Perception of the World
Sensors for Mobility

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TOPICS

Applications in Mobility

Main Fields of Interest

How to use sensors effectively

Ownership of Collected Data

From Data to Knowledge

Applications in Mobility

- Positioning
- Guidance
- Object identification
- Enforcement
- Payment systems – public transport, tolling
- Flow analysis – FCD, pedestrian streams
- ADAS / Connected & self driving vehicles
- Safety – e.g. avoiding collissions
- Understanding the surrounding environment

Positioning

- Ground based predecessors used terrestrial longwave radio transmitters, e.g. LORAN
- Outdoor - GNSS
  - GPS since 1978
  - GLONASS - 24 satellites for global coverage (2011)
  - GALILEO – 2020 in full service, 11 (+4 +3) of 30 satellites
  - COMPASS or BeiDou-2 – 10 of 35 satellites, 2020 in global service

- Indoor – based on
  - Hard coded information (rails, stops, ...)
  - Precision maps
  - Recognition of environment (pattern/codes, landmarks, ...)
  - Wireless networks

Guidance

Knowing the position, guidance can be

- Relative
- Absolute
- Using maps
- Using routable maps e.g. Roads, rivers, ...
- Including other information
  - Driving bans
  - Traffic and delays
  - Weather

Object identification

- Presence
- Size/dimensions
- Properties
  - Profile/Height – h≤1.3m on first of two axles = class1, else class2
  - Axle count
  - Weight
    - WIM – weigh in motion to capture / record axle and gross vehicle weights
    - MPLW – maximum permissible loaden weight
  - Colour
  - Form
  - Information
    - License plate – LPR/ANPR
    - Danube River Information System – DORIS using transponders http://www.doris.bmvit.gv.at/en/

Enforcement

Ensuring compliance with laws, regulations, rules, standards, or social norms, like

- Speed
- Restricted access
- Parking
- Correct payment –public transport or tolling

Payment systems

- Public transport
  - Payment according to origin/destination
  - Automated reading of tickets
  - NFC and other communication for payment
  - Recognition of users
- Tolling for the use of infrastructure (access, motorway)
  - Detect use
  - Identify user
  - Classify user and determine tariff
  - Check correct payment
  - Create court-proof evidence for wrong or non-payment

Flow Analysis

- Where do objects move?
- Different object types:
  - Speed
  - Typical tracks
  - How to detect
  - How to change habits
  - Definition of critical situations
  - Simulation of scenarios
  - How to avoid critical situations

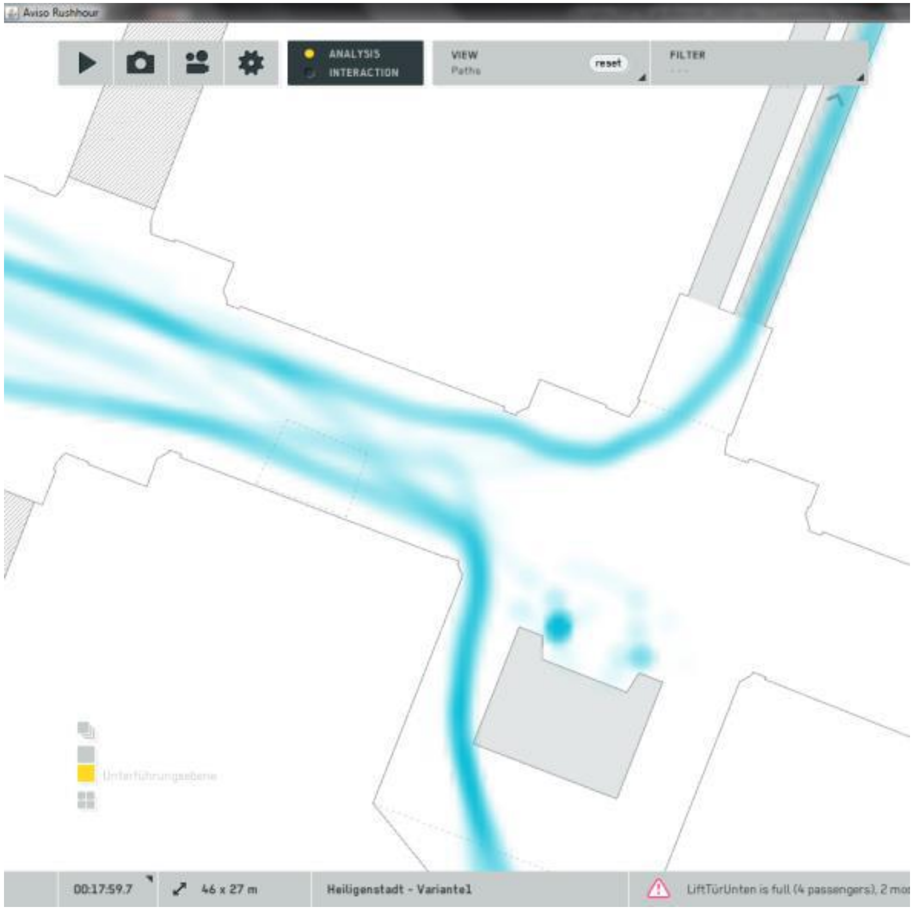
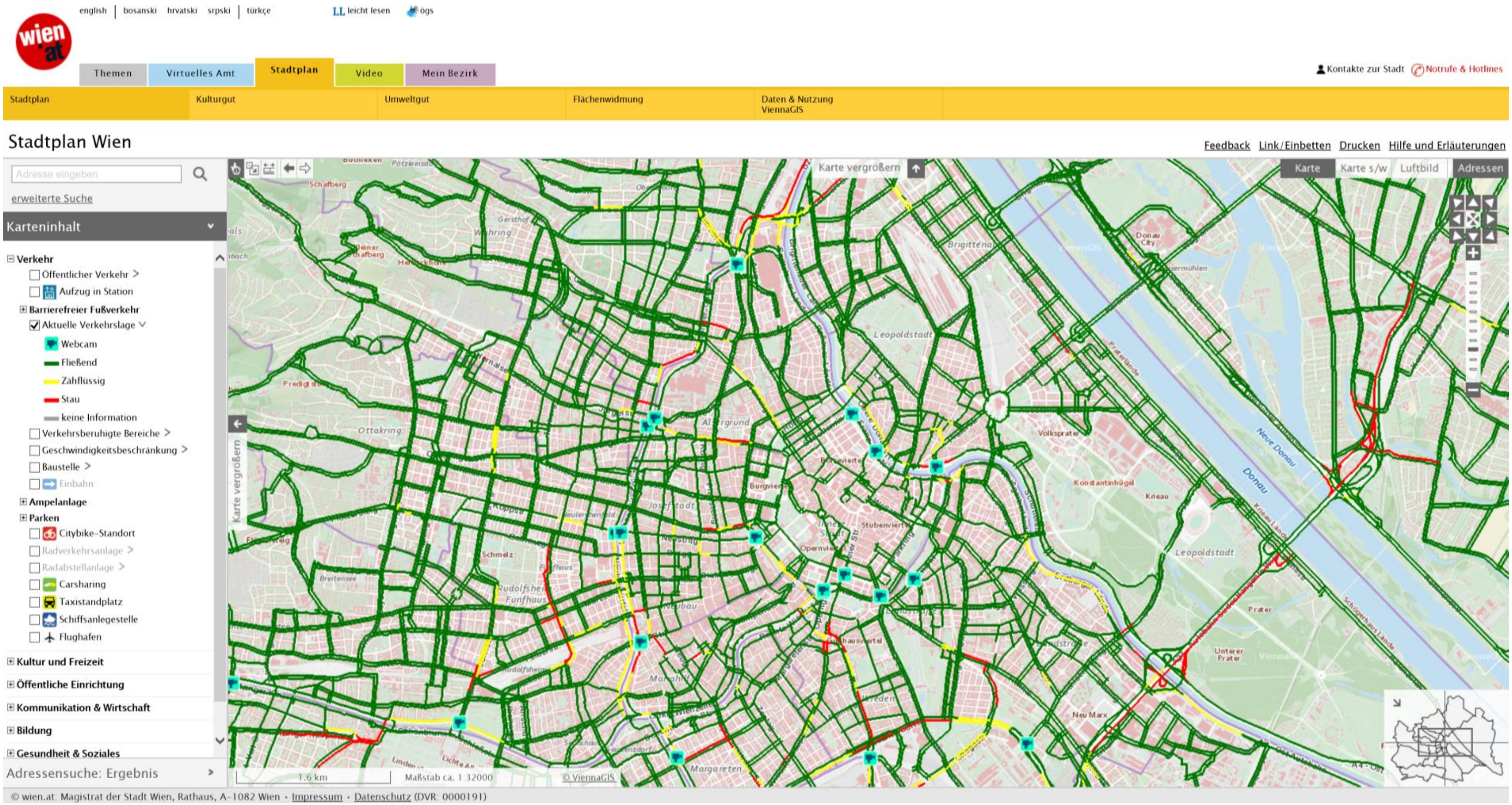


Figure from AIT project AVISO http://www2.ffg.at/verkehr/projektpdf.php?id=840&lang=en and https://www2.ffg.at/verkehr/file.php?id=642

Traffic Situation derived from FCD Data



ADAS

Advanced Driver Assistance Systems

- Adaptive cruise control (ACC)
- Glare-free high beam and pixel light
- Adaptive light control: swivelling curve lights
- Automatic parking
- Automotive navigation system with typically GPS and TMC for providing up-to-date traffic information.
- Automotive night vision
- Blind spot monitor
- Collision avoidance system (Precrash system)
- Crosswind stabilization
- Cruise control
- Driver drowsiness detection
- Driver Monitoring System
- Electric vehicle warning sounds used in hybrids and plug-in electric vehicles
- Emergency driver assistant - eCall
- Forward Collision Warning
- Intersection assistant
- Hill descent control
- Intelligent speed adaptation or intelligent speed advice (ISA)
- Lane departure warning system
- Lane change assistance
- Night Vision
- Parking sensor
- Pedestrian protection system
- Rain sensor
- Surround View system
- Tire Pressure Monitoring
- Traffic sign recognition
- Turning assistant
- Vehicular communication systems
- Wrong-way driving warning

https://en.wikipedia.org/wiki/Advanced_driver_assistance_systems

ADAS

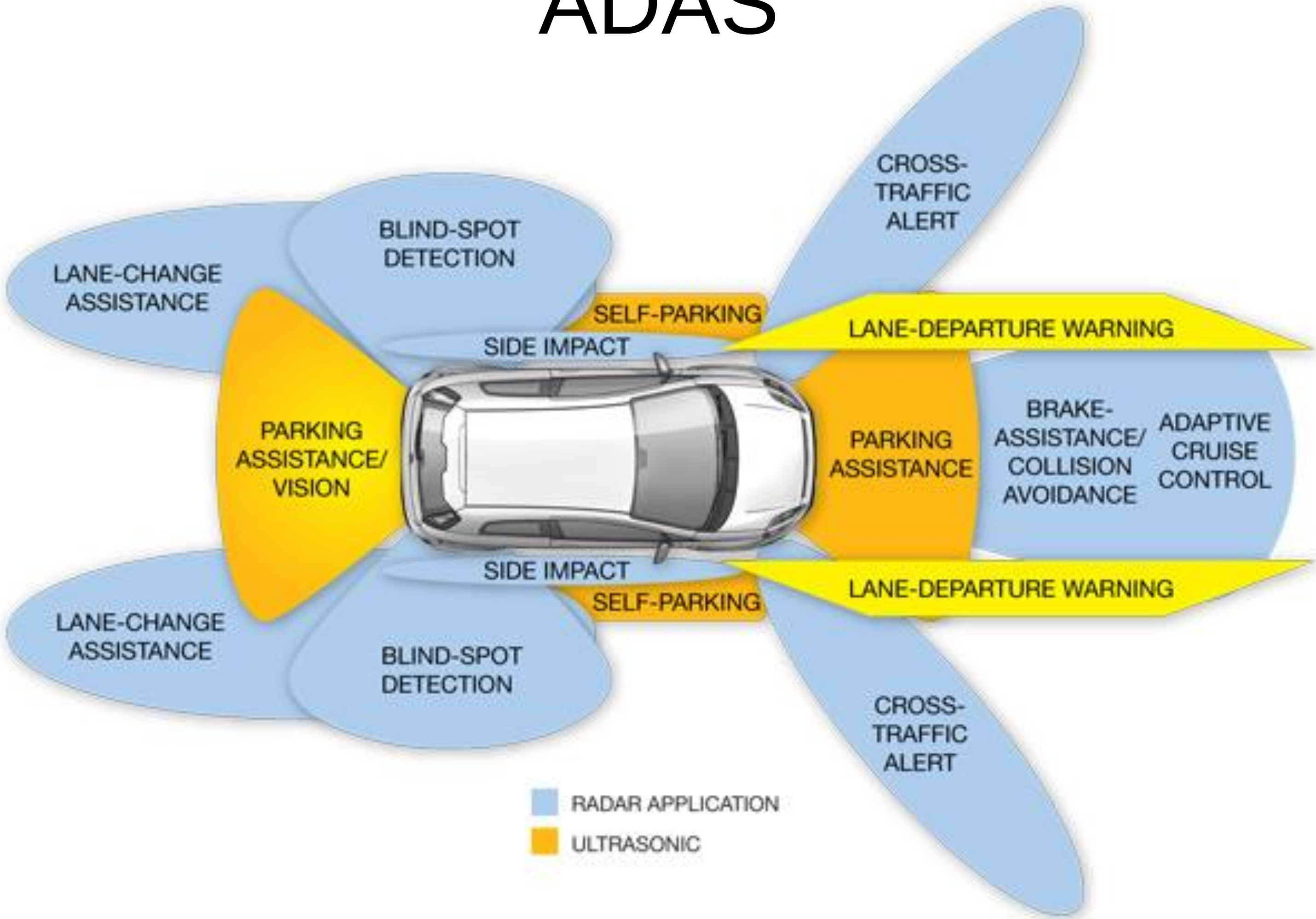
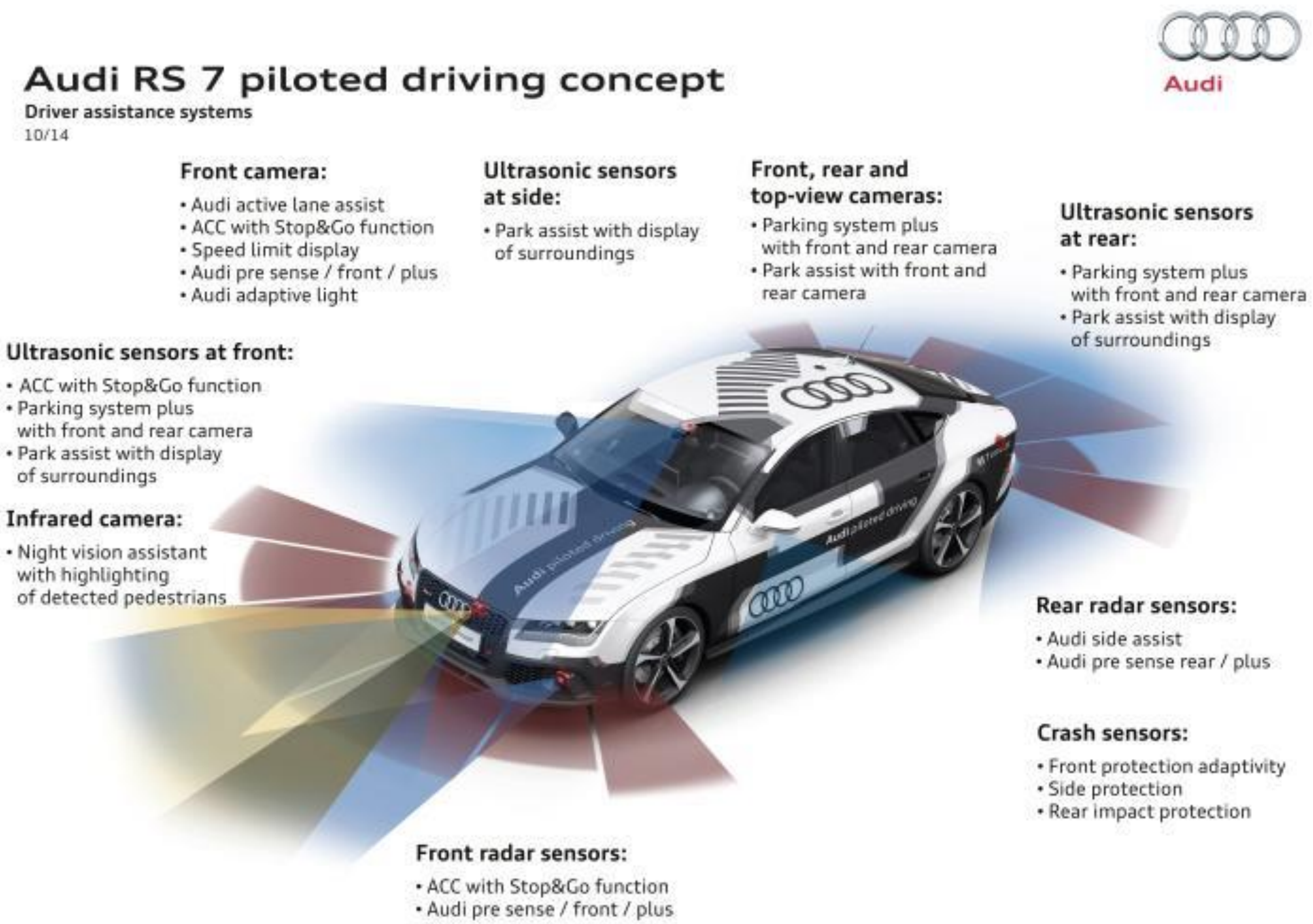


Figure 2 Several driver-assistance systems are currently using radar technology to provide blind-spot detection, parking assistance, collision avoidance, and other driver aids (courtesy Analog Devices).

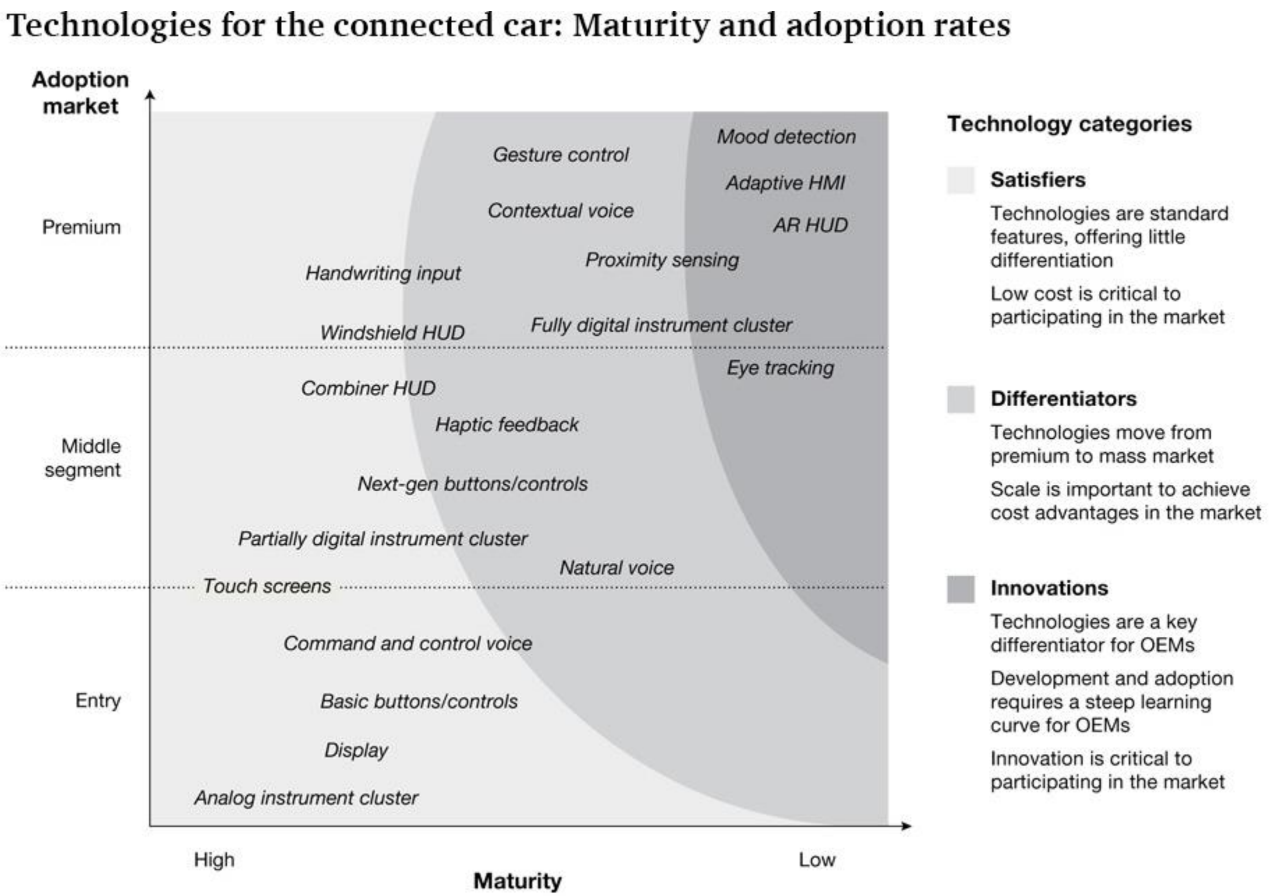
http://www.edn.com/design/automotive/4368069/Automobile-sensors-may-usher-in-self-driving-cars

ADAS



http://www.nydailynews.com/autos/news/self-driving-cars-ready-put-computer-dr-article-1.2320628

Connected & Self Driving Vehicles



Note: AR=augmented reality; HMI=human–machine interface; HUD=head-up display.
Source: Industry interviews; Strategy& analysis

http://www.strategyand.pwc.com/reports/connected-car-2016-study

Connected & Self Driving Vehicles

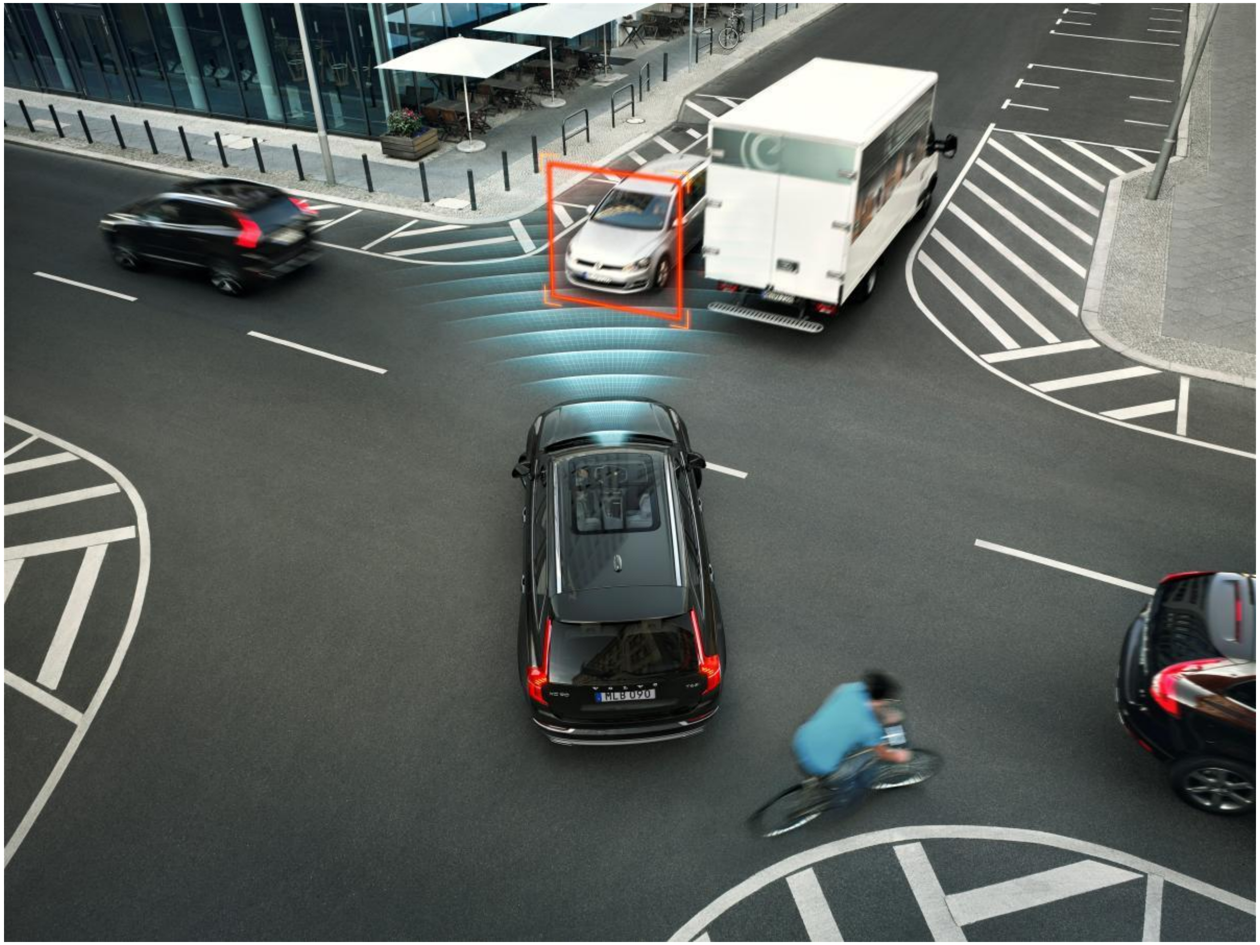
“Connected Car Effect 2025”

Bosch study shows: more safety, more efficiency, more free time with connected mobility

- Model calculations for the year 2025 show the benefits of connected and assisted driving for the US, China and Germany
- 260,000 accidents avoided, nearly 400,000 tons of CO_2 emissions saved, considerable time gains
- EUR 4.43 billion lower material and damage costs
- 350,000 fewer traffic accident injuries

http://www.bosch-presse.de/pressportal/de/en/bosch-study-shows-more-safety-more-efficiency-more-free-time-with-connected-mobility-82818.html

Surrounding Environment



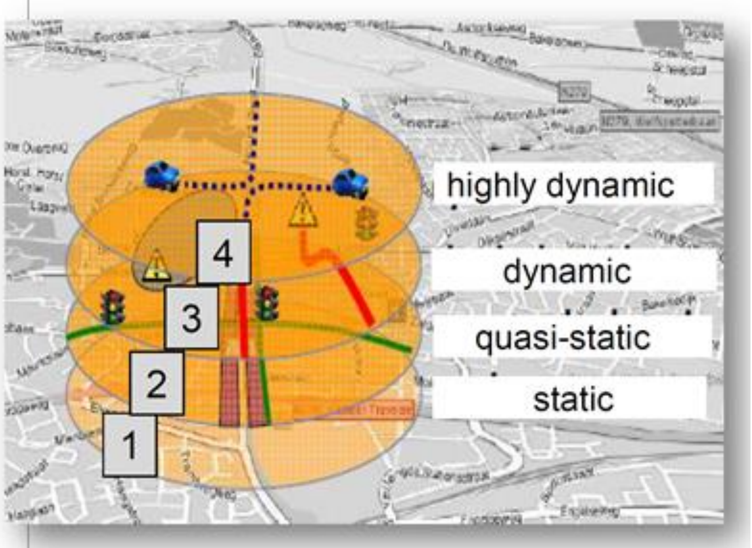
http://www.nydailynews.com/autos/news/self-driving-cars-ready-put-computer-dr-article-1.2320628

Surrounding Environment

LDM Local Dynamic Map – Representation and Standardisation

Layer Relations:

- *Layer 4*
  Highly dynamic data
  CEN/TC278 and ISO/TC204, ETSI TC ITS
- *Layer 3*
  Dynamic data
  CEN/TC278 and ISO/TC204, ETSI TC ITS
- *Layer 1 and layer 2*
  Static data and quasi-static data
  ISO/TC204



Local Dynamic Map - LDM

LDM is a conceptual data store which is embedded in an ITS station containing topographical, positional and status information within a dedicated geographic area of interest. For visualization purposes, mapping on a road map is beneficial for a human user. user. For road-safety applications, mapping on a road map may be necessary to achieve the purpose, e.g. collision avoidance.

- The meaning of "local" in LDM depends on the usage:
  - collision avoidance: short distance around my car, mainly in driving direction, given by speed of a car.
  - infrastructure purposes: area of significant size given by context, e.g. a street, a road network, a city, a region, ...
- The meaning of "dynamic" in LDM depends on the usage:
  - collision avoidance: lifetime of objects is given by speed of traffic. Updates may be necessary several times a second.
  - infrastructure purposes: time span of significant size given by context, e.g. minutes, hours, days, weeks, ...

http://release1.its-standards.eu/WhitePapers/UnderstandingCITSstandards-Session3-Presentation1-LDMdefinition-SCHADE.pdf

Safety

- Using sensors to collect data
- Sensor fusion
- Extracting information
- Awareness of surrounding environment
- Real time decisions
- Immediate actions, if required

What are the main fields of interest?

- Understanding the surrounding environment
- Positioning
- Object classification
- Object identification
- Counting
- Moving objects
- Crowd and motion
- Remote sensing
- Sensor networks, sensor fusion
- Extracting information
- Communicating information
- Big Data – produced/used by connected or SD cars

How to use sensors effectively

- Starting point are individual solutions
- „Killer applications“
- Large deployment
- Interface definitions
- Purchasing regulations
- Industry standards
- International Standardisation

International ITS Standardisation

cen	ISO
WG 1 EFC	**WG 5** Fee and Toll Collection
WG 2 Freight and logistics	**WG 7** Freight Operations
WG 3 Public transport	**WG 8** Public transport
***WG 4** Traffic and traveller information*	**WG 10** Traveller information systems
WG 7 ITS spatial data	
WG 8 Road traffic data / DATEX	**WG 9** Transport Information and Control
***WG 9** DSRC*	
WG 10 Human machine interfacing	
	WG 3 ITS Database technology
	WG 14 Vehicle/roadway warning systems
	WG 16 Communications
	WG 17 Nomadic devices
WG 12 Vehicle identification	**WG 4** Vehicle identification
***WG 13** ITS architecture*	**WG 1** ITS architecture
***WG 14** Recovery of stolen vehicles*	
WG 15 eSafety/eCall	
WG 16 Cooperative ITS	**WG 18** Cooperative ITS
WG 17 Urban ITS	

http://www.itsstandards.eu/index.php/about-cen-tc-278

Ownership of Collected Data

- Why did it become normal for big volume of data about you to automatically become the property of others?
- Why do we have a "server" model of information exchange for so many of our data services, reminiscent in ways of the early days of mainframe computing, where "someone else" is responsible for data security and service availability?
- Much of the current thinking for making systems “smart” about their operation and energy consumption recapitulates old ideas with new technological varnish.

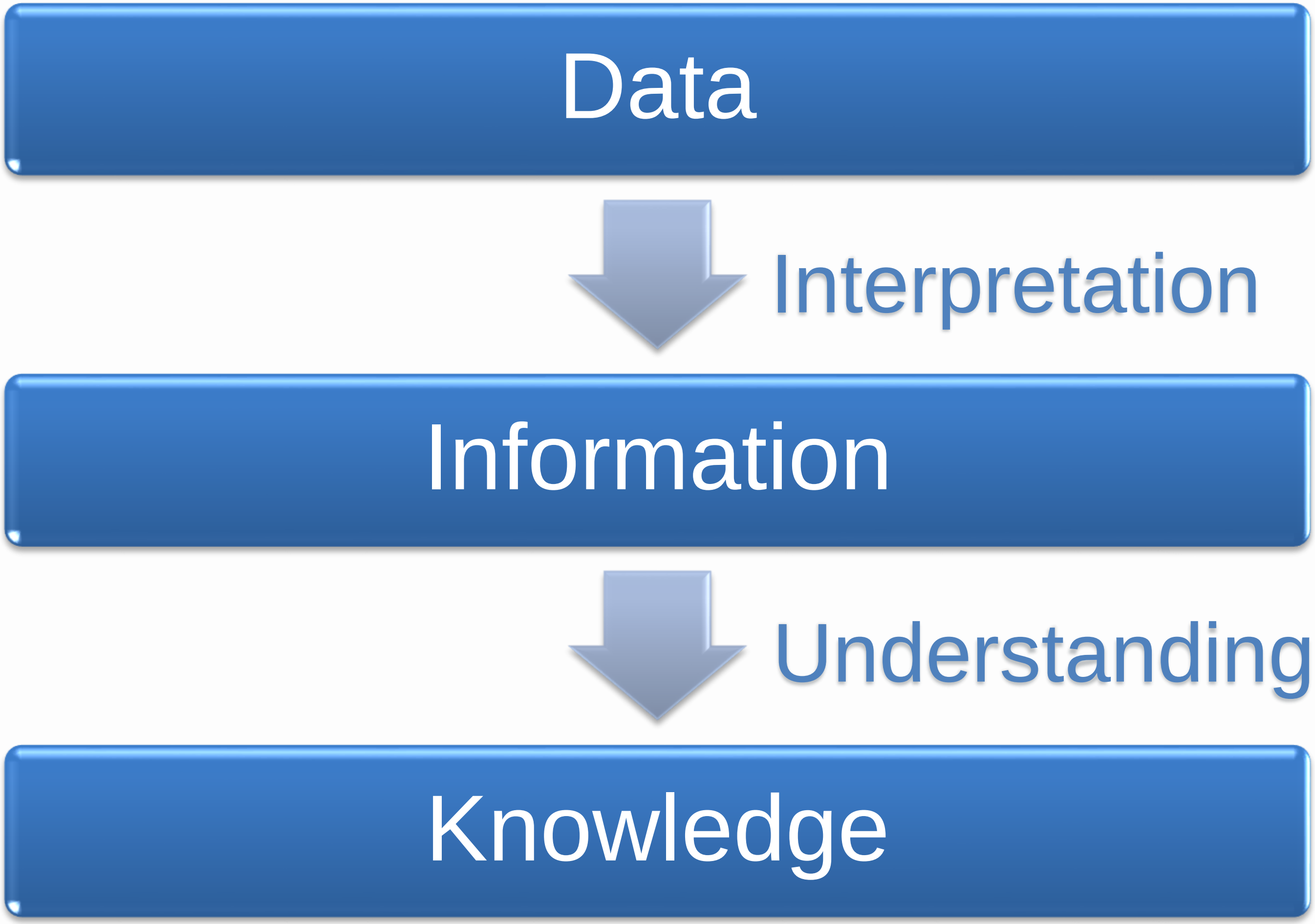
Ownership of Collected Data

- Most approaches involve a decentralized network of sensors, and an old dilemma is becoming increasingly apparent.
- While networking provides remote access to data and control inputs, gathering useful information may require the installation of an expensive array of sensors.
- Thus leading to high requirements for bandwidth and data protection.
- Delivering actionable information economically to the right eyes while preventing revelations to the wrong eyes has become an endemic problem.

Ownership of Collected Data

- Privacy by (system) design has to be taken into account.
- Sensors have to be relatively easy to install.
- There is a need for new approaches for deploying and coordinating the operation of sensors to secure data, minimize the need for communication bandwidth, and ensure the presentation of actionable information for enhancing system operation.
- By law data must only be used for the purpose it has been collected.
- How to handle “opt-out” possibility if used by many?

From Data to Knowledge



Thank you for your attention!

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