Connected and Automated Driving Requirements for digital infrastructure

3rd SIP-adus Workshop on Connected and Automated Driving Systems 2016

Dr. Frank Foersterling

Continental

Automated Driving
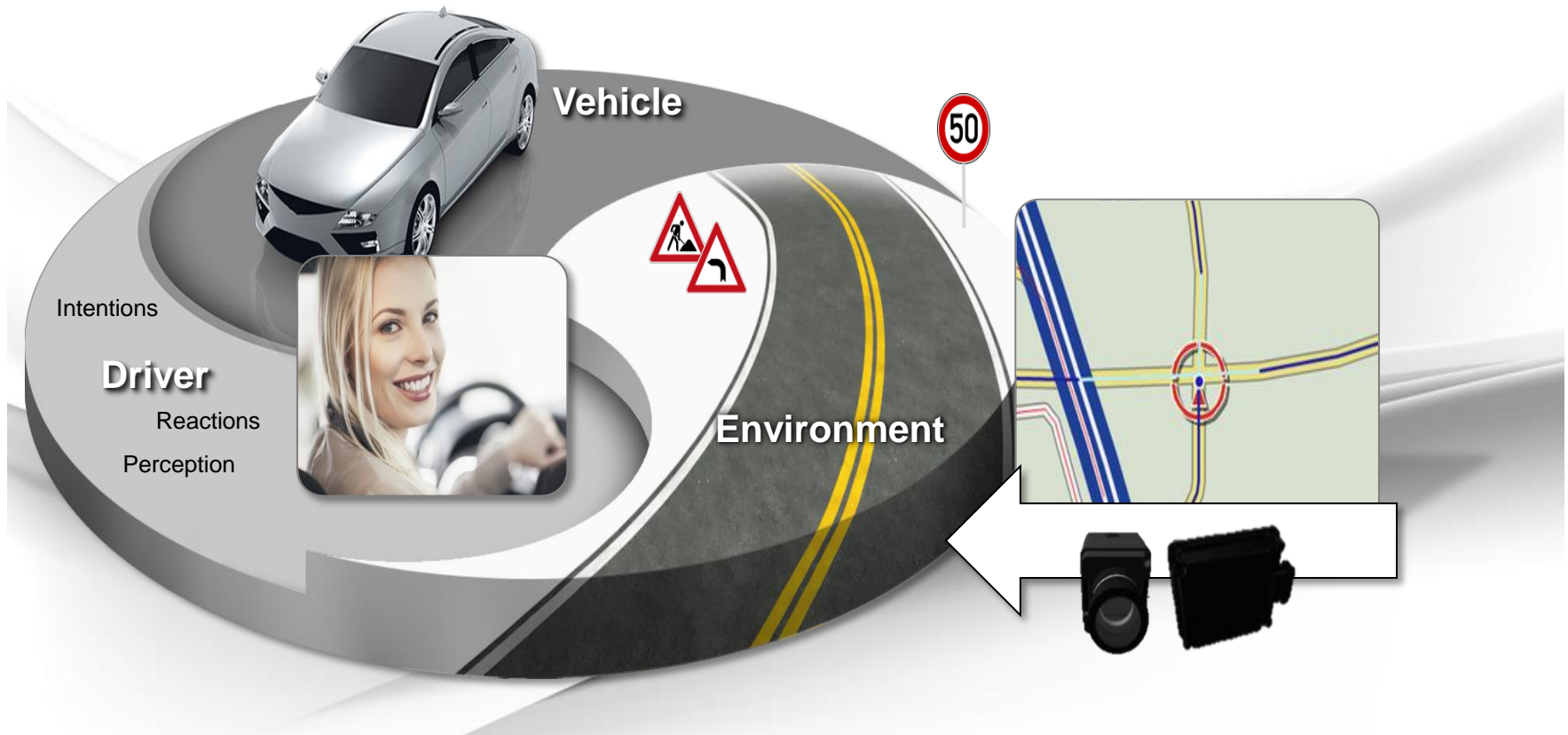## Close the Loop Between Driver, Vehicle & Environment

Vehicle

Intentions

Driver

Reactions

Perception

Environment

50

Visual Range 300m
Is this Really Enough?

Environment Detection

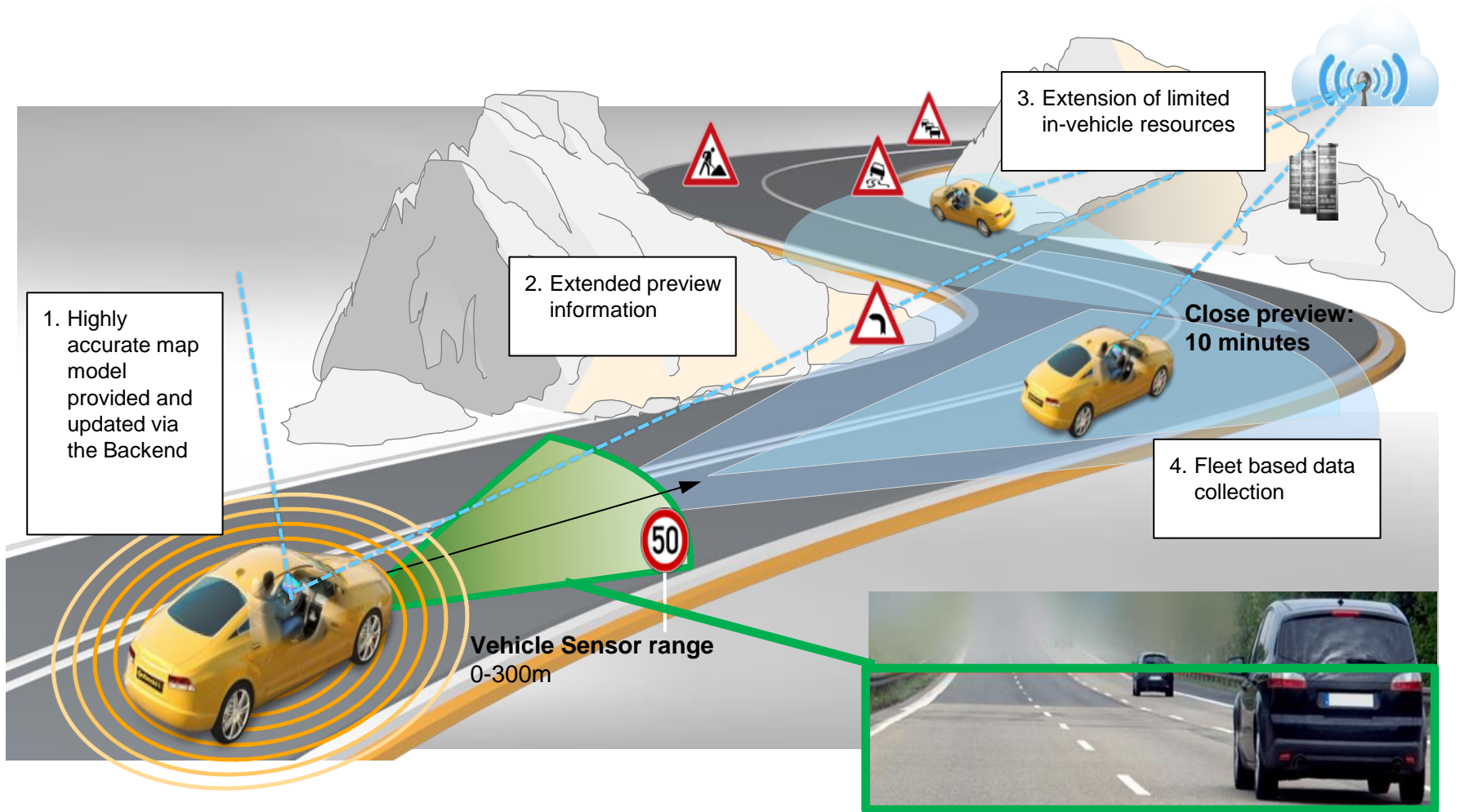Digital Onboard Maps:Provide Information Beyond the Line of Sight – **eHorizon**

Vehicle

Intentions

Driver

Reactions

Perception

Environment

50

Continental

Next Step: Digital Maps and Online Data
Provide real-time Information – **dynamic eHorizon**

Vehicle

Intentions

Driver

Reactions

Perception

Environment

50

Continental
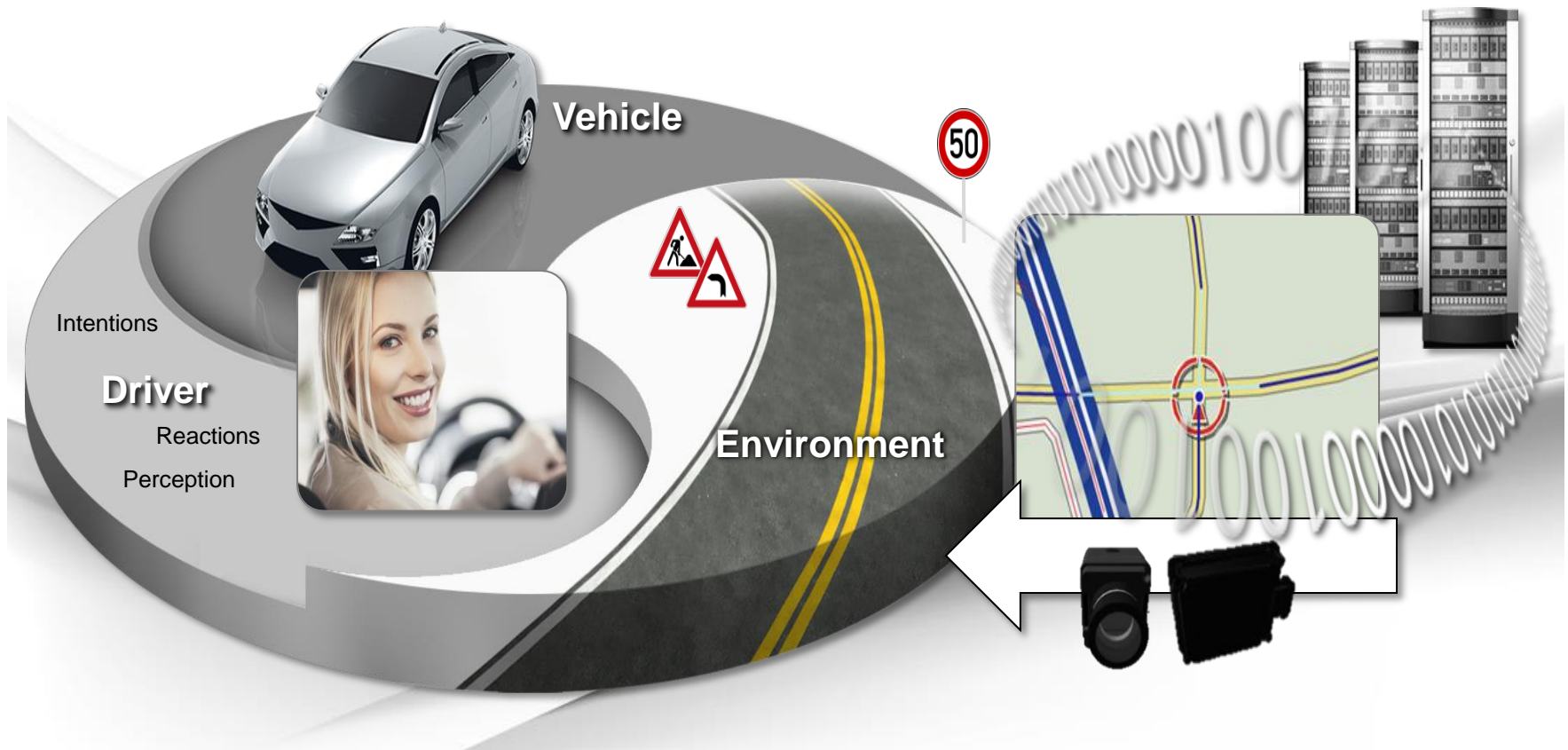
Tomorrow's Situation: Sensors, Maps and Online Data
The Vehicle Looks beyond 300m and Around the Corner

3. Extension of limited in-vehicle resources

2. Extended preview information

Close preview: 10 minutes

1. Highly accurate map model provided and updated via the Backend

4. Fleet based data collection

Vehicle Sensor range 0-300m

Automated Driving: "Fresh Data" from the Cloud
Highly Precise Map and Dynamic Data – Crowd Sourced
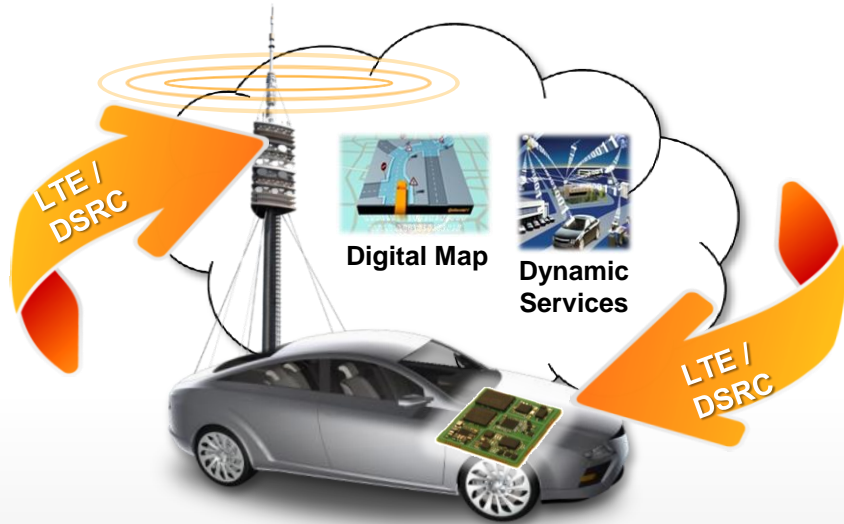
Digital Map

Functions

› Static Basic Map
› HAD Map Extension (lane, landmark, …)
› Dynamic Events (Speed Limit, …)

Features

› Highly precise (location, time)
› Highly up-to-date (real-time)
› Learning map (via crowd sourcing)

Dynamic Services (Reference List) - based on Traffic Management Information

Lanes Closure

Traffic Sign

Traffic Jam ahead

Construction Assistant

Digital Infrastructure Requirements for AD
Provision of up-to-date digital map

Key feature: Cloud based digital map – always up-to-date and precise

Always up-to-date

> › tile based approach
> › learning map (e.g. gantries)
> › versioning
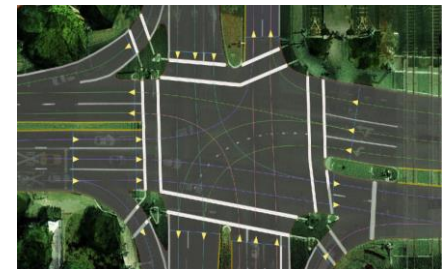> › Predictive tile download to the vehicle (based on eHorizon MPP)

precise

> › lane accurate information
> › precise map matching (lane specific)

CHALLENGE: HD Road Model
> › What kind of information? → landmarks, lane info, what else?
> › how to get initial model
> › how to run updates / maintenance
> › how to ensure self localization and precise positioning?

Digital Infrastructure Requirements for AD
Support of Landmark concept

Key feature: precise landmarks along the highway

Absolute Positioning

› based on GNNS technology
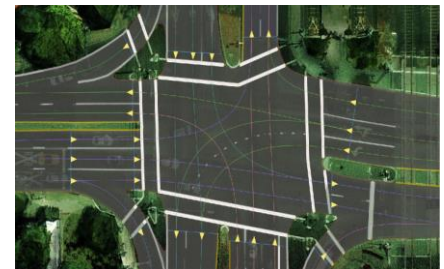› in addition with correction mechanisms

Relative Positioning

› via landmarks
› via Camera based solutions (option: radar based)

CHALLENGE: Life cycle
› Update mechanism of landmarks

Digital Infrastructure Requirements for AD
Provision of up-to-date dynamic events / traffic information

Key feature: infrastructure based environmental prediction beyond the local vehicle sensors

Support of speed adjustment:
› Incident prediction (jam, dangerous objects, dangerous weather, …)
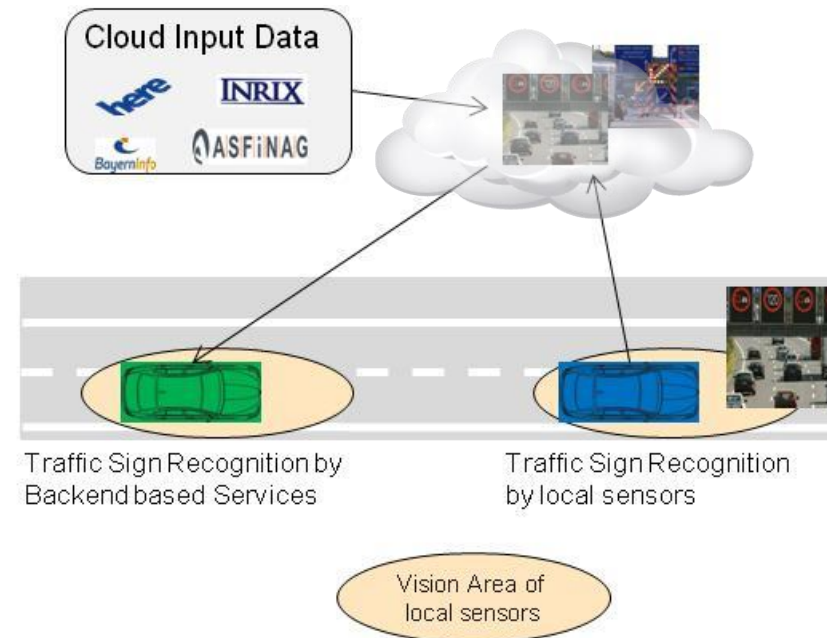› Predictive information about speed limits

Support of lane changing strategy
› Prediction of closed lanes
› Prediction of no-passing areas

Support to evaluate the road features
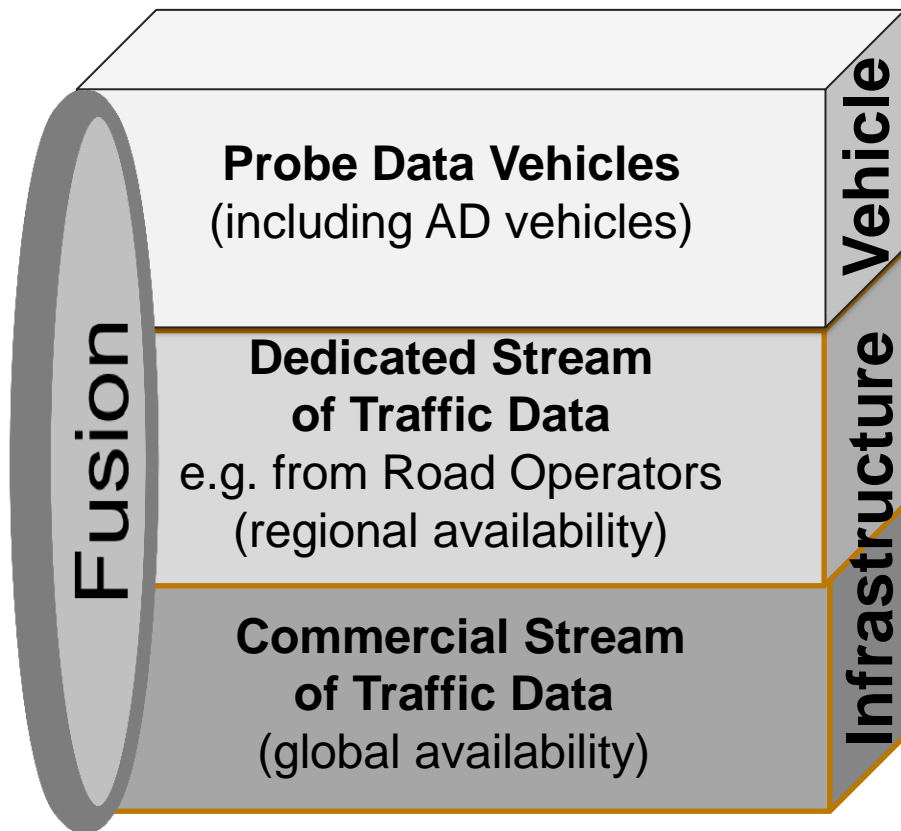› Recommendation of AD release (Road/Link Blacklist)

Support of controlled vehicle stop

Cloud Input Data

Traffic Sign Recognition by Backend based Services

Traffic Sign Recognition by local sensors

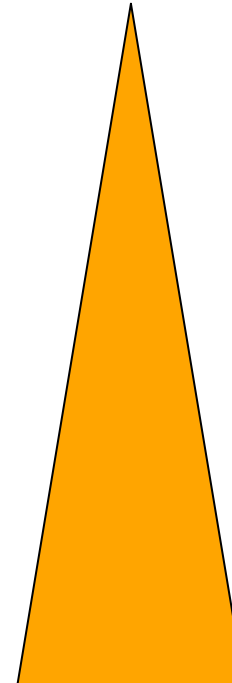Vision Area of local sensors

Continental

Digital Infrastructure Requirements for AD
Provision of up-to-date dynamic events / traffic information

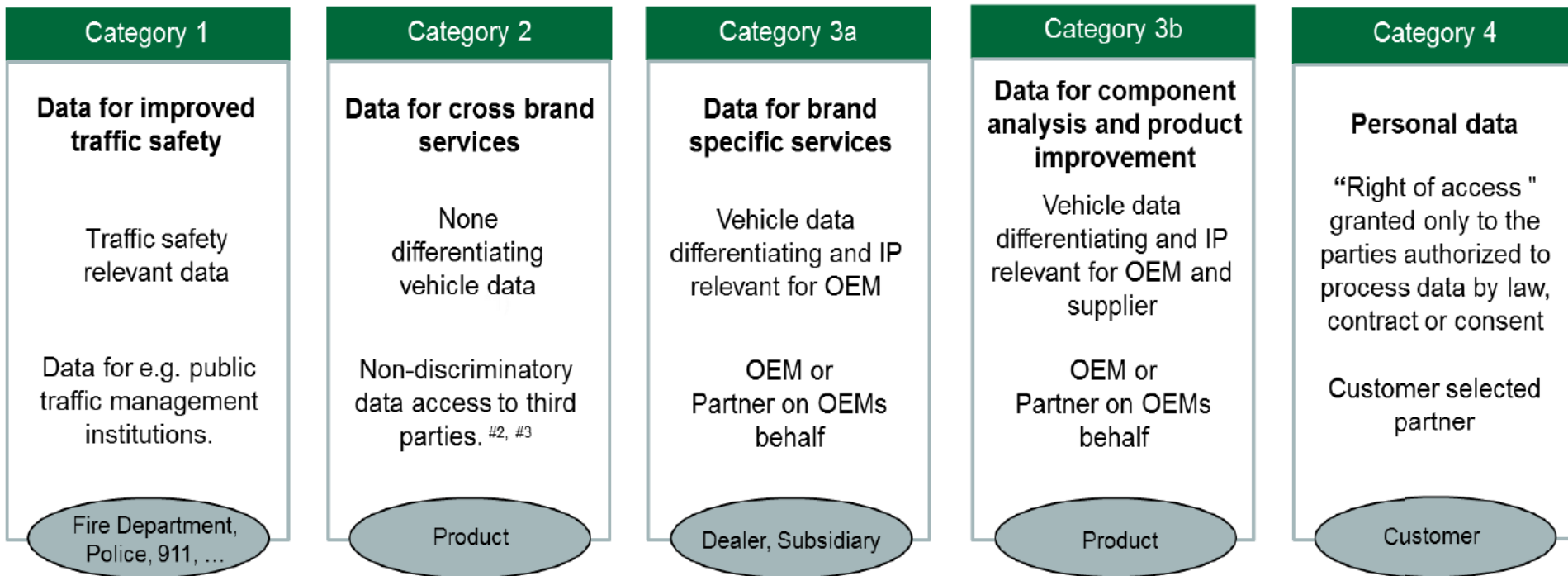**Stepwise deployment of AD vehicles require dedicated data fusion strategy**

Fusion

Probe Data Vehicles
(including AD vehicles)

**Dedicated Stream
of Traffic Data**
e.g. from Road Operators
(regional availability)

**Commercial Stream
of Traffic Data**
(global availability)

Vehicle

Infrastructure

**Data Availability
as of today**

**Data Quality as of
today (for AD)**

Ⓒontinental
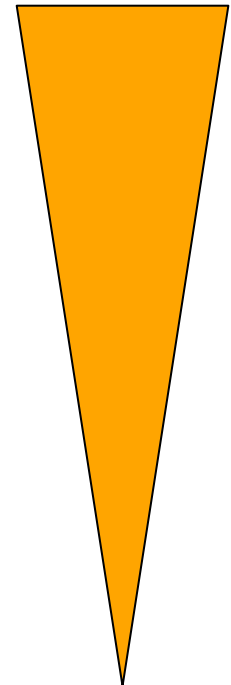
Digital Infrastructure Requirements for AD
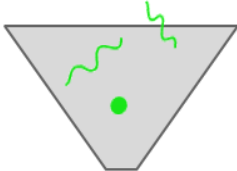## Data Usage Categories

Position of VDA Germany (communicated to EC)

Category 1	Category 2	Category 3a	Category 3b	Category 4
Data for improved traffic safety	**Data for cross brand services**	**Data for brand specific services**	**Data for component analysis and product improvement**	**Personal data**
Traffic safety relevant data	None differentiating vehicle data	Vehicle data differentiating and IP relevant for OEM	Vehicle data differentiating and IP relevant for OEM and supplier	"Right of access" granted only to the parties authorized to process data by law, contract or consent
Data for e.g. public traffic management institutions.	Non-discriminatory data access to third parties. [2, 3]	OEM or Partner on OEMs behalf	OEM or Partner on OEMs behalf	Customer selected partner
Fire Department, Police, 911, ...	Product	Dealer, Subsidiary	Product	Customer

The customer [1] will be informed of data usage and OEMs will provide the customer with decision options which the customer can reverse at any time, unless the function is required by law

Digital Infrastructure Requirements for AD
Support of Functional Safety Requirements
Five map safety aspects have to be considered

	Question	Possible Measure
1) Content	Is the **map content quality** as good as indicated in the metadata?	Map content quality assessment
2) Provision	Can we rely on the **map provider**?	Map provider audit
3) Transmission	Was the **data transmitted** without falsification of map data or metadata?	End-to-end checksum
4) Interpretation	**How correct, precise and up-to-date** is the received data set?	Map quality metadata
5) Processing	Does the **automotive E/E system** work according to the specification?	Functional safety audit / assessment ASIL

Digital Infrastructure Requirements for AD
Reliable hybrid telecommincations infrastructure
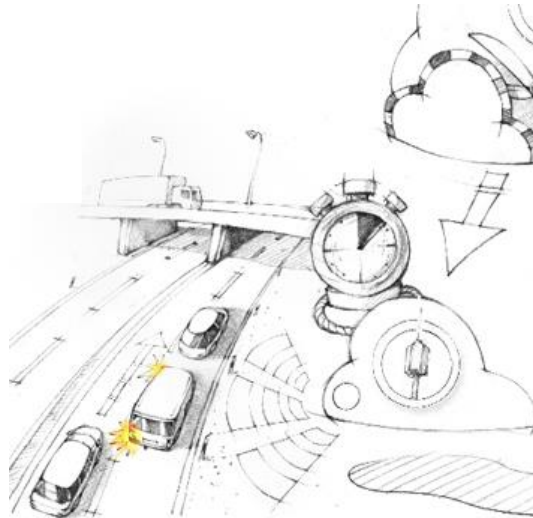
ITS G5 Communication
Direct vehicle to vehicle

ITS G5 Communication
Short Range

LTE / 5G Communication
Incl. LTE V2X / LTE MEC

Vehicle-to-vehicle is about proximity, path prediction and collision anticipation/warning:
- Intersection & Lane Change
- Rear end

Vehicle-to-infrastructure is about broader road conditions:
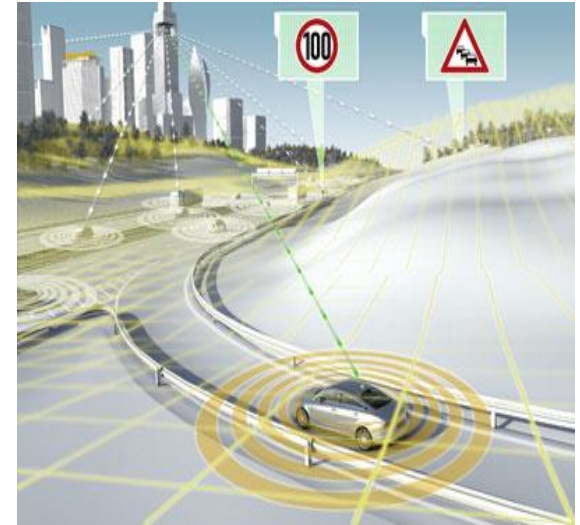- Incidents
- Alerts

V2X via location-cast is about Electronic Horizon far ahead of the vehicle:
- Weather/road/traffic conditions
- Incidents

Continental T·· Fraunhofer ESK NOKIA

Digital Infrastructure Requirements for AD
Reliable hybrid telecommincations infrastructure

Option: Mobile Edge Computing to reduce latency
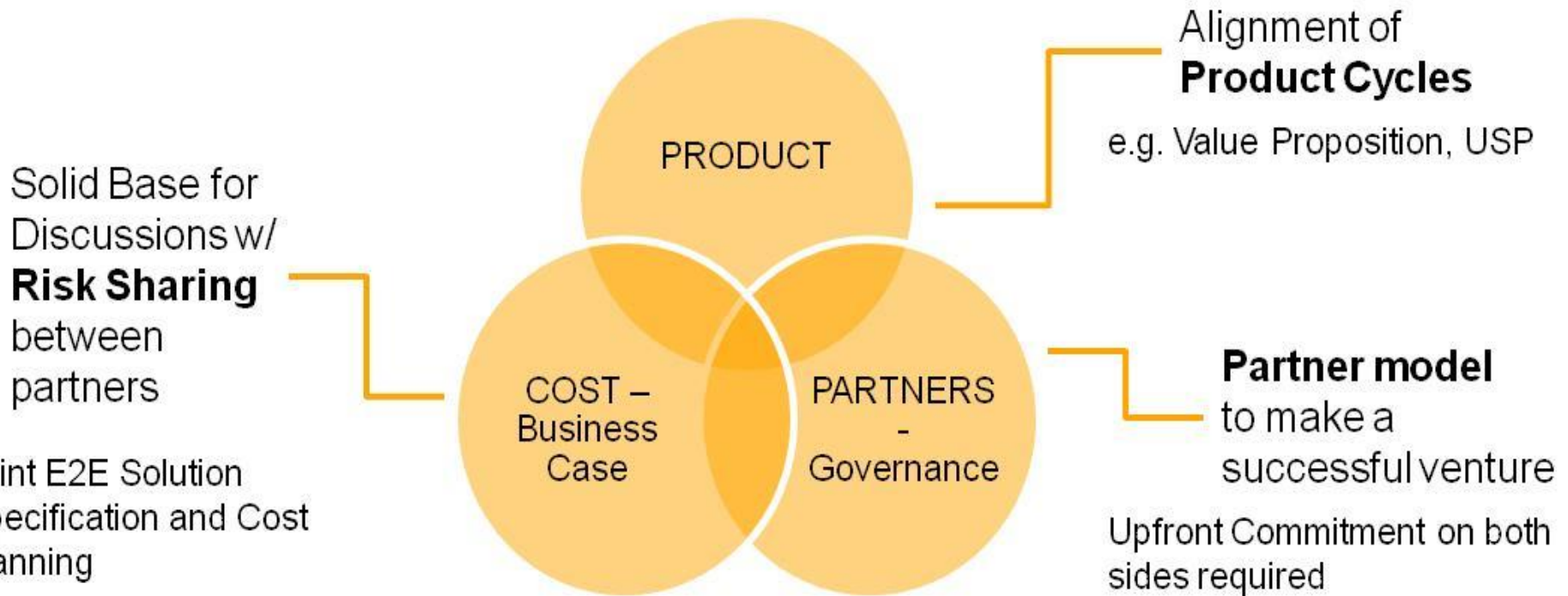
LTE network

20 ms

Central cloud for connected cars

Distributed „cloudlets" for connected cars

Section of A9 test bed

Continental T··· Fraunhofer ESK NOKIA

Collaboration – Way Forward Auto and Telco industries – Common Development of Product and Businesses

Alignment of **Product Cycles**

e.g. Value Proposition, USP

Solid Base for Discussions w/ **Risk Sharing** between partners

Joint E2E Solution Specification and Cost planning

PRODUCT

COST – Business Case

PARTNERS - Governance

Partner model to make a successful venture

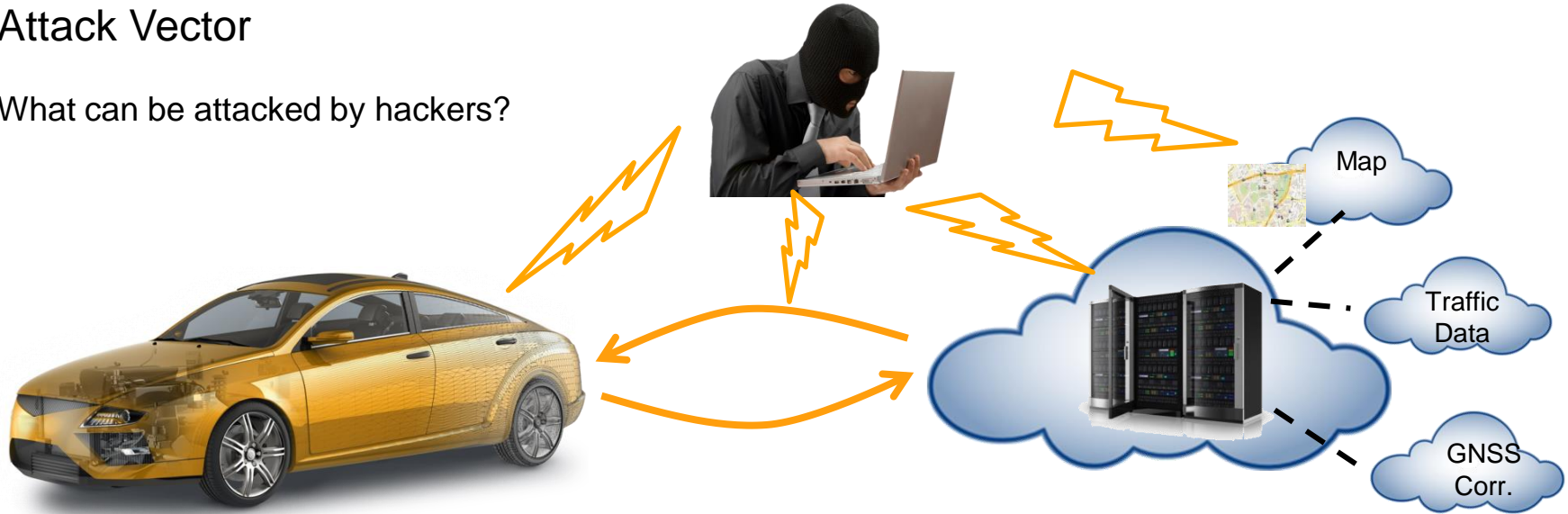Upfront Commitment on both sides required

European Alliance between Telecom & Automotive to promote the wider deployment of connected & automated driving

Digital Infrastructure Requirements for AD

Security & Privacy
Attack Vector

What can be attacked by hackers?

Vehicle
› Position, Lane Information, GNSS Speed, Road Slope, Road Curvature, AD Status etc.
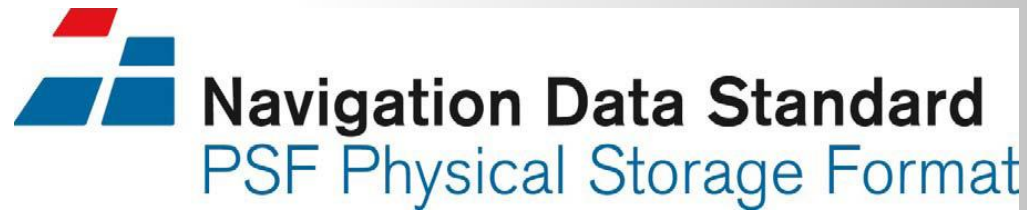
Connection
› LTE, GSM
› V2X

Backend
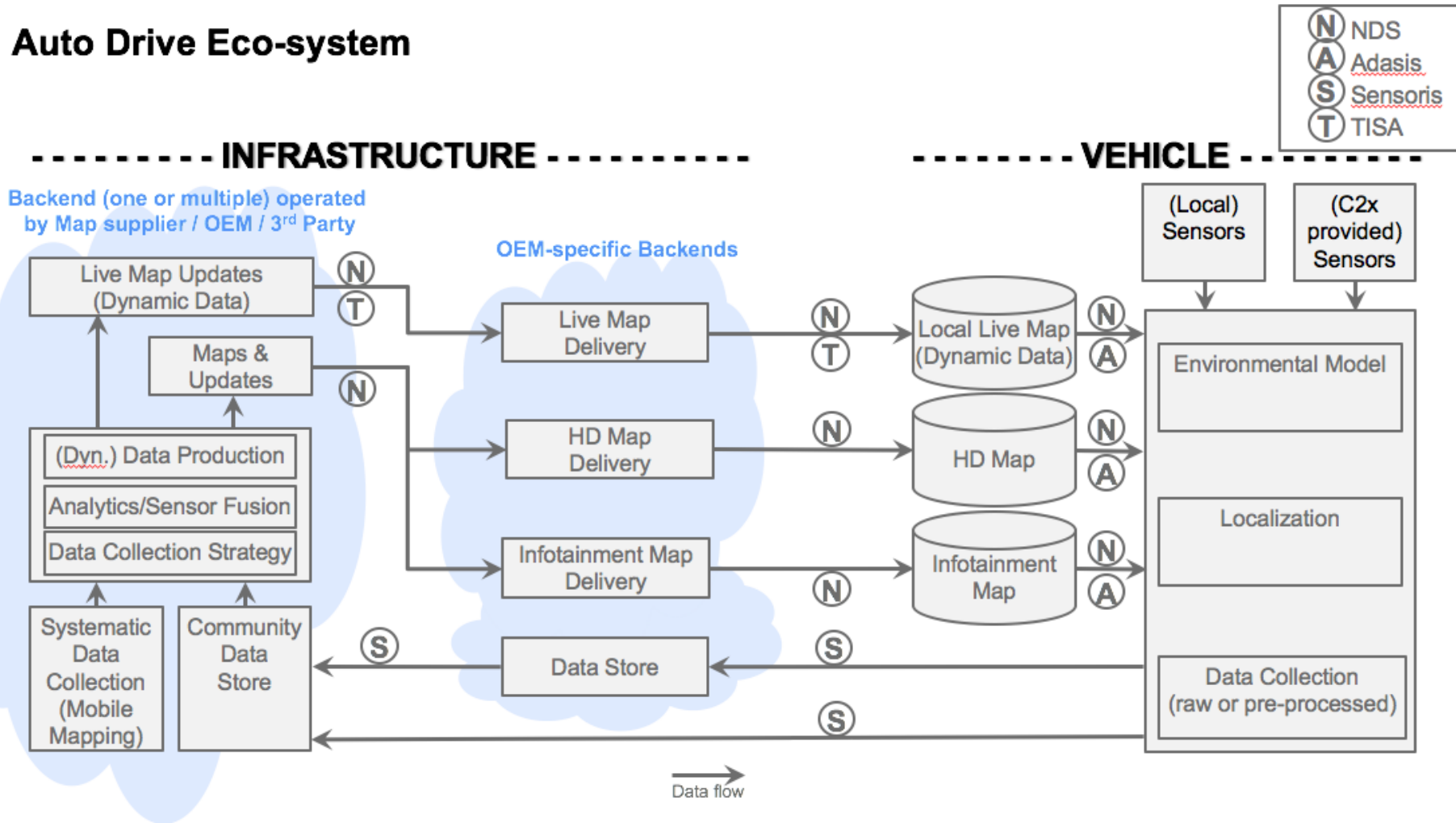› HD Map Data, Dynamic Traffic Data, GNSS Correction Data

Digital Infrastructure Requirements for AD
Follow Standardization

Open AutoDrive Forum (OADF) Reference Architecture

Auto Drive Eco-system

The Change has been Started
Automated Driving in Evolutionary Steps

>2025
FULLY AUTOMATED
› Monitoring of the system not required
› Driver does not need to be able to take over the driving task

2020
HIGHLY AUTOMATED
› Monitoring of the system not required
› Driver needs to be able to take over the driving task with lead time

2016
PARTIALLY AUTOMATED
› Monitoring of the system required
› Driver needs to be able to take over the driving task at any moment

Thank you!

istockphoto3646001 © Yuri