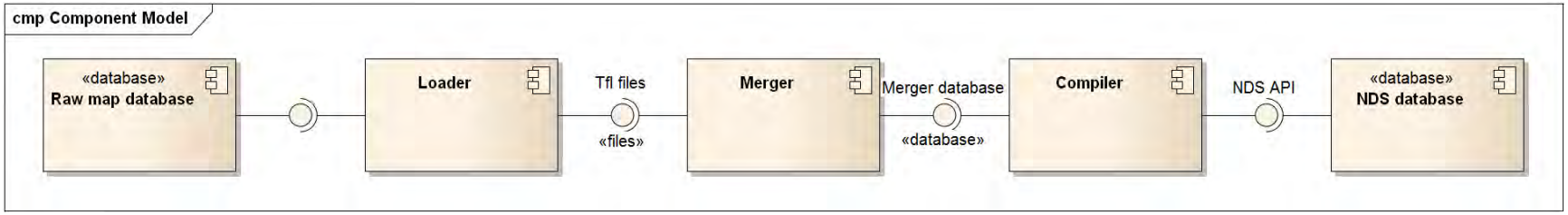
Partial update of the map over the air. Exchange of update regions with respect to their border gates and consistent link IDs.

Incremental Update

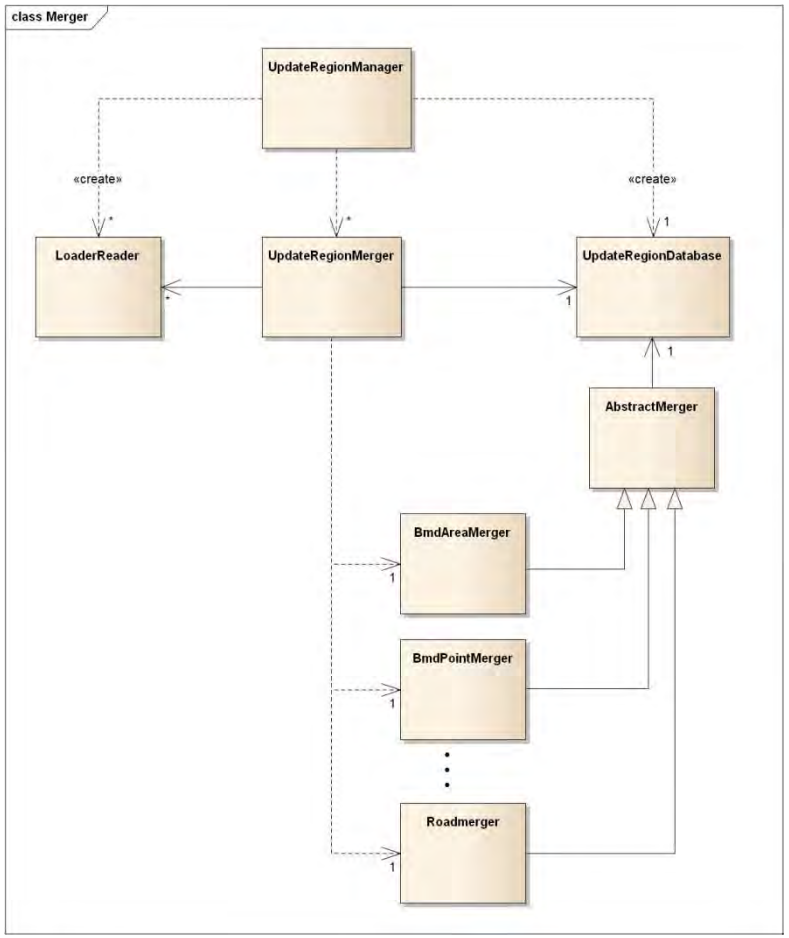
Incremental delta update of the map over the air. Just actual change sets are applied to the map. Significantly reduced data traffic.

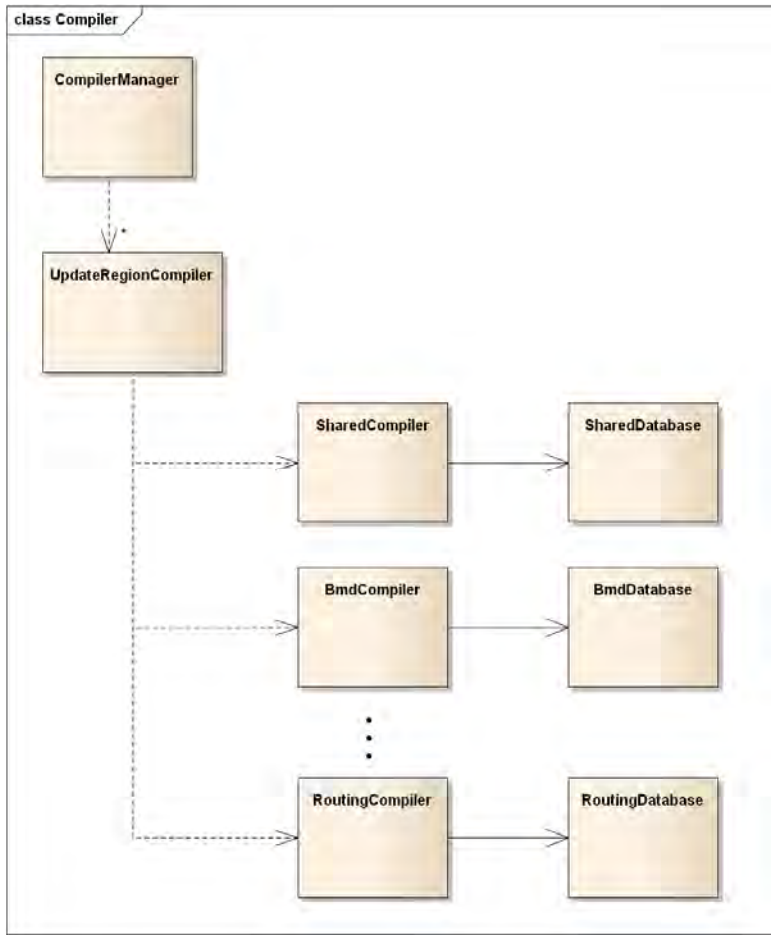
- Five stage compilation and validation pipeline
- Implementation in Java SE 8
- SCM with Subversion / git
- Configuration and management of build jobs with Jenkins

➲ **Transformation of map raw data into standard compliant NDS maps**

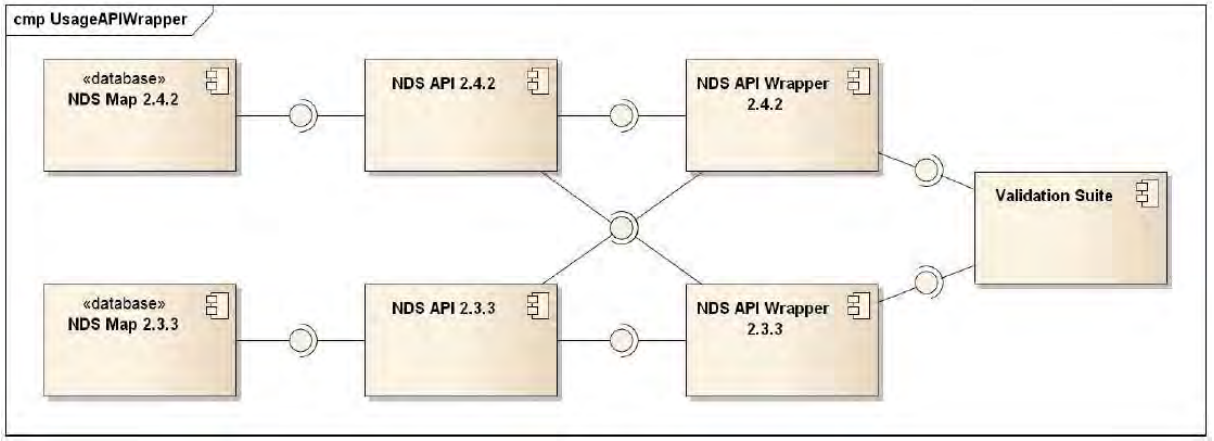


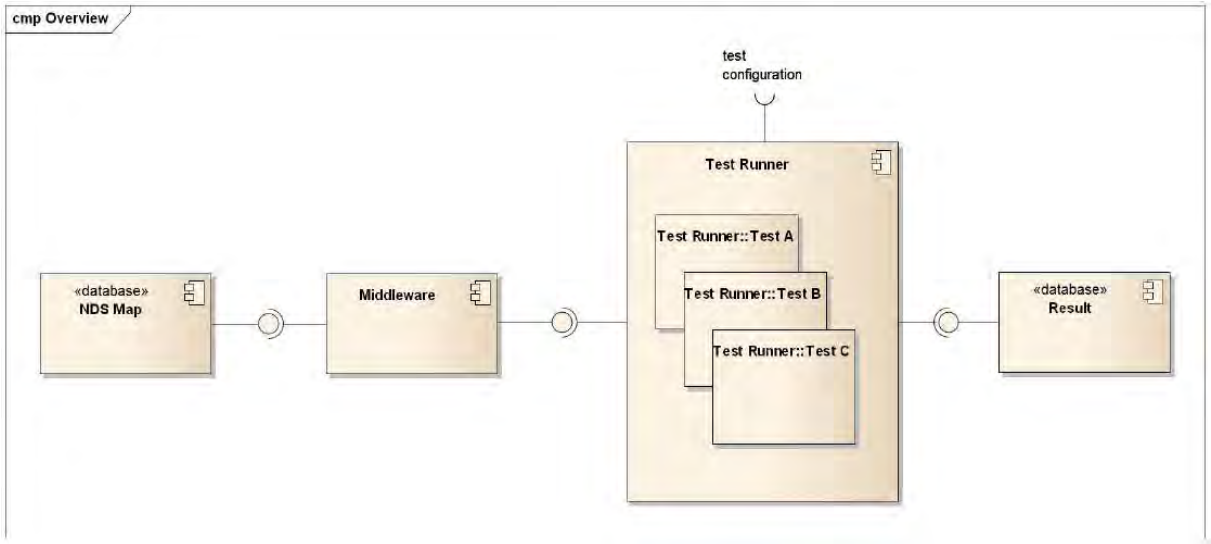
- Raw data is merged into update regions
- Separate handling of the different building blocks



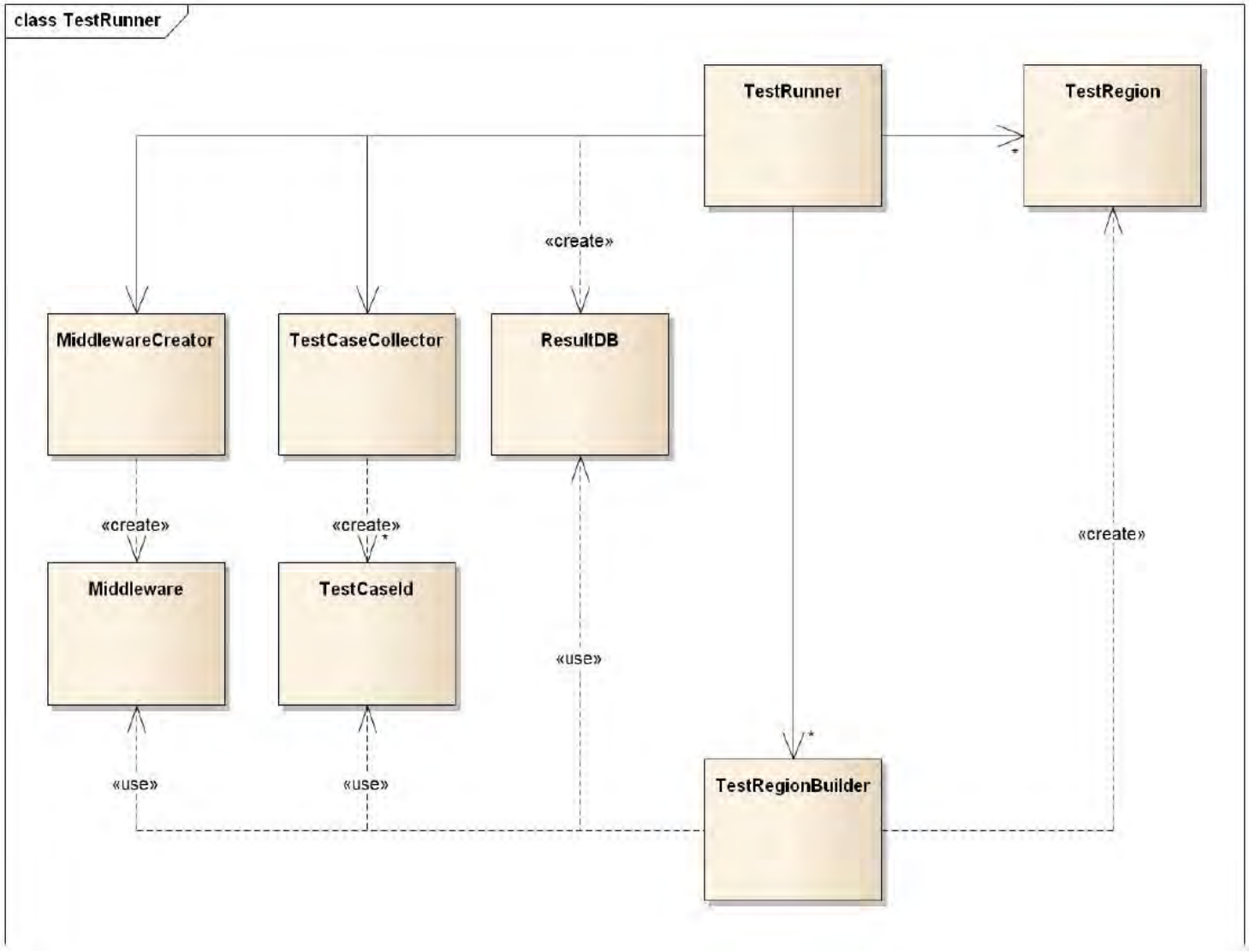


- Wrapping of different NDS API versions
- Generalized Validation Suite
- Execution of different test runs
- Parallelization for performance optimization possible

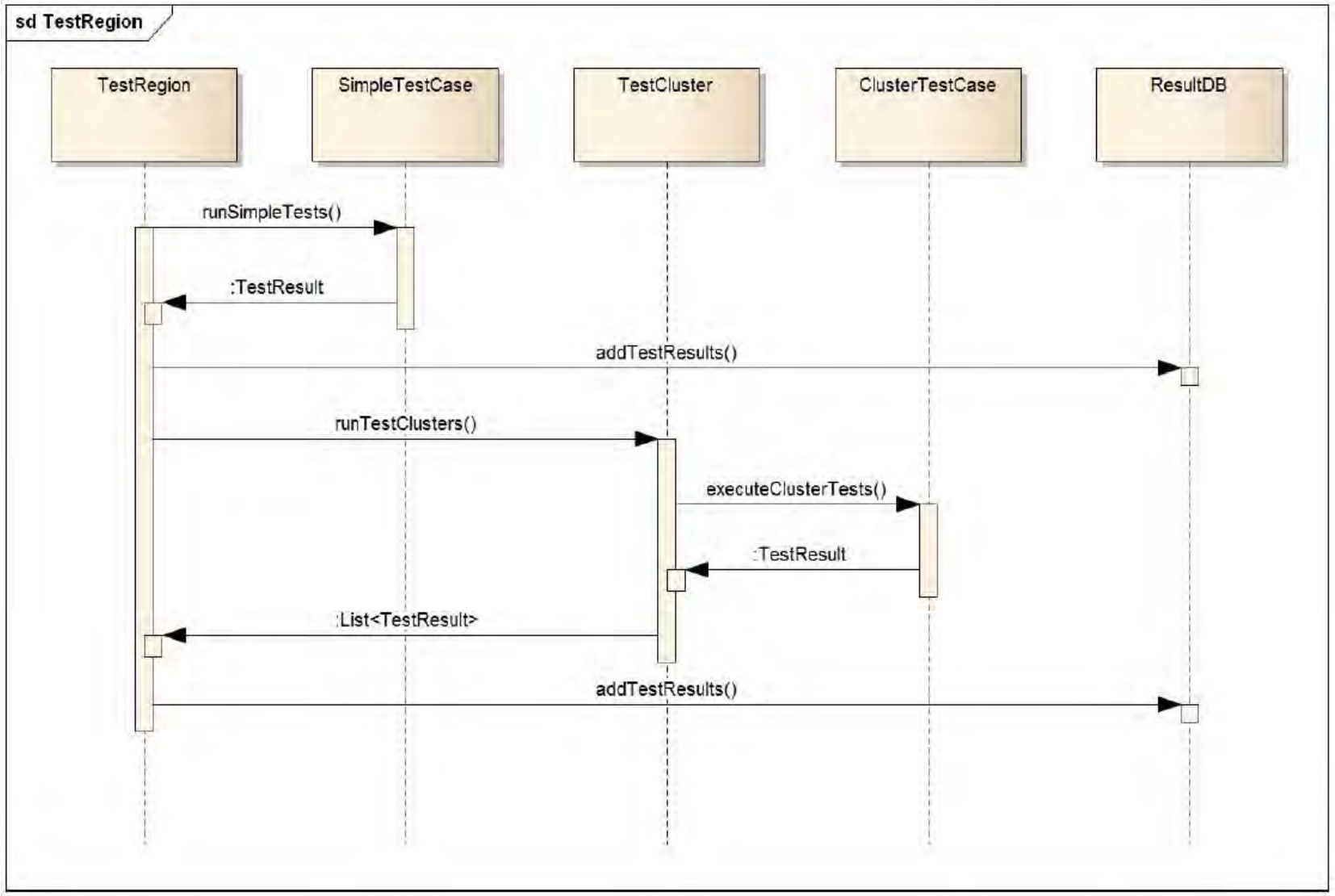




Digital Maps – TestRuns and TestRegions

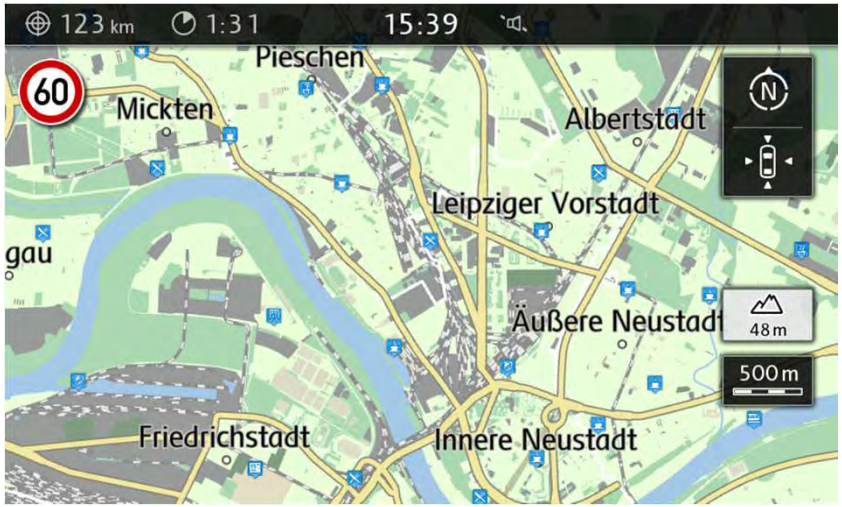


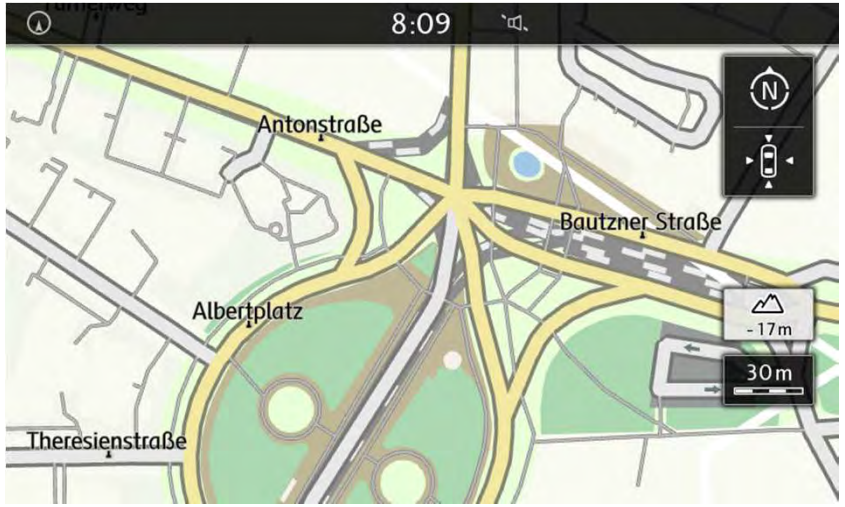
Digital Maps – Simple and Complex TestCases



Digital Maps – Compilation of Open Street Map Raw Data

	Copy artifacts	Compile map for preset: Dresden_OSM	Run LOG Validation	Run CB Validation	Export stable map for preset: Dresden_OSM
Average stage times:	2min 15s	3min 31s	268ms	1min 0s	12s
#103 Oct 13 11:13 No Changes	2min 15s	3min 31s	268ms	1min 0s	12s





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In 2021 approximately 56% of the
global population lives in urban regions.

26+ BILLION
devices will be
connected by 2020

$4-11 Trillion
Economic Impact

54% of top performer
companies will invest
more in sensors this yr

➲ **Future cities will have large problems with transportation, traffic, parking, air pollution, a.s.o.**

required is a 

navigation for

e-mobility

car sharing

intermodal mobility

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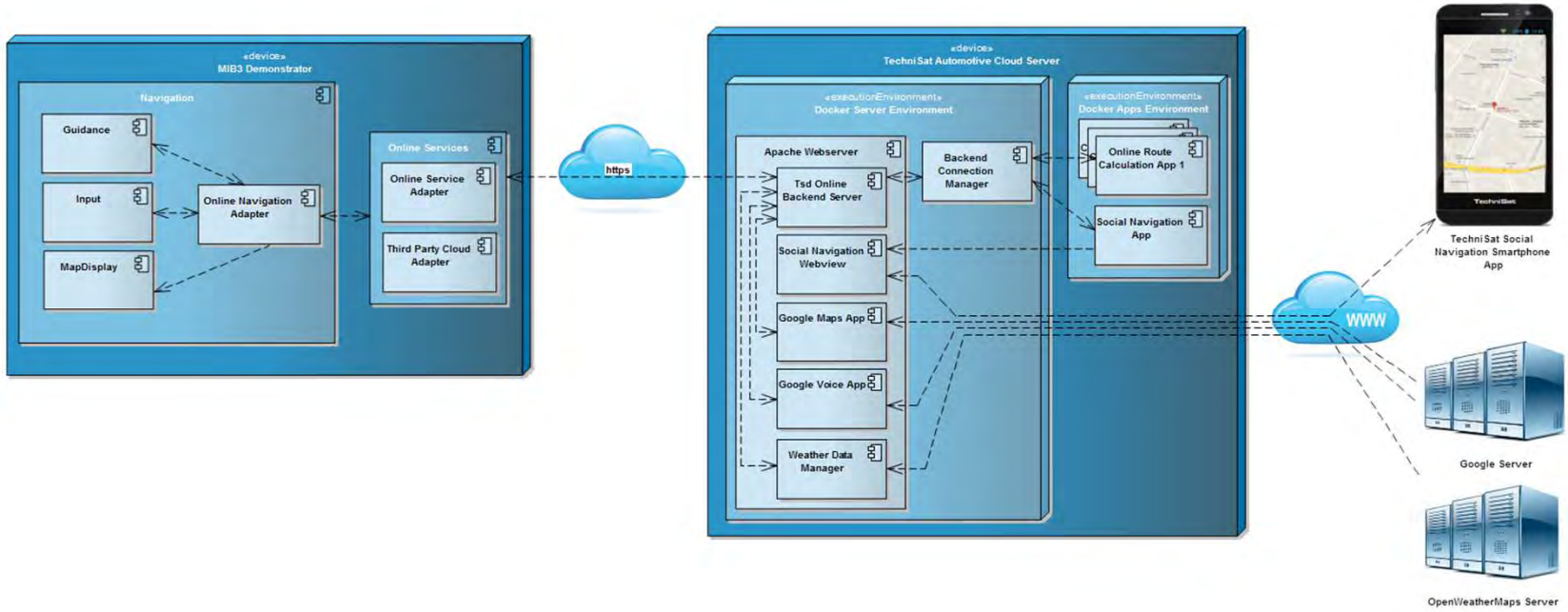
- Classical Approach: offline navigation
- Mobile Approach: online navigation

- Next Gen IVI: hybrid navigation

- Mixture of onboard and online functionality
- Customer expects an always working in-vehicle navigation
- Current mobile network coverage impedes a fully online IVI navigation

- **Hybrid navigation demonstrator implemented in 2014**
- **Leads to Proof-of-concept phase with Volkswagen and TomTom for hybrid IVI navigation**
- **Online functionality:**
  - Route calculation
  - Google satellite images
  - Google speech recognition
  - Weather service
  - Social navigation



- Initial Concept for VW Hybrid Navigation presented in April 2015
- Cooperation with TomTom as possible supplier for map data and connected services
- Concept allows an arbitrary number of service suppliers
- Proof-of-concept successful and nominated for series development

- Relization of next-gen demonstrator with cloud services „under the desk“
- Realization of MIB3 Proof-of-concept with Amazon Web Services

- Inquired suppliers for series development:

CenturyLink Business
amazon web services
vmware vSphere
IBM Cloud
Google Cloud Platform
Microsoft Azure

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Q: What means (Automotive) Augmented Reality?

A: *„Enrichment of the driver's view with additional information“*

➲ Why Augmented Reality?

- Direct and context-related presentation of information (high user acceptance)
- Increasing safety by reducing driver distraction
- Enables new infotainment and ADAS features

➲ Use Cases

Navigation Augmentation:

- Visualization of route guidance, maneuver, destination, racing line

Safety Augmentation:

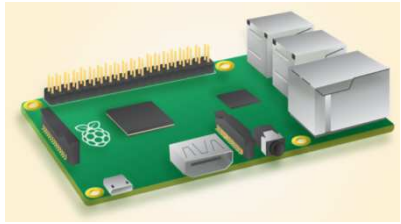
- Warning for lane departure, risk of collision, crossing pedestrian/cyclists, changing traffic light phases

Information Augmentation:

- Emphasizing of road names, road signs, POIs, dead ends etc.

Setup AR-Preh:

➲ ***Focus on low cost out-of-the-box components***



Embedded Device

➲ **Raspberry Pi 3 as central AR-unit**

- Processing camera information
- Processing IV-Navigation data
- Augmentation of information

Camera

➲ **Raspberry Pi camera (8 MP, Sony IMX219 sensor)**

In-Vehicle-Navigation

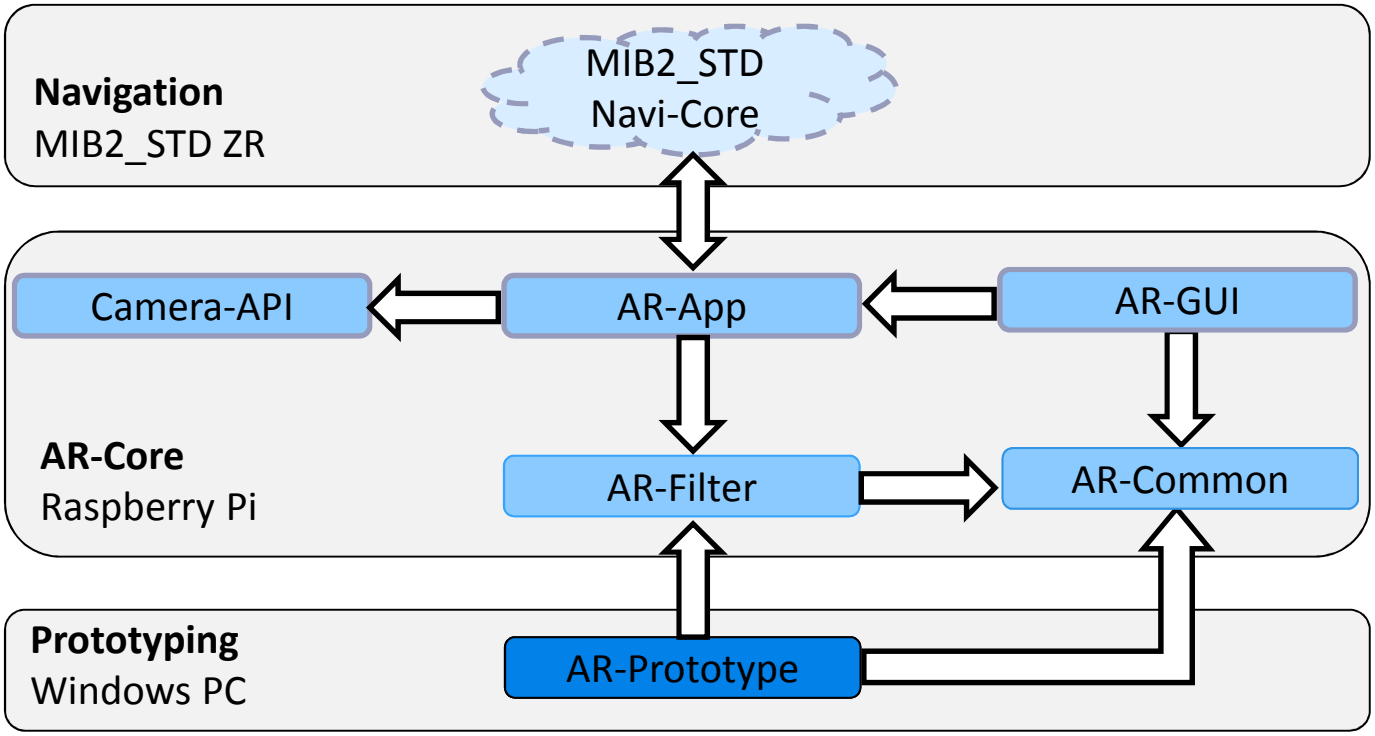
➲ **Preh MIB2_STD**

- Connected to raspberry via ethernet
- Providing content for augmentation (e.g. route guidance, map data)

- Improving lane detection with positioning and map information

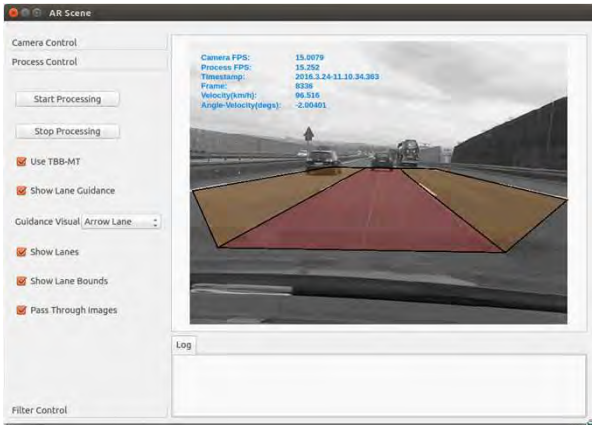
Software Architecture

- Strongly modularized and platform independent design for AR-Core
- Encapsulation of image processing functions within AR-Filter module
- Processing filter are connected via signals within a filter graph
- Separate prototyping tool to accelerate development of filter



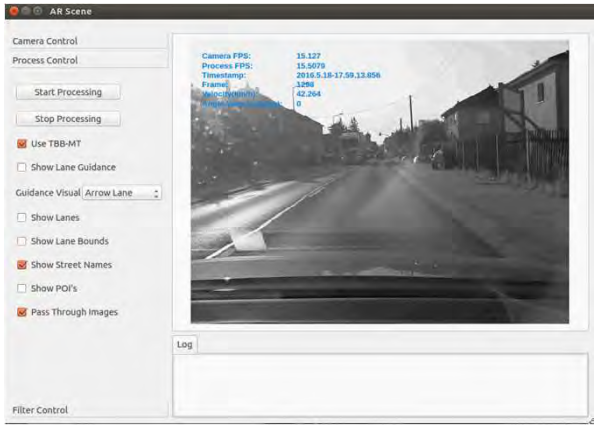
Guidance Augmentation:

- EKF based multi lane detection performs with 10 Hz on Raspberry
- Navigation provides information about recommended lane and vehicle motion
- Augmenting recommended lane, if vehicle is on wrong lane
- Next step is augmenting the maneuver action (left/right turn, u-turn etc.)



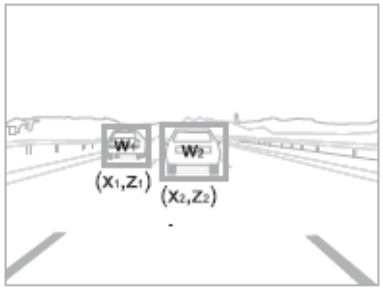
Map Augmentation:

- Right now, names of crossroads are augmented in the real view
- Next step is augmentation of additional map data (POIs, road signs etc.)



Next Steps:

- Extending navigation augmentation for maneuver, poi and destination
- Adding safety augmentation
  (in-front vehicle detection/ pedestrian detection)



AR Windshield:

- Pushing AR content on the windshield
- Presentation of information should be related to driver's line of sight (*contact analogue*)
- Integration of in-vehicle face and gaze recognition
- Integration of head-up display or projection

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