Intelligent, Connected Cars — Volkswagen’s Vision of the Future

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Global trends

- Time is scarce
- Space is scarce
- Oil is scarce
- Ubiquitous broadband communication
- Advances in electronics
- Novel battery technologies
Motivation for integrating communication into vehicles

- Improving road safety
- Improving traffic efficiency
- Providing up-to-date information services
Road safety

Increasing need for security:
EU goal „-50% fatalities“

Driving experience should remain being joyful!
„Fahrvergnügen“

Source: IRTAD
Road safety: The driver as element of uncertainty

Causes of fatal accidents

- Mental causes: 38%
- Misjudgements: 46%
- Unexpected behaviour: 11%
- Technology: 5%

Source: GdV, VW Unfallforschung
**Road safety potential**

- **Today**
  - Stiff passenger compartment
  - Car structure
  - Seat belt
  - Airbag
  - ABS
  - Brake assistant
  - ESP

- **Active safety**
  - Front Assist
  - Side Assist

- **Passive safety**
  - Pyro Brake
  - Car-to-car com.

- **Pre-crash**
  - Driver assistant
  - Car assistant
  - Pre-crash

- **Car to X**

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Road safety: Guardian angel

Handling like a skilled driver

Seeing like an alert human

Driving like a trained driver

Acting like an experienced human

and everything safely
Actuators: Handling like a skilled driver

Electromechanical steering

DSG transmission

Electronic accelerator
Sensors: Seeing like an alert human

- Back video camera
- Short-distance radar
- Interior sensor
- Multi-beam laser
- Ultrasonic sensors
- Front video camera
- Infrared camera
- Long-distance radar
Sensors: Seeing like an alert human
Vehicle dynamics: Driving like a trained driver
Intelligence: Acting like an experienced human
**Technology box: Components enabling safety**

- **Driving at the limit**
  - Positioning
  - Speed-optimised trajectory

- **Driving in unknown territory**
  - Environment sensing
  - Positioning
  - Path planning

- **Driving according to traffic rules**
  - Detection of situations
  - Driving strategy
  - Safety
  - Environment sensing
  - Positioning
  - Path planning

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And everything safely: **Automatic driving functionalities in iCar**

- Lane keeping
- Clear drive and tracking
- Driving in traffic congestion (stop & go)
- Lange changing and overtaking manoeuvre (driver approved)
Which systems does Volkswagen offer today?

- Longitudinal guidance
  - ACC
  - ACC F2S
  - AWV

- Latitudinal guidance
  - SWA
  - LDW

- Parking assistance
  - Back video camera
  - Park Assist

- Driver information
  - Light
  - AFS
  - Swivelling headlight
An example:
**Car-to-car communication: Extension of vehicle sensors**

- Extension of driver horizon by radio communication
- Short latency in information dissemination
- Reduced driver response time in dangerous situations

*sensors* as good as the driver

*communication* better than the driver
Increasing the effective range: "Car-to-X"

- Sensors
- Communication technology / GPS
Improving traffic safety
Improving traffic safety: Warnings and driver assistance

Information from an ambulance

Warning of disregarded traffic signs

Bad visibility

Road works
Motivation for integrating communication into vehicles

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Challenges for society: Traffic volume increases substantially

Traffic congestion: time and desire for in-vehicle entertainment grows

Scenario VW 2002-2020
- Passenger transportation: + 20%
- Freight transportation: + 34%

A2
+ 125% Lorries

A6
+ 181% Lorries
Navigation systems today and tomorrow

Current features of RNS 510:

- Reliable and efficient guidance to every destination
- Touch screen
- Up-to-date traffic information via RDS / TMC
- Import of music from PC via SD card
- Sophisticated help system with avatar “Carla”
- Wireless operation of mobile

Future connected navigation systems:

- Receive information from many cars out of the vicinity to avoid and prevent traffic congestion
- Improve routing by highly dynamic and detailed traffic information
- Combine navigation with POIs and events dynamically from the Internet
- Act also as up-to-date travel guide and shopping assistant
- Provide a ubiquitous help system with connection to VW and the Internet
Increase of traffic efficiency: Example traffic light assistant

- Car-to-traffic-light communication to inform drivers
- Optimal speed to encounter phased traffic lights
- Phase optimization of traffic lights by car information
Increase of traffic efficiency: Example Traffic Guard

- Analysis of oncoming traffic
  - traffic density
  - velocity

- Truck laser scanner
  - alignment,
  - lateral Profile

- Vehicle sensors (FCD)
  - position, course
  - distance, velocity

- Traffic management centre
  - static information (speed limits)
  - road works information

- Communication nodes (RSU)
  - application for analysis
  - dissemination of information
Traffic Guard: Information processing

Vehicle at end of section:
- Recording of own sensor data

Vehicle tour through road works

Vehicle at start of section:
- Pre-adjustment of traffic-optimised ACC
- Display of precise information to driver

Communication outflow-RSU:
- TCP/IP
- Evaluation of:
  - road path (GPS)
  - number of lanes (GPS)
  - traffic situation (speed)

Data analysis in outflow-RSU

RSU connection

Communication inflow-RSU:
- Broadcast
- Inflow-RSU
- Aggregated information

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Traffic Guard: Information usage in the vehicle

A) Traffic-optimised driving behaviour

- Driving recommendation for driver or
- Modification of ACC

B) Driver information

- Displaying road geometry and traffic speed
Avoidance of congestion by car-to-x communication
Traffic Guard: Impact on traffic efficiency

Empirical data (30.10.07)
- Traffic congestion

Reproduction in simulation
- Same traffic patterns
- Penetration rate:
  0 % Traffic Guard

Simulation of traffic guard
- Same traffic patterns
- Penetration rate:
  10 % Traffic Guard

Significant reduction of traffic congestion!
Motivation for integrating communication into vehicles

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Integration of online Internet services

Traffic information
Fuel prices
Time tables
Restaurants and hotels
Tourist information
Current events
Drivers of an „auto@web“ car can use their navigation system to ...

- explore the map for interesting locations regarding travel, city life and leisure
- search the Internet for destinations
- retrieve highly current information about event venues and free park spaces
- listen to and rate online music and podcasts from the portal
Standardization is the enabler of cooperation

- The minimum penetration rate for most safety applications is not achievable even for a large volume manufacturer
- The quality of car-to-car applications increases with higher penetration rate
  - Cooperating vehicles must communicate in the same “language”
- Freight is global, people are global, Volkswagen is global
  - Proliferation of different standards increases time-to-market and costs

Let’s produce global ITS standards for a global world!
Harmonization of world-wide ITS standards

C2C-CC working documents

ISO CALM standards

IEEE 802.11p + 1609.X standards

ITS Station Reference Architecture

- Applications
- Facilities
- Networking & Transport
- Access Technologies

Security

Management
ITS Station Reference Architecture: “Alphabet” for a common ITS language
Somebody sent me a text ...

What did he write?

Drive, fool!
It’s green!

Thank you!