

NDS & OADF

NDS Status and Activities

14-16.11.2017

Strategic Innovation Program -
Automated Driving for Universal
Services, Tokyo

Dr. Volker Sasse

VP, Chairman NDS / OADF

BRAIN

1./2.Schwalbach

3.Amsterdam

4.San Jose

5.Beijing

6.Brussels

7.Chicago

8.Tokyo

Gorbatschow:

*"He who comes too late
is punished by life."*

Switch to International Standards:

*"He who comes too late
is punished by the AD market."*



Navigation Data Standard

OPEN
AUTO DRIVE
FORUM

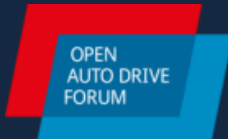
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Autonomous Driving (AD) Revolution

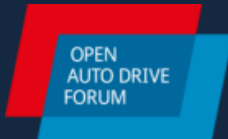
Map/Information is Important



- History shows: The **Map** was always of high importance
- AD requires the **support** of better maps
- Consequence: The whole world will be **mapped** extremely precise
- Japan collected all freeway **maps** for AD at Olympia 2020
- But AD requires **worldwide** standard maps and more cooperation
- Each car acts on **map** data collection, other updates are too slow
- Massive map data are stored and processed in clouds
- Up and down streams will fill the air with **map** data
- Legal, ethic & insurance issues, which includes **maps**, need to be solved
- AD sensor information including **maps** needs to be secure after all



1. NDS the Navigation Data Standard
2. HD the High Definition (Resolution) Map (not SD Map)
3. NDS < > OpenDRIVE
4. NDS Roadmap
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7. Outlook



Standardization Organization: NDS

Compatibility and interoperability

Compatibility and interoperability for the exchange of map data between NDS compliant systems is the key objective of the NDS format.

Separation of application software & map data

In proprietary navigation systems the application software and the map data are combined. A separation of the two creates the desired flexibility between NDS compliant systems.

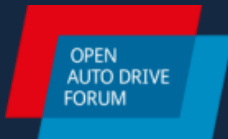
Standardization Organization: NDS

Updates

At present, a variety of different update media and several update mechanisms are available for several in-car systems or mobile clients. NDS provides a harmonized format for different systems, and flexibility regarding map composing and map update.

Roadmap of Association – WORK on the “NDS Successor”

Current activities result in revolutionary new design
Scope of the new product is **AD**



Standardization Organization: NDS

Further features / objectives

- World-wide usability
- Format compactness and efficiency
- Support of different distribution and work media
- Map enhancements like 3D objects and detailed maps for cities as well as driver assistance functions
- Flexibility in terms of extension and inclusion of proprietary data
- Prevention of illegal copying
- Validation of the format interoperability by a conformance checking tool

Standardization Organization: NDS

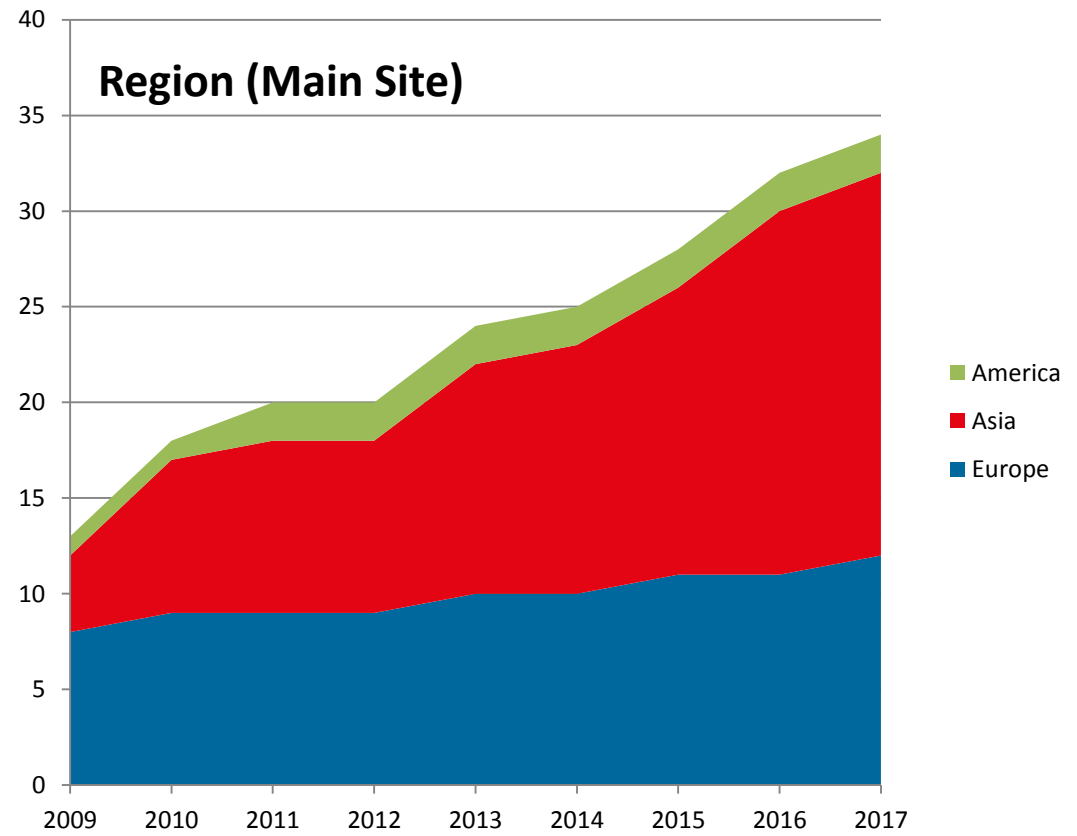
Web site:
nds-association.org

Partners: ->

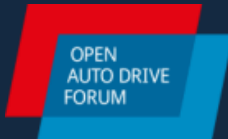


NDS Member Distribution

America:	2	6%
Asia:	21	60%
Europe:	12	34%
Total:	35	



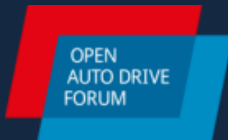
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How does NDS address HD Map Standardization?

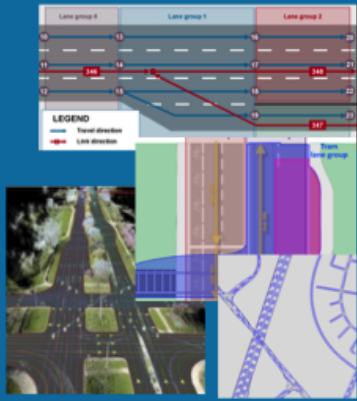
Organization

- NDS Steering Committee put HD map on **standardization agenda in 2013** by installing dedicated Working Group 3
- Development and standardization process has been adapted to allow **fast-track development of HD map standard**
- NDS Working Group 3 is active and has delivered numerous Fast-Track-Extensions before including HD map format in stable **NDS standard version 2.5**
- **In 2017 NDS standard is ready for 2020 autonomous cars**

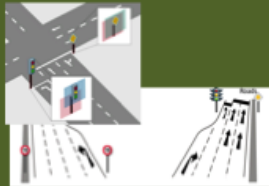


HD Map Layers in NDS

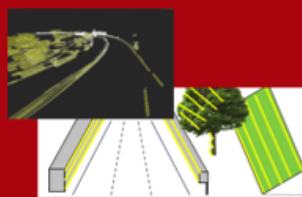
Technology



HD Lane Model



Localization Landmarks



Obstacles



Clustered point cloud

TBD

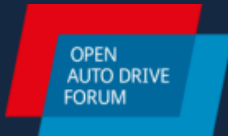
Infotainment building blocks



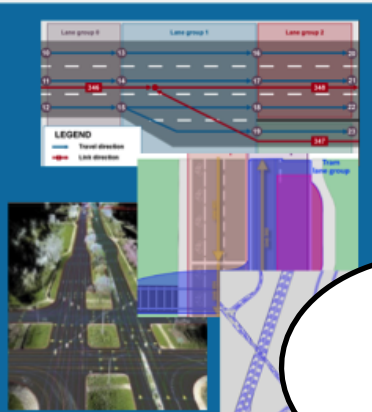
Road geometry



Road topology



**Already
available in NDS
format
TODAY!!!**



HD Lane Model



- Supports functional safety aspects
- Enables location-based update and stream caching
- Highly compact storage to reduce over-the-air bandwidth
- Confidence indication for single features and classes of features

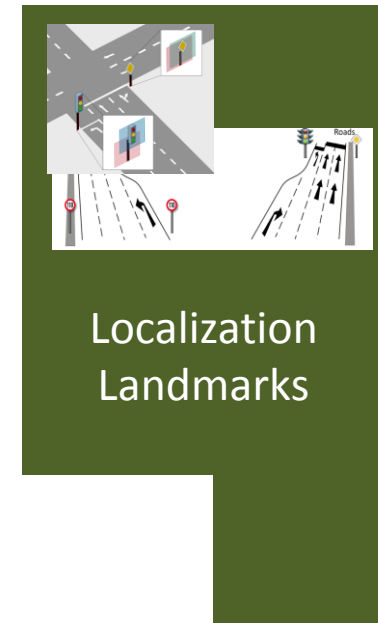
NDS Lane model features

- Millimeter resolution 3D lane geometries
- Full lane connectivity for lane level path planning
- Big amount of lane and boundary types
- Public transport lanes (e.g. tram tracks)
- HD traffic lights information



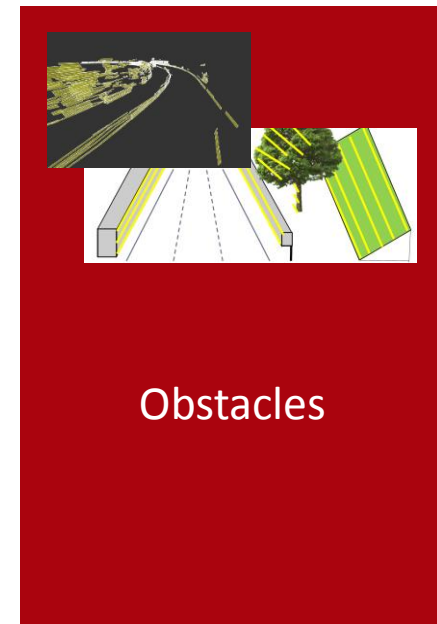
NDS Localization Landmark features

- Millimeter resolution landmark geometries
- Sign faces
- Poles
- Road markings
- Walls
- Traffic lights (position)



NDS Obstacles features

- Millimeter resolution
- Simplified & unclassified localization objects
- Additional height information



The diagram illustrates the HD Lane Model. It features a top section with a grid of lane groups (Lane group 0, Lane group 1, Lane group 2) and numbered lanes (10-23). A legend indicates 'Travel direction' with a blue arrow and 'Link direction' with a red arrow. Below the grid, there are three vertical colored bars (green, blue, purple) representing different lane groups, and a 'Tram lane group' section. The bottom part of the diagram shows an aerial view of a road intersection and a 2D map view of the same area.

HD Lane Model

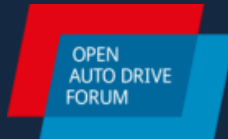
The diagram shows 'Localization Landmarks'. It includes two 3D perspective views of a road intersection with landmarks like traffic lights and signs. Below these are two 2D map views showing road layouts and landmarks.

Localization Landmarks

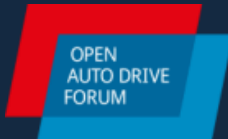
The diagram illustrates 'Obstacles'. It features a 3D perspective view of a road with a tree and a building. Below it is a 2D map view showing the same road layout with the obstacles highlighted.

Obstacles

HD Map Building Blocks to successfully create first Generation of self-driving Car Applications World-wide



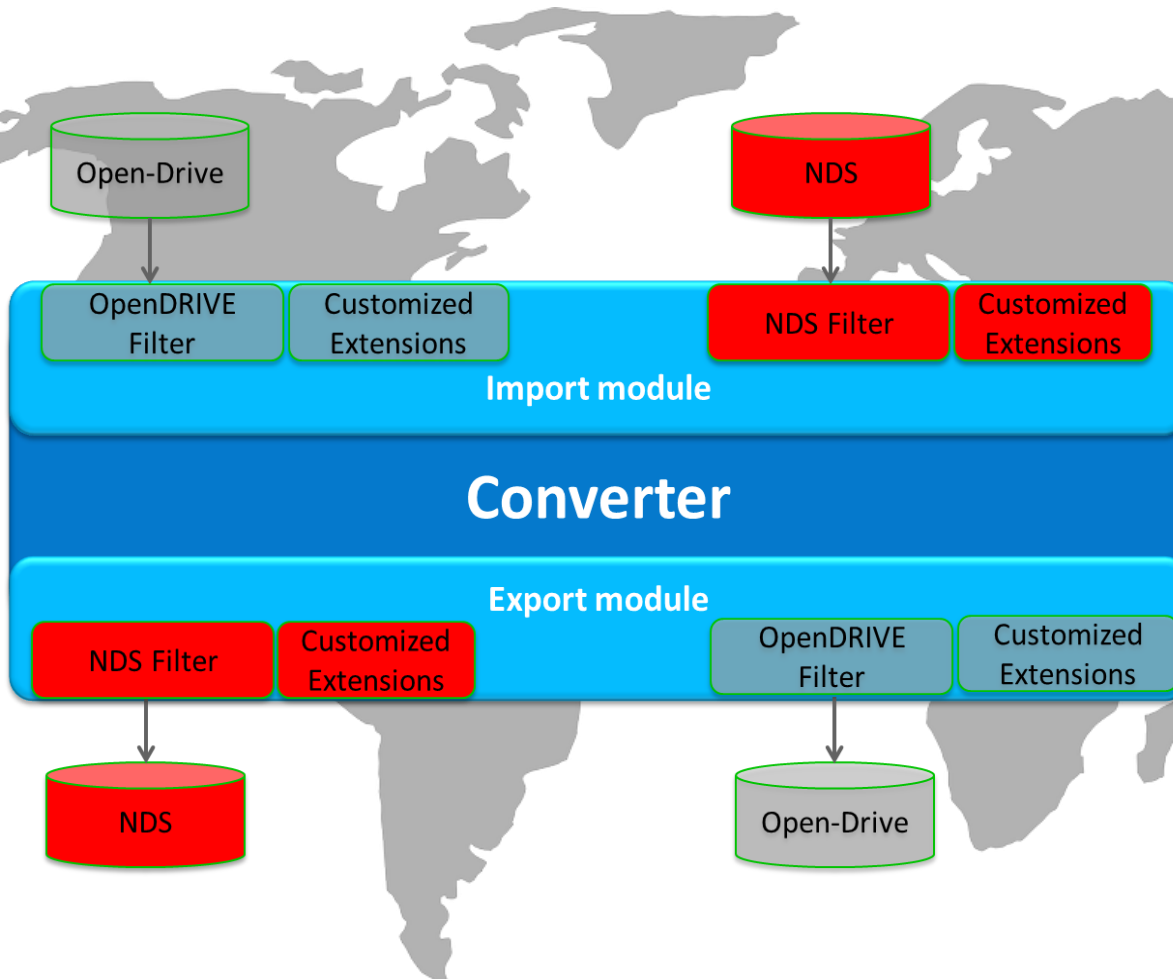
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NDS < > OpenDRIVE

<http://www.opendrive.org/>

Conversion



OpenDRIVE[®] is an open file format for the logical description of road networks.

It was developed and is being maintained by simulation professionals.



NDS



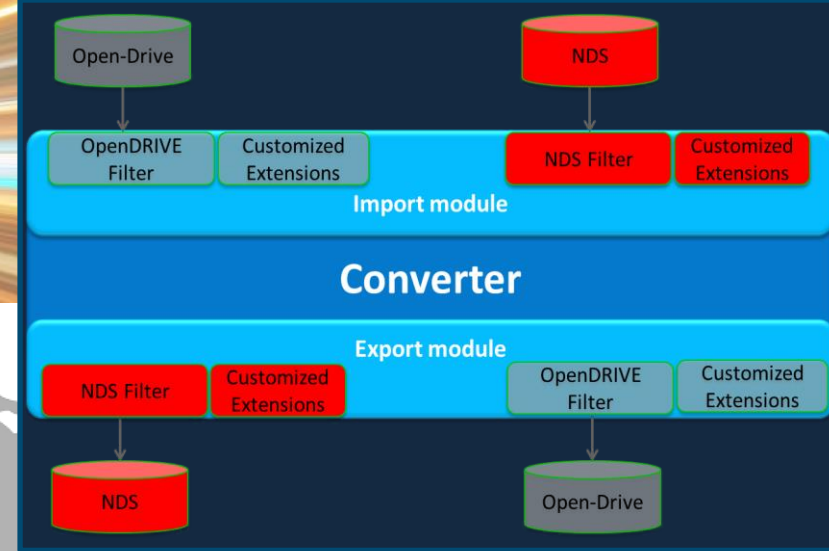
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NDS < > OpenDRIVE



- Beta released, 28.07.2017
- Converts OpenDRIVE < > NDS version 2.5.2
- Download available at internal NDS Artifactory
- Currently in testing
- Final release end of year 2017
- Additional feature package in development

Japanese DMP Exchange File Conversion Option in 2018



NDS



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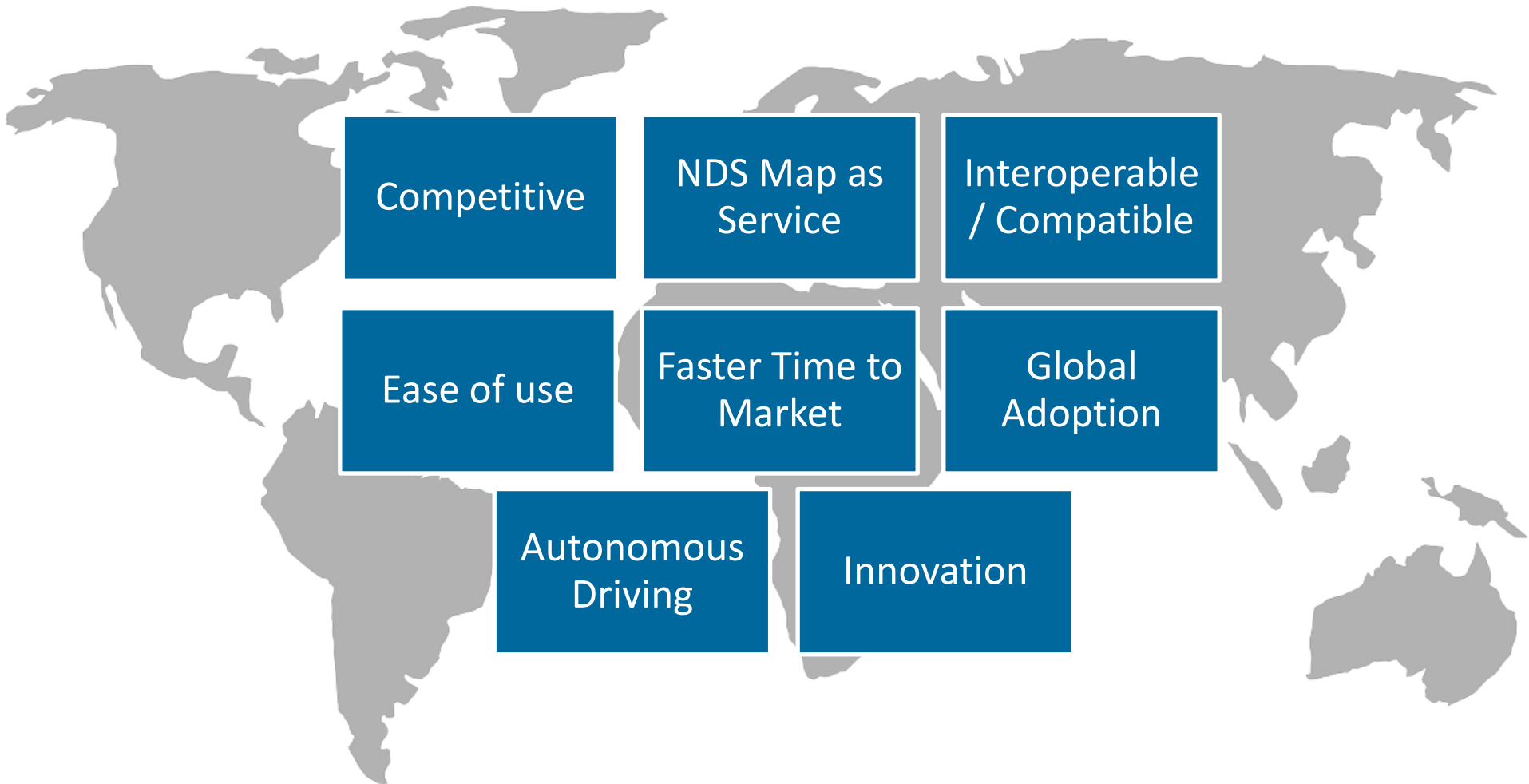
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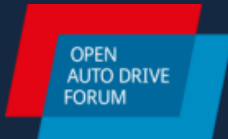
NDS Roadmap

Improvement & Innovation

Targets/Goals



NDS



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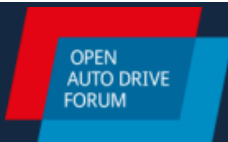


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- NDS is continuously maintained and expanded
- The NDS PM together with the PM of the members are adjusting
- The technical experts of the members realize the detailed description
- NDS is working fast and flexible
- This is based on the requirements of Projects and Roadmap
- NDS is international and thus the roadmap is accordingly adapted
- AD is a key driver of the future roadmap
- The penetration of the AD market with a standard is optimal for all

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External Independent View on NDS

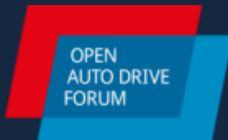
NDS in the Global Market

Source: Frost & Sullivan, MD0F-18, 1.9.2017

- The following pages show a few quotes from Frost & Sullivan
- The original large report is not ordered by the NDS association
- F&S is a business consulting firm involved in market research and analysis, growth strategy consulting, and corporate training across multiple industries



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Automotive Navigation Data Standard: Market Drivers, Global, 2017–2026

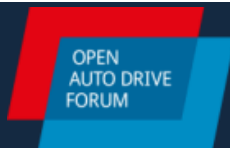
Driver	1–2 Years	3–4 Years	5–10 Years
Compatibility: NDS enables better corporation between system integrators, map makers, and OEMs	H	H	H
Incremental Updates: NDS promotes easy updates leveraging <u>flexible</u> map composing and harmonized standards	H	H	H
OEM Demand: European OEMs are pushing to adopt NDS as a standard	H	M	L

Impact Ratings: H= High, H/M= High/Medium, M= Medium, M/L= Medium/Low, L= Low

Automotive Navigation Data Standard: Market Restraints, Global, 2017–2026

Restrains	1–2 Years	3–4 Years	5–10 Years
Decision making: Implementing new changes to the NDS format would require the NDS Association's approval	H	H	H
Adopting a new standard: Shifting from a company's proprietary standard requires additional investment	H	M	L
NDS membership: Joining the association requires a fee	H/M	M	M/L

Impact Ratings: H= High, H/M= High/Medium, M= Medium, M/L= Medium/Low, L= Low



Europe and China the Start, but today World-Wide

Regional Highlights

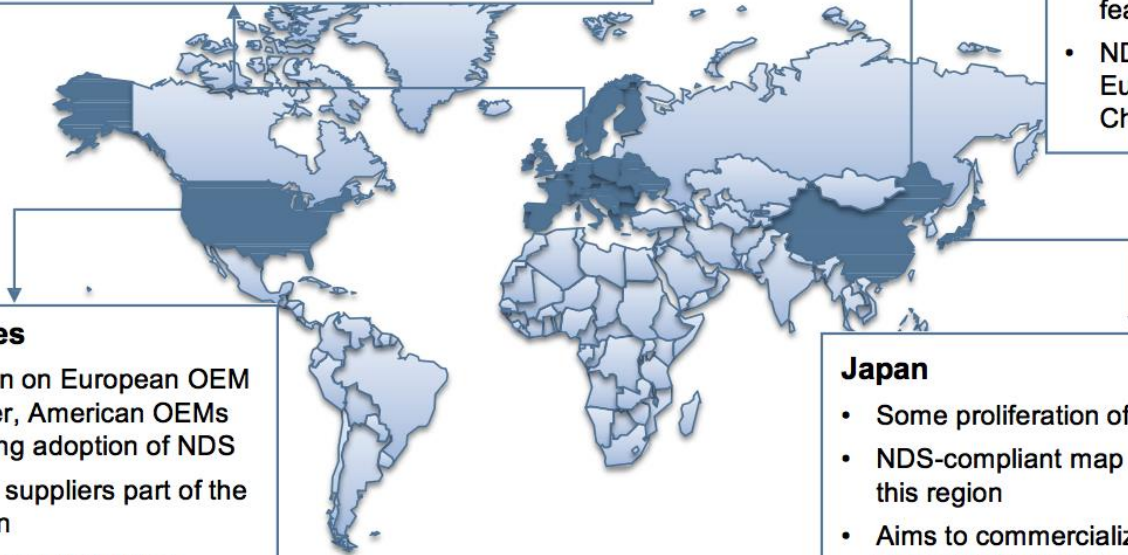
Source: Frost & Sullivan, MD0F-18, 1.9.2017

Europe

- Region with the most NDS proliferation
- Home of the NDS Consortium, most OEMs and suppliers are members of the consortium
- NDS-compliant map database available for this region

China

- One of the first NDS-compliant regions
- One of the first embedded navigation solutions featured from this region
- NDS proliferation among European OEMs and some Chinese manufacturers



The United States

- NDS proliferation on European OEM models; however, American OEMs are still evaluating adoption of NDS
- A few American suppliers part of the NDS Association
- NDS-compliant map database available for this region

Japan

- Some proliferation of NDS
- NDS-compliant map database available for this region
- Aims to commercialize driverless taxis for Tokyo 2020 Olympics
- Government working on proprietary format along with participants such as Toyota, Mitsubishi Electric, and Zenrin



NDS



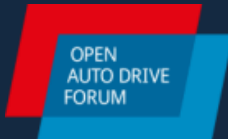
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- **Value Chain:** NDS creates flexibility for OEMs to change their suppliers and faster time-to-market. However, it does increase competition between suppliers, leading to cost-competitive solutions.
- **Ecosystem Evolution:** The commercialization of fully autonomous cars are expected to change the ecosystem, as conventional navigation engine suppliers are expected to be the worst affected.
- **Addressable Market:** NDS adoption is expected to gain more market traction by 2020 with OEMs trying to commercialize their L3 and L4 automated cars in this timeline
- **Global NDS-Penetration:** 2016=7%, 2020=18%, 2025=42%



Applicable Segments	Autonomous Driving	Navigation	Cooperative ITS	OTA
Applicable Regions	North America	Europe	Japan	Latin America

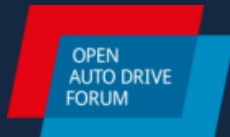
- Vision Transformation
- Megatrends Impact
- Disruptive Applications
- Business Models**
- Current Offerings
- New Capabilities**
- Value-add Services
- Vertical Markets
- Geographic Expansion
- Partnerships
- Investment/M&A

Context and Opportunity

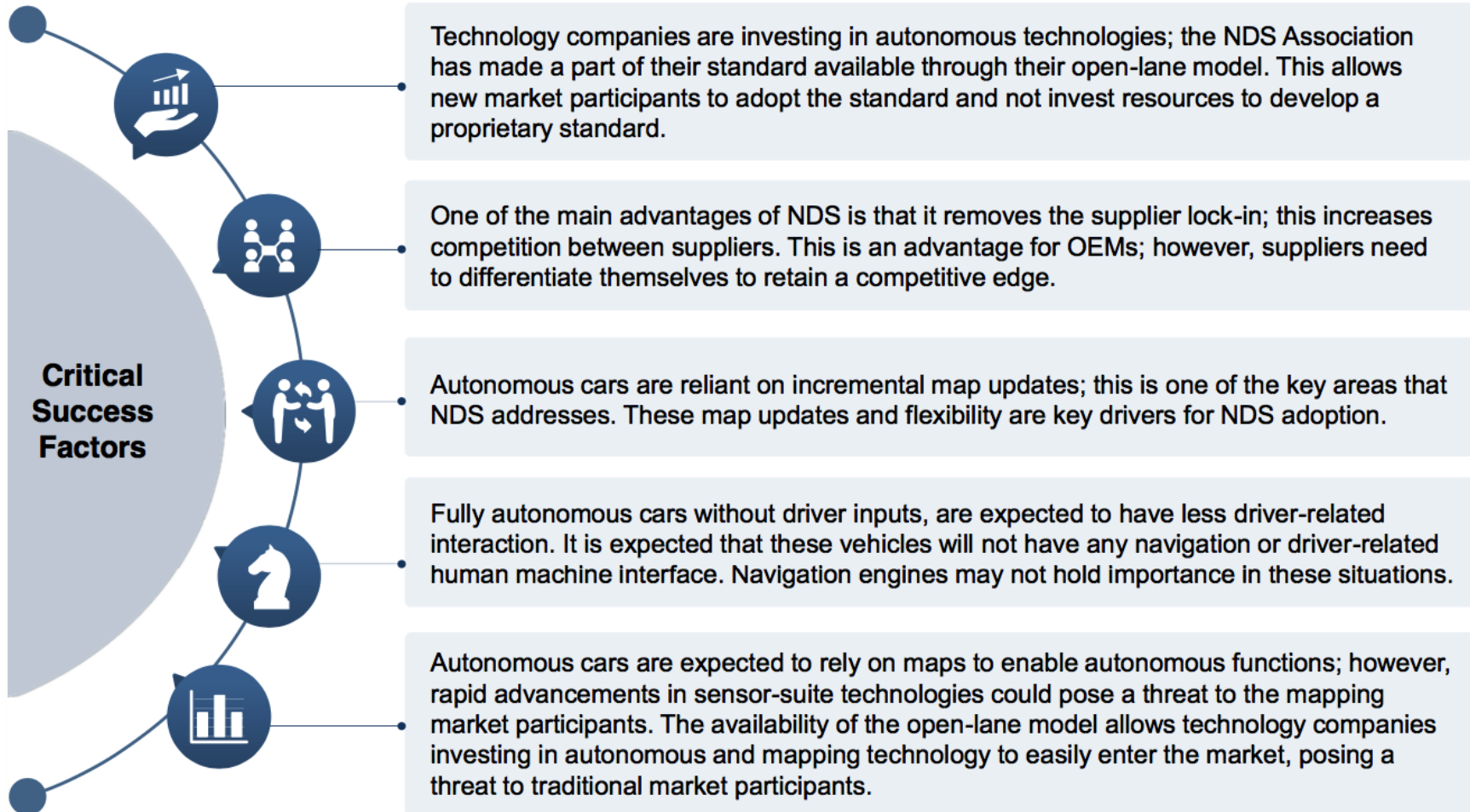
- Business models are not expected to change drastically; however, third-party NDS compilation services may lose their edge or be acquired, as map suppliers are offering NDS-compliant maps.
- NDS is expected to unlock opportunities for OEMs, as it allows them to easily change between suppliers.
- One of the key advantages of NDS, is its incremental update support. It is expected to rely on OTA updates to ensure that the map remains updated to support autonomous driving functions.

Call to Action

- NDS is expected to increase competition among suppliers, as it allows OEMs and Tier-I companies to change suppliers without much inconvenience. Flexibility remains one of the key reasons for NDS adoption.
- Establishing and maintaining standards are expensive, NDS promises to reduce costs by maintaining a single standard for automotive navigation.
- The NDS Association has made their open-lane model available to interested parties; this would allow technology companies working on autonomous vehicles to adopt this standard.



Open-Lane Model supports AD Research



- NDS which **is** a “good to have” solution is expected to **become** a “must have” solution keeping the number of map updates and interoperability as focus points.
- It is expected to hold a significant market share by 2025, and navigation market participants would miss a sizeable opportunity if they do not adopt NDS.



- **Reference:** <https://store.frost.com/navigation-data-standard-nds-in-the-global-automotive-navigation-market-2016.html>

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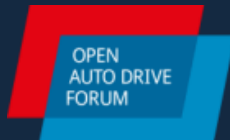
The Initiative



- OADF Forum: founded by NDS e.V. and the ADASIS Forum in November 2015, first meeting in December 2015
- Meanwhile, also SENSORIS & TISA joined
- Connected with SIP-adus (Japan) and ISO
- More organizations of the relevant business are about to join



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Autonomous Driving Domain Control

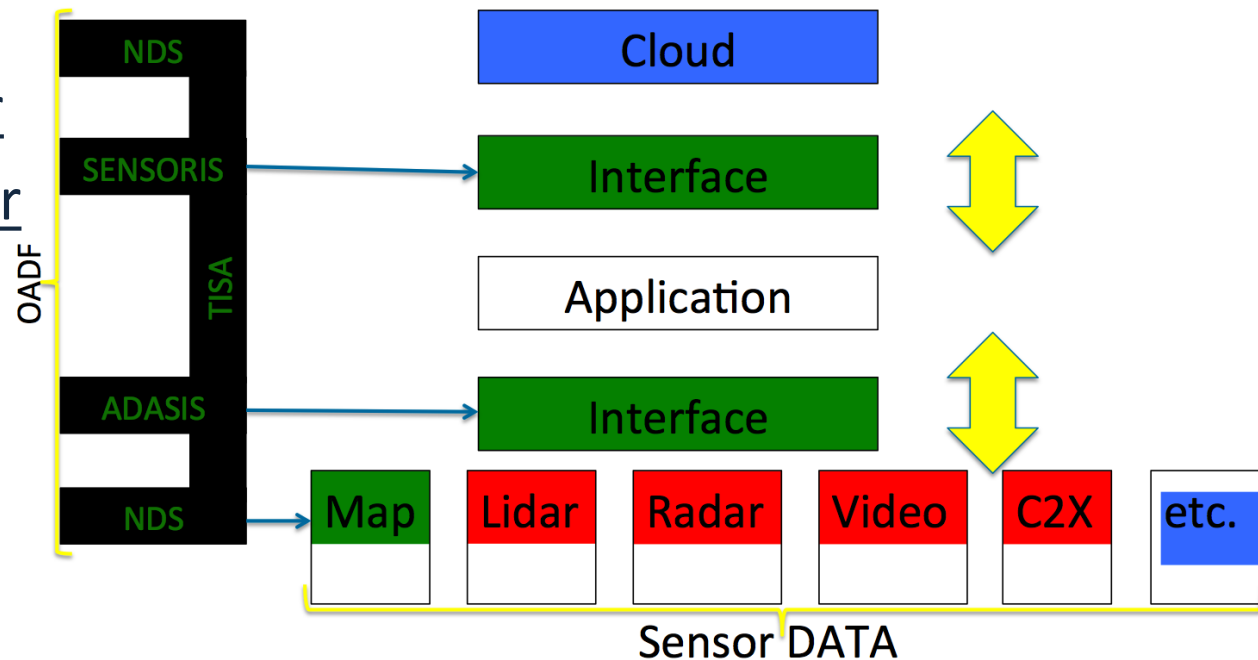
> HW Platform with AD SW and Data

Cloud
Maps are Updated
Geocoded Sensors

- **Map** Suppliers assure consistency in the map clouds
- **Sensors** create a buffer around a car
- A domain controller is the central new **BRAIN** in a car

Legend for sensor data standardization:

- Red circle: None Std
- Green circle: Standard
- Blue circle: Partly Std



Auto Drive Ecosystem (v 1.0)

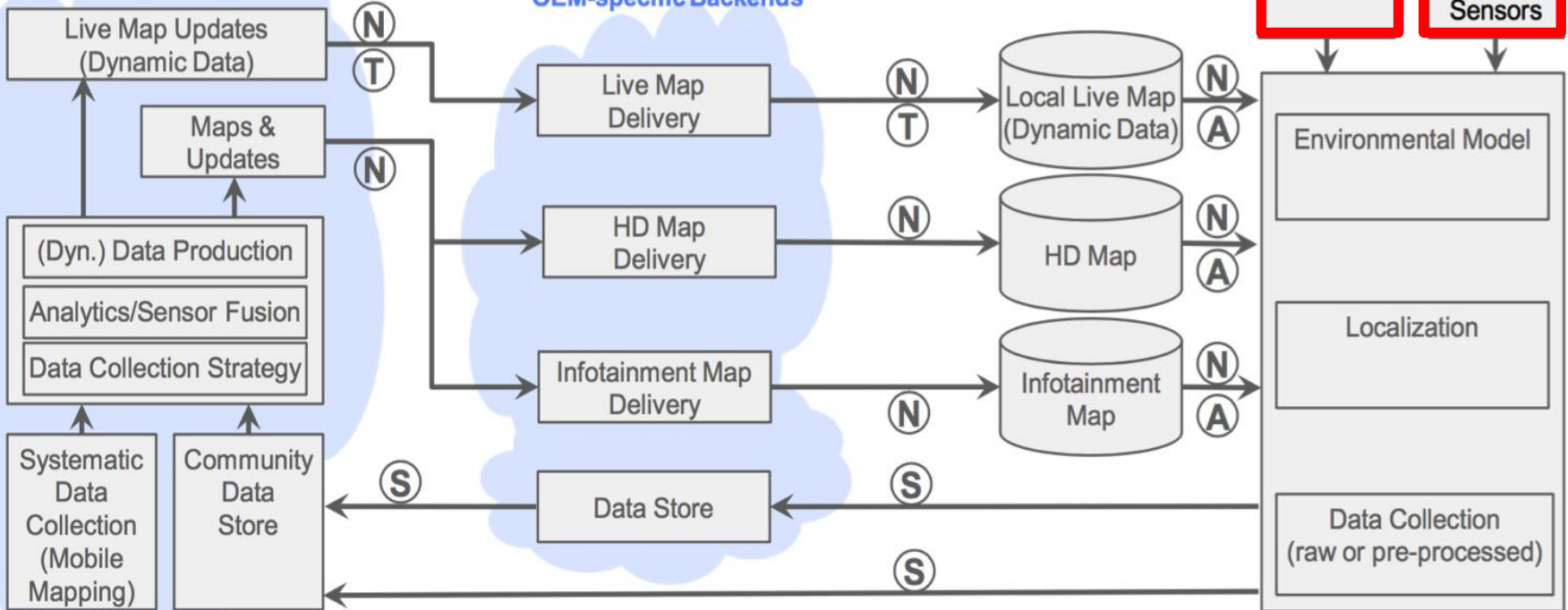
OADF >

- N** NDS
- A** Adasis
- S** Sensoris
- T** TISA

----- INFRASTRUCTURE -----

Backend (one or multiple) operated by Map supplier / OEM / 3rd Party

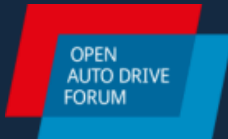
OEM-specific Backends



Auto Drive Ecosystem (V 2.0) will be presented soon



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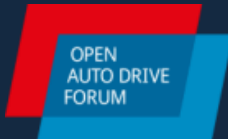
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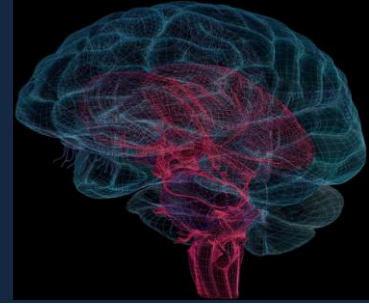
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Outlook →

The Map is Part of a
Central Shared Information System

BRAIN



Autonomous Driving

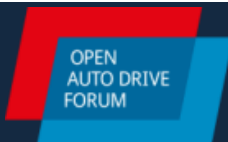
Requires to **Join** Forces

in order to Support the Development within a
Highly Competitive New World
with a lot of Challenges.

More than in the Past we NEED to
Share **Globally** Information and Knowledge
for the Sake of **Safe** Solutions.



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