The Future of Automotive Navigation Systems

Dr.-Ing. Stefan Döbrich
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.
Facts & Figures

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
Tuner & Software Defined Radio

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
Forward Engineering – Further Topics

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
Feature Overview
Availability 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
- SiriusXM
- Housenumber first DI
- Driver Distraction
- Encoded Map
- Elevated Roads
- Governmental censure
- National Security Act
- DMB
- Writing right to left
- Patriarchy
- VICS & ETC
- Left-hand driving
- Different address system
Global Navigation Core (3) - Crossplatform and Compatibility Aspects

- **Fully Supported**
  - TISA
  - QNX
  - Windows

- **Partly Supported**
  - GENIVI
  - Cloud
  - OpenOLR

- **Not Supported (Yet)**
  - ADASIS
  - SENSORIŚ
  - VICS
  - ETC2.0
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Map consists of update regions and building blocks
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 – Simple and Complex TestCases

![UML Diagram]

- TestRegion
- SimpleTestCase
- TestCluster
- ClusterTestCase
- ResultDB

- runSimpleTests() → :TestResult
- addTestResults() → runTestClusters()
- :List<TestResult>
- executeClusterTests() → :TestResult
- addTestResults()
### Digital Maps – Compilation of Open Street Map Raw Data

<table>
<thead>
<tr>
<th></th>
<th>Compile map for preset: Dresden_OSM</th>
<th>Run LOG Validation</th>
<th>Run CB Validation</th>
<th>Export stable map for preset: Dresden_OSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copy artifacts</td>
<td>2min 15s</td>
<td>3min 31s</td>
<td>268ms</td>
<td>1min 0s</td>
</tr>
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<td>Average stage times:</td>
<td></td>
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<tr>
<td></td>
<td>2min 15s</td>
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![Map of Dresden](image1.png)

![Another map view](image2.png)
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In 2021 approximately 56% of the global population lives in urban regions.
Future Trends & Development – Connectivity Around the Globe

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

Source: Deloitte | PWC | McKinsey
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.
Agenda

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Hybrid Navigation: Motivation

- **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: First Steps

- 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:
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Augmented Reality

Questions
Q: What means (Automotive) Augmented Reality?
A: „Enrichment of the driver's view with additional information“

 وغير آلة 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

 وغير آلة 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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Questions
Thank you for your kind attention