Addressing the increasing challenges and complexity for navigation systems in the context of autonomous driving

Elektrobit

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Agenda

- History of Navigation and Today
- Live Traffic
- Electronic Horizon
- Over-the-Air map updates
- Navigation for Highly Autonomous Driving
- Relevant Standards for Autonomous Driving
- Open AutoDrive Forum
- Summary

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History of navigation

Pure on-board navigation solutions

- Typically Tier1 has been responsible for hardware, navigation software and map compilation
- Only map data having been supplied by 3rd party suppliers

Consequences

- No cross-project re-use e.g. of navigation software map compilation
- Large efforts involved with supplier switch e.g. for implementation of customer specific features
- Huge dependency between OEM and Tier 1

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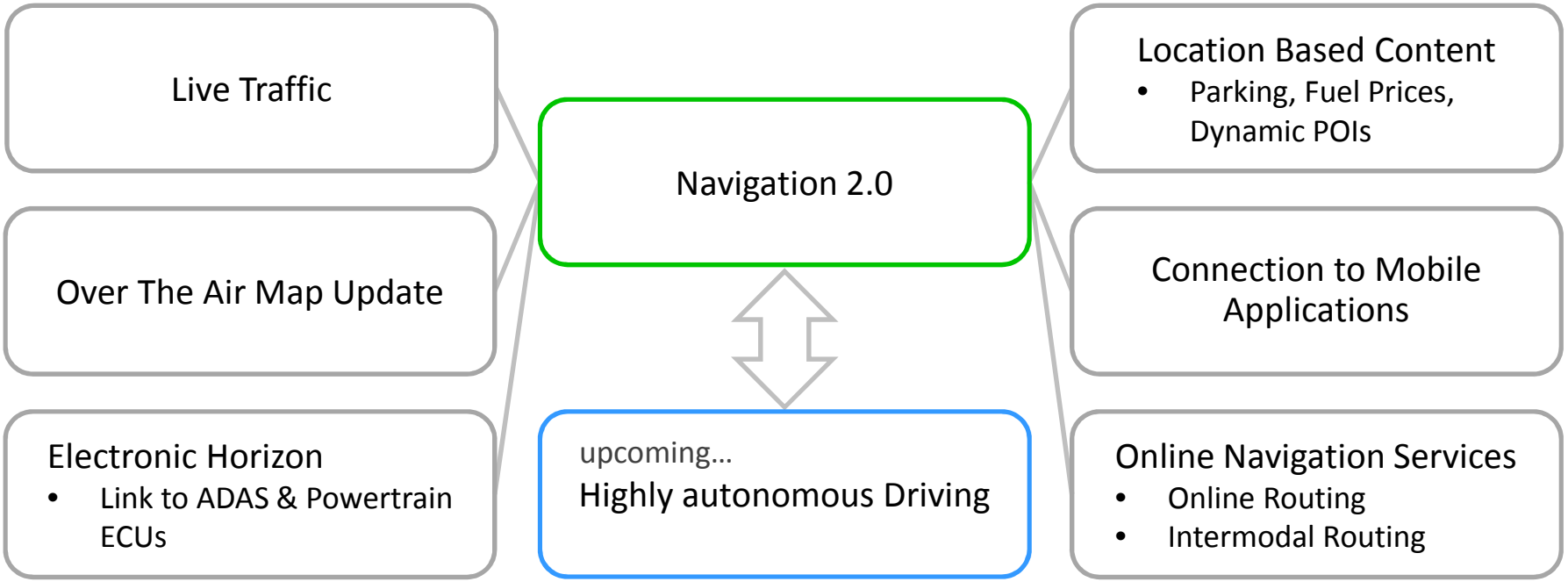
Evolution of navigation



- More and more navigation related services are appearing in the cars
- A lot of different companies are acting in the field of navigation systems:
  OEM, system supplier, navigation software supplier, traffic service providers, online content providers, service operators, …
- Highly autonomous driving is adding additional complexity
- Definition and usage of aligned interfaces is crucial for efficient development and colaboration

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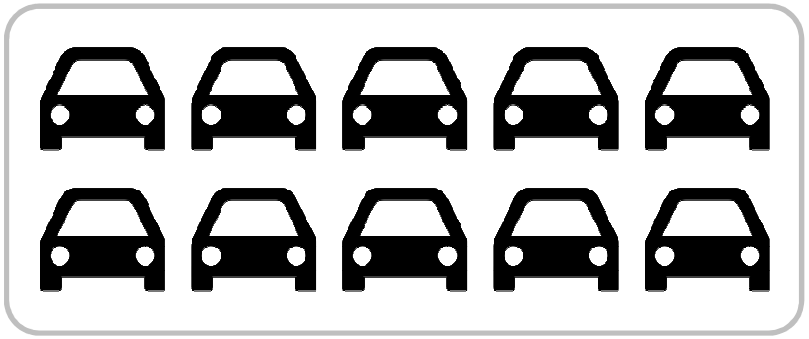
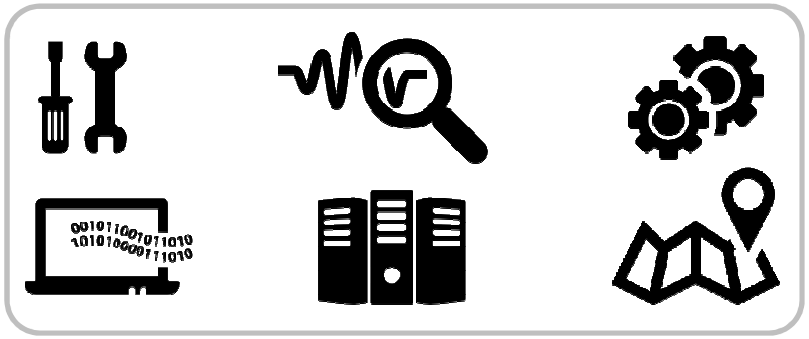
OEM & Tier 1 requirements





OEM

- Encourage competition
- Enable cross-project SW-Reuse
- Force Flexibility/Interoperability
- Reduce Time to Market
- Optimize Pricing
- Usage of OEM owned SW (e.g. HMI)

Tier 1/2 and service providers

- Interoperability
- Flexibility
- Enable cross-customer SW reuse

Combined colloboration on standard/API definition may significantly reduce efforts for participating companies compared to agreement on proprietary interfaces between two partners

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Live traffic

Traffic information is received from service provider via an online connection and/or broadcast services

Navigation continuously checks incident and speed and flow information and dynamically adjusts the route according to the traffic situation

Challenges for navigation systems

- Large amount of messages
- Significant processing power required for decoding of dynamic location references
- Short update cycle

What's next

Lane level accuracy information required for Autonomous Driving

TISA is very active in standardization of traffic services

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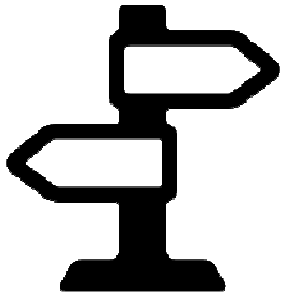
Electronic horizon – Concept

The electronic horizon provides information about upcoming roads

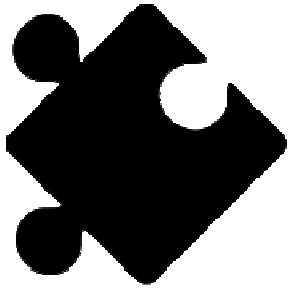


Content

- Geometry
- Intersections
- Road attributes

Position based

Most probable path/route based



Used in addition to on-board sensors in order to validate sensor data and to extend the range of view

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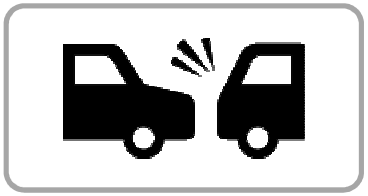
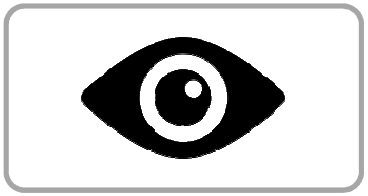
Applications benefitting from electronic horizon



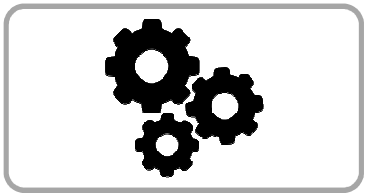
Active driver assistance systems

i.e. lane keep assistant, collision mitigation braking



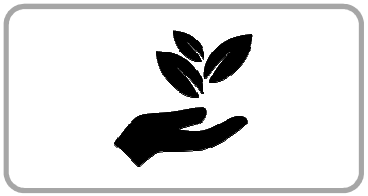
Passive driver assistance systems

i.e. curve speed warning, traffic sign fusion



Motor/gear management

i.e. predictive engine management



Economic/ecologic assistance systems

i.e. battery recharge and range management

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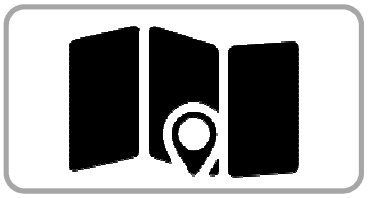
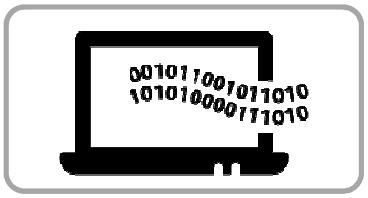
Trends for electronic horizon solutions



Highly accurate map data

Precise representation of intersections, geometries and attributes with lane level accuracy

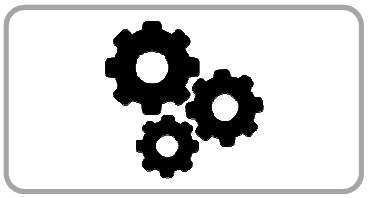


Dynamic data

Over-the-air update of map data and integration of highly dynamic live content

Highly accurate positioning

High motion estimation and localization algorithms meeting autonomous driving requirements



ADASIS is driving standardization of electronic horizon technology

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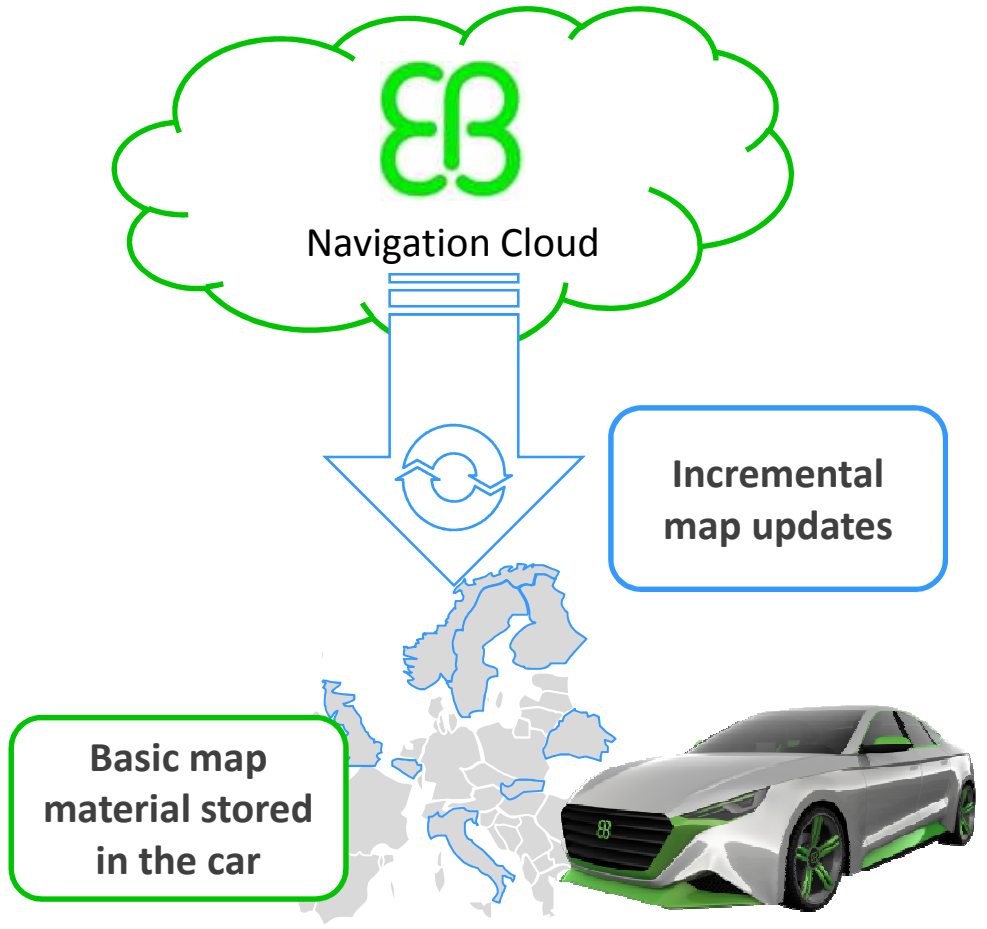
Over-the-air map update

- Incremental updates minimize the transfer volume required to keep the on-board maps up-to date
- On-Demand download of high volume data like e.g. satellite images and 3D map content reduces the data footprint on the device
- On demand download of volatile data guarantees freshness of data being subject of frequent changes

Map Update on-demand download concepts are being standardized by the NDS consortium



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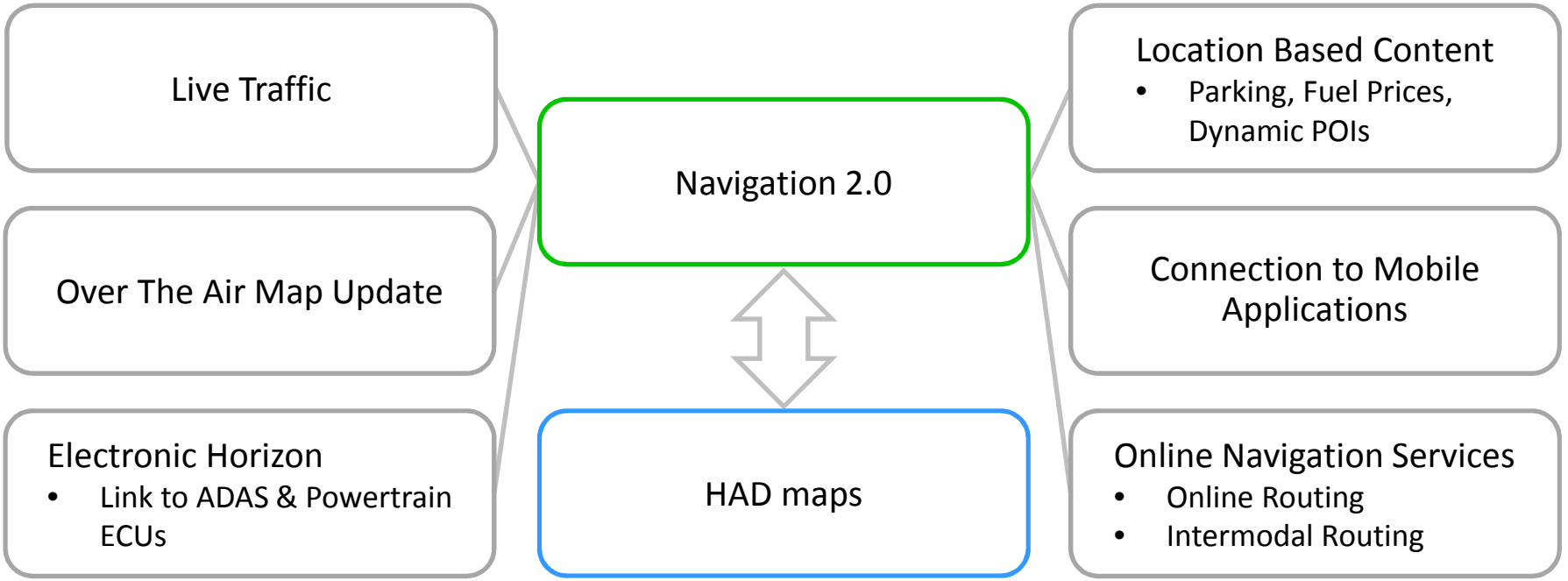
Navigation for HAD



Highly autonomous driving is adding additional complexity

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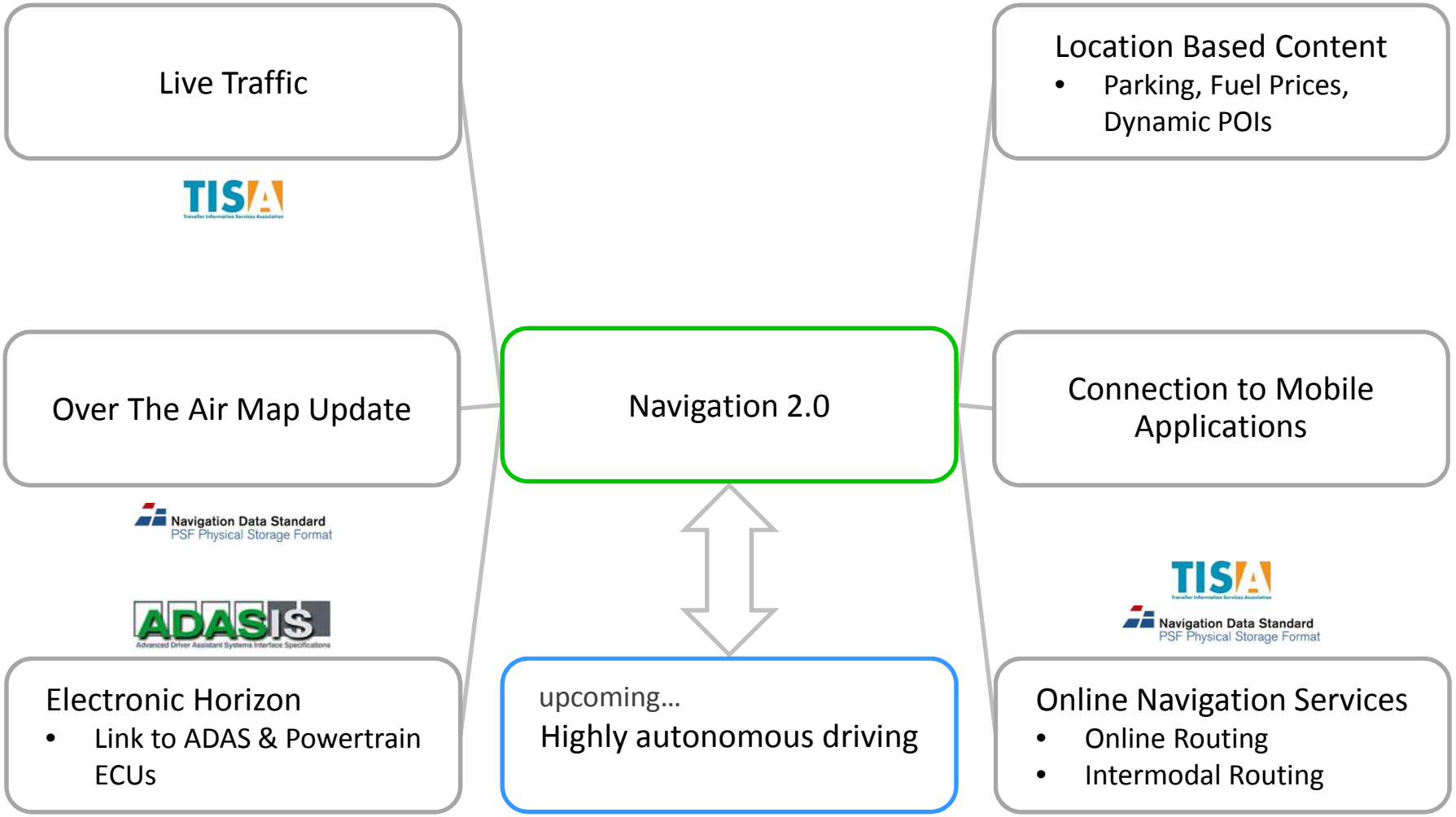
Relevant standards for navigation systems



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TISA – Overview

TISA is a market-driven membership **association** with worldwide scope, established as a non-profit company focused on **proactive implementation of traffic and travel information services** and products based on existing **standards**, including primarily **RDS-TMC and TPEG technologies**

TISA has been established in **Dec. 2007** as a non-profit organization taking-over the activities from the **former TMC forum**, the **TPEG forum** and the **German Mobile.Info** project

More than 100 members from different areas representing the entire traffic and travel information value chain

- **Terminal Client Manufacturers**
- **Car manufacturers**
- **Public Authorities**
- **Broadcasters**
- **Service & Content Providers**

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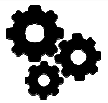
TISA – TPEG

	Traffic Event Compact (TEC)	Fuel Price Information (FPI)	
	Weather Information (WEA)	Road and Multimodal Routes (RMR)	
P	Parking Information (PKI)	Electro Mobility Information (EMI)	
	Traffic Flow Prediction (TFP)	… more are under development	

Supported Bearers:
- IP based services
- DAB

Location Referencing Methods:
- Pre-coded Locations (TMC)
- Dynamic Location Referencing (OpenLR)

Standards are being defined within TISA and typically being handed over to ISO for international standardization

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NDS History

Navigation Data Standard
PSF Physical Storage Format

Founded 2009

Initial scope of NDS
Standardize navigation map data format

OEM

- Flexibility
- Cost and risk reduction

- Costs for map compilation an validation
- Independent exchange of map supplier and/or navigation software supplier

Navigation System Supplier

- Flexibility
- Effort reduction

- Use one map for different OEMs
- Use maps from external map compilation services

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NDS – Series introduction

Navigation Data Standard
PSF Physical Storage Format

Photos by BMW

Photos by Daimler

Photos by VW

Photos by Volvo

2013 2014 2015

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NDS – Current activities

Navigation Data Standard
PSF Physical Storage Format

WG1 Standard

Release of published standards

- Currently released: Version 2.4.3
- Upcoming version 2.5 will reduce number of possible coding variants and thus will increase interoperability

WG2 Hybrid

Defining concepts for map content for hybrid navigation systems

- Loadable Map Data
  - Load high volume map data on demand
    - When they are needed
    - Only for the area which is really needed
- Volatile Data Solution
  - Real time attribute values (Speed Limits, drivable lane management, Dynamic POI attribute values)
  - Real time HD map data (geometry and traffic regulations) for moving construction sites

WG3 AutoDrive

Addressing map related requirements for support of highly autonomous driving

- High accurate lane geometries
- Detailed lane border properties

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ADASIS – Released standards

ADASIS
Advanced Driver Assistant Systems Interface Specifications

ADASIS v2.0	ADASIS v3.0
Basic road geometry (Road center geometries) and Attributes (e.g. Speed Limits, number of lanes) along most probable path optionally covering branching roads	Work in progress: Definition of ADASIS v3.0 adressing HAD requirements Introduction of advanced geometries with **increased accuracy** in cm range**, lane center line geometries, lane boundary geometries and types** and **connectivity model for intersection**s

ADASIS is implemented independent from a dedicated vehicle bus system

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Standards for Highly Autonomous Driving (HAD)

Previously mentioned standards are already covering different aspects of autonomous driving

- NDS is already working on standards for high-precise maps for highly autonomous driving and dynamic map content
- ADASIS is extending the current protocol in order to support the distribution of high-accuracy map and positioning information via an ADAS horizon to several ADAS ECUs
- TISA is discussing increase of accuracy of TPEG traffic information to reach lane level accuracy

HAD

Parts of the HAD standardization activities overlap

- Dynamic content is handled both within TISA and NDS
- Map content and dynamic data being defined within NDS needs to be able to be distributed via ADASIS Horizon
- The ADASIS horizon needs to transmit traffic infomation being received via TISA TPEG protocol

The Open Autodrive Forum has been initiated in order to drive cross domain harmonization of standardization activities

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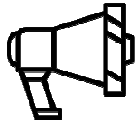
Open AutoDrive Forum

NDS, ADASIS and SENSORIS initiated OpenAutoDrive Forum

- Cross domain harmonization of standards relevant for AutoDrive (ADASIS, SENSORIS, TISA, NDS)
- Provide NDS extensions relevant for AutoDrive for development as open source
- Open Forum (no membership needed)

Closed Loop

- Car Sensors
- Cloud Data Processing
  - High frequent map updates (map compilation)
  - Realtime volatile data overlay; variable signposts etc.
  - Traffic flow information
- Electronic Horizon providing map data to car sensors



Announcement: 4th Open Auto Drive Forum on June 29, 2016 in San Jose, CA

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Summary

Most important standards

Navigation Data Standard
PSF Physical Storage Format

ADASIS
Advanced Driver Assistant Systems Interface Specifications

TPEG
TRANSPORT PROTOCOL EXPERTS GROUP

Open AutoDrive is working on the harmonization among above mentioned activities

Most important benefits for OEMs and Suppliers

- Efficiency
- Re-Use
- Inter-operability
- Flexibility

EB is pro-actively driving all mentioned standards and is encouraging further parties to join standardization activities

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