VOLKSWAGEN

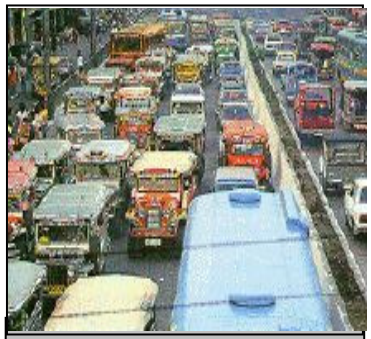
AKTIENGESELLSCHAFT

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

Dr. Markus Lienkamp – Electronics and Vehicle Research

Global trends

Time is scarce



Space is scarce

Oil is scarce

Ubiquitous broadband communication

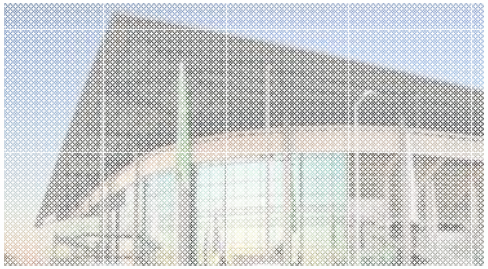
Advances in electronics

Novel battery technologies

Motivation for integrating communication into vehicles

Improving road safety

Improving traffic efficiency



Providing up-to-date information services

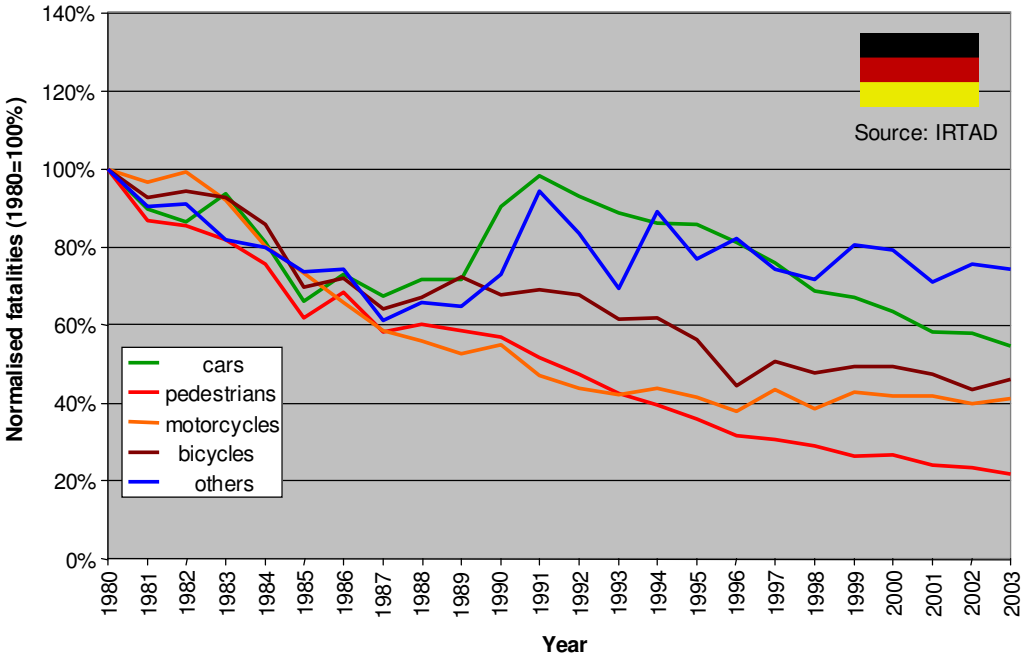
Road safety

Driving experience should remain being joyful!

„Fahrvergnügen“

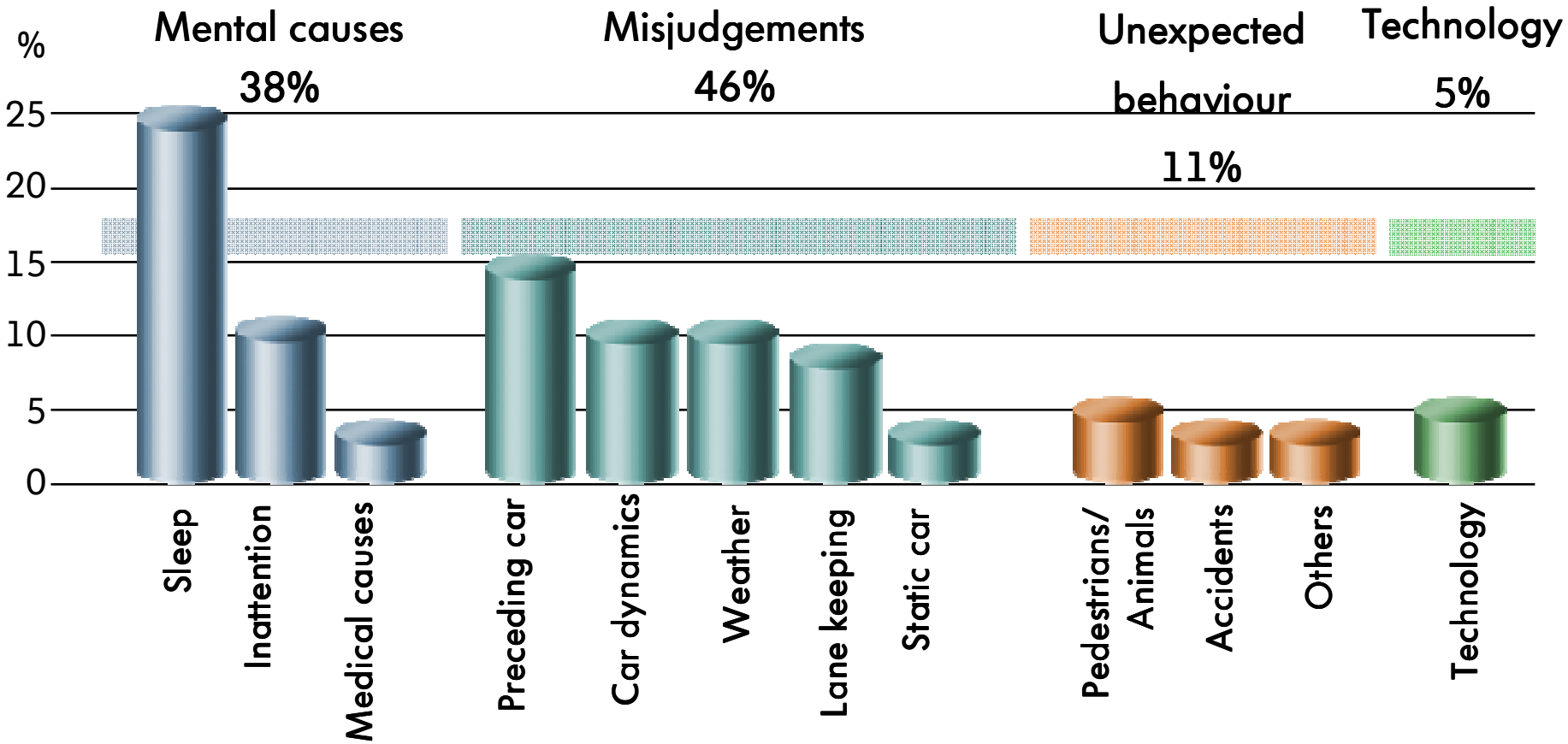
Increasing need for security:

EU goal „-50% fatalities“



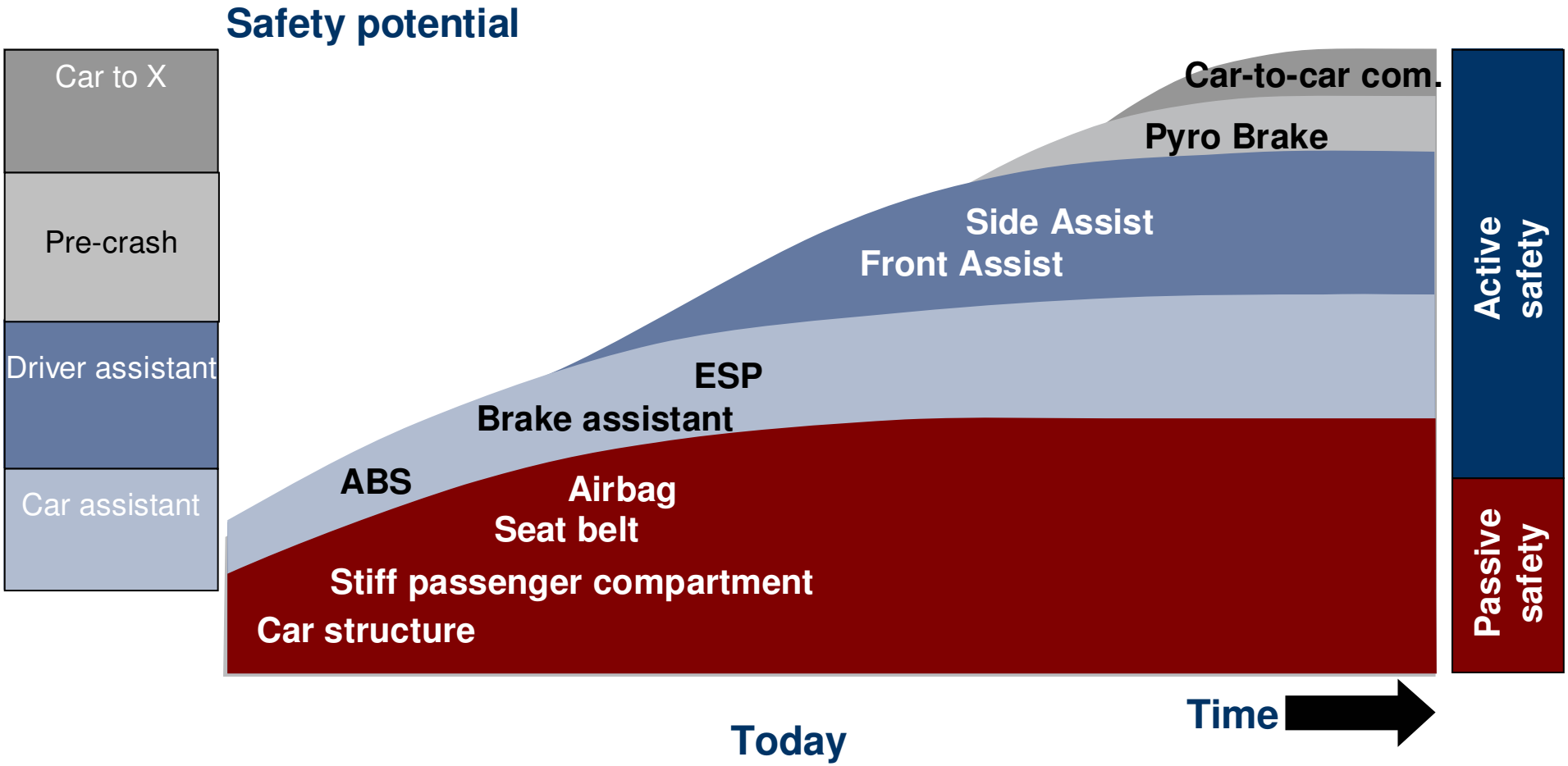
Road safety: The driver as element of uncertainty

Causes of fatal accidents



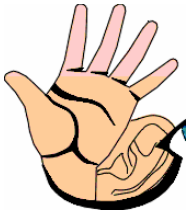
Source: GdV, VW Unfallforschung

Road safety potential

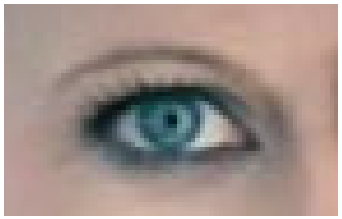


Road safety: Guardian angel

Handling like a skilled driver

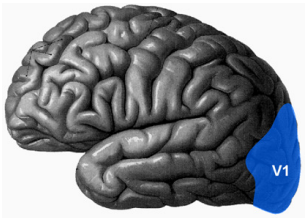


Seeing like an alert human



Driving like a trained driver

Acting like an experienced human



and every-thing safely

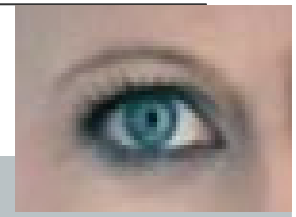
Actuators: Handling like a skilled driver

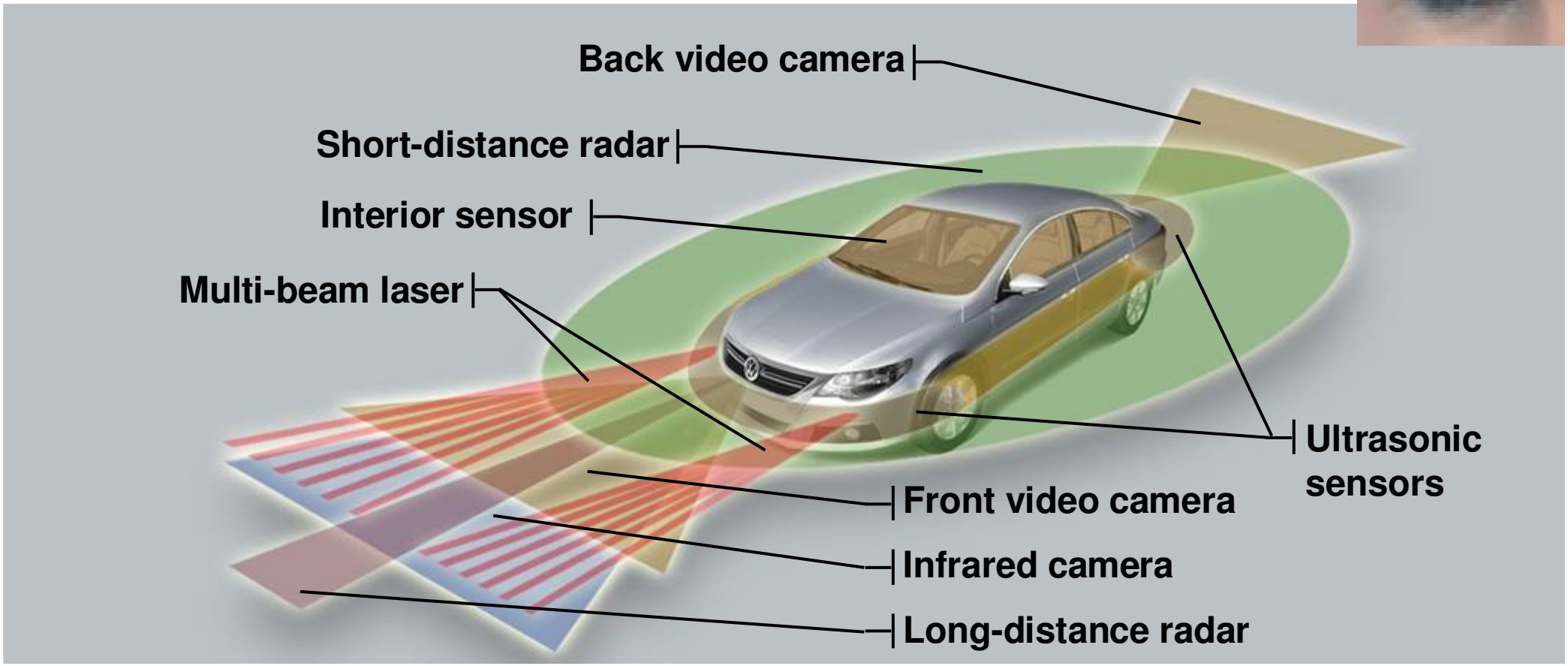
Electromechanical steering

Electronic accelerator

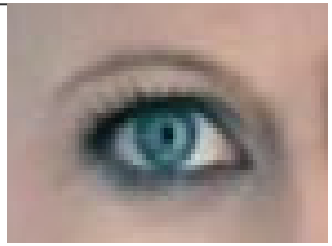
DSG transmission

Sensors: Seeing like an alert human

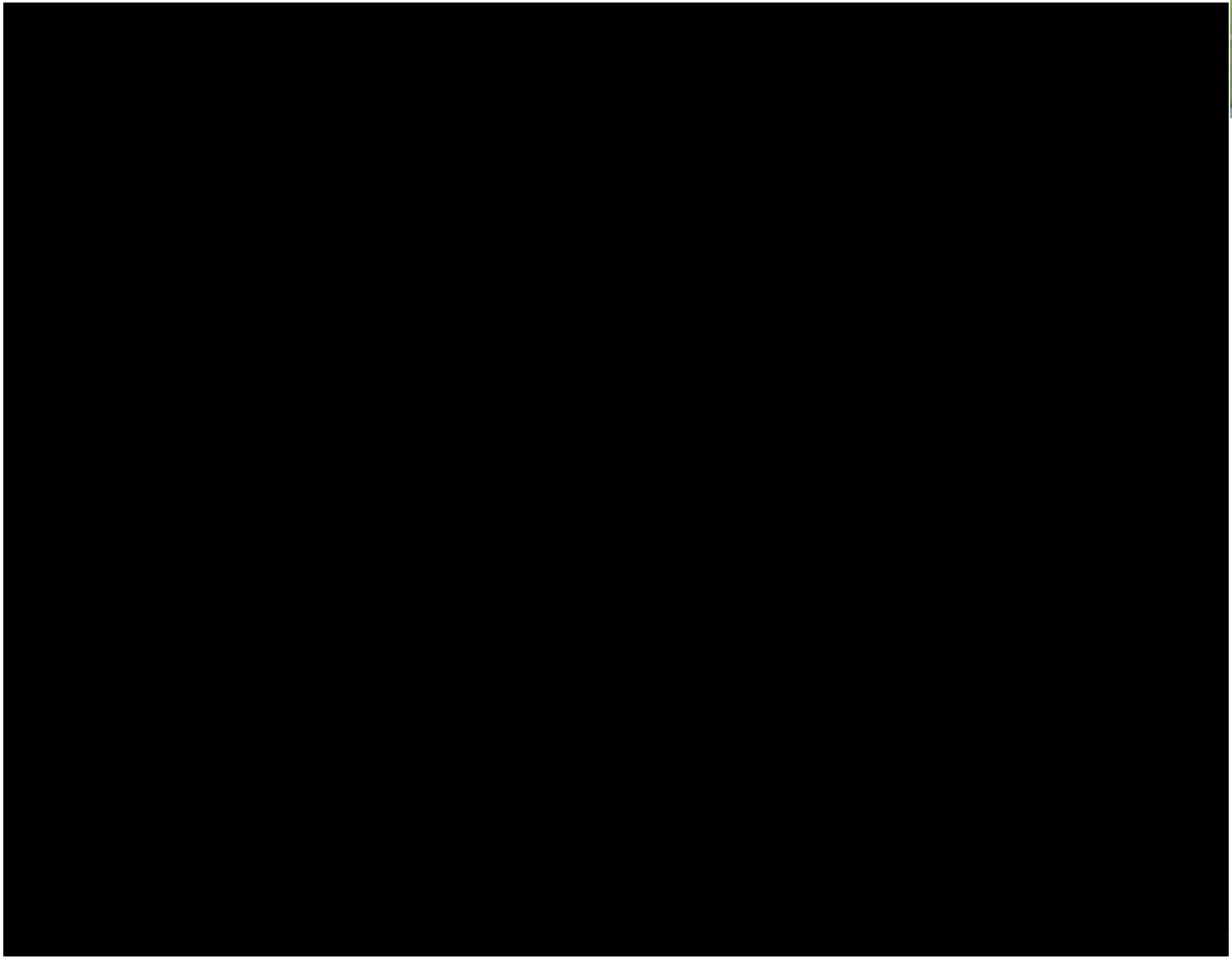




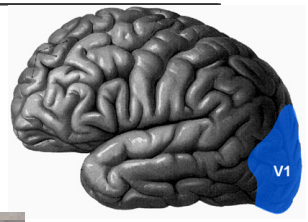
Sensors: Seeing like an alert human

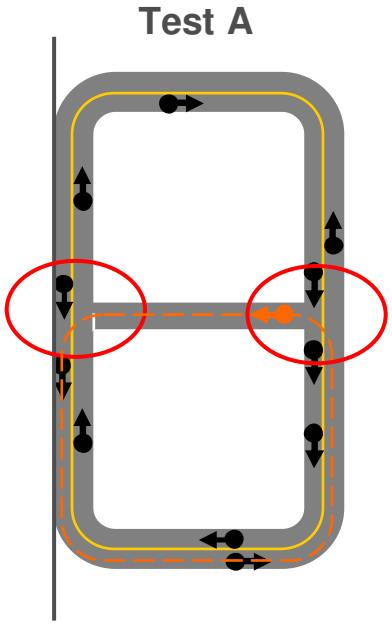


Vehicle dynamics: Driving like a trained driver



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

And everything safely: Automatic driving functionalities in iCar

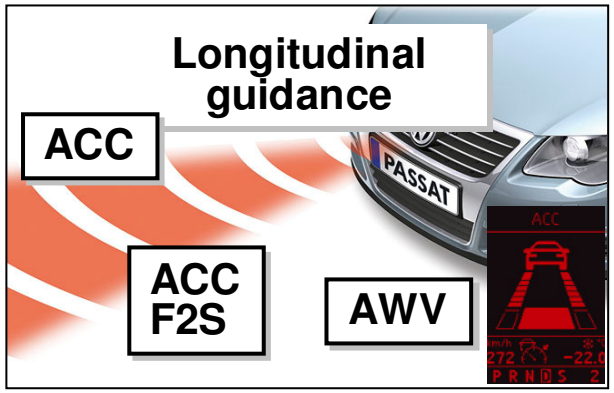
Lane keeping

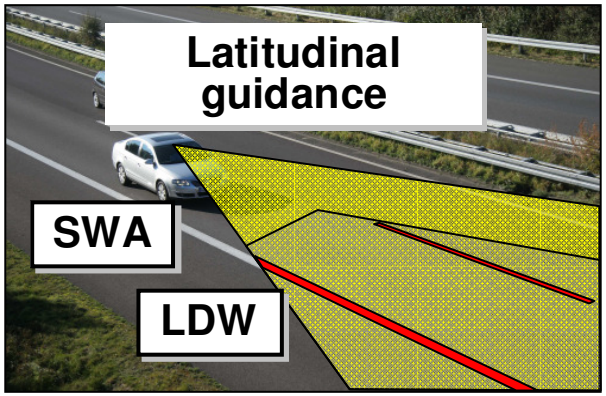
Clear drive and tracking

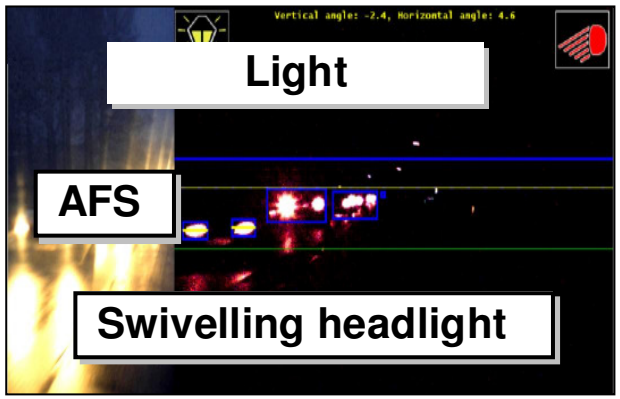
Driving in traffic congestion (stop & go)

Lange changing and overtaking manoeuvre (driver approved)

Which systems does Volkswagen offer today?





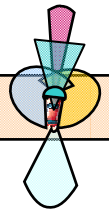


An example:

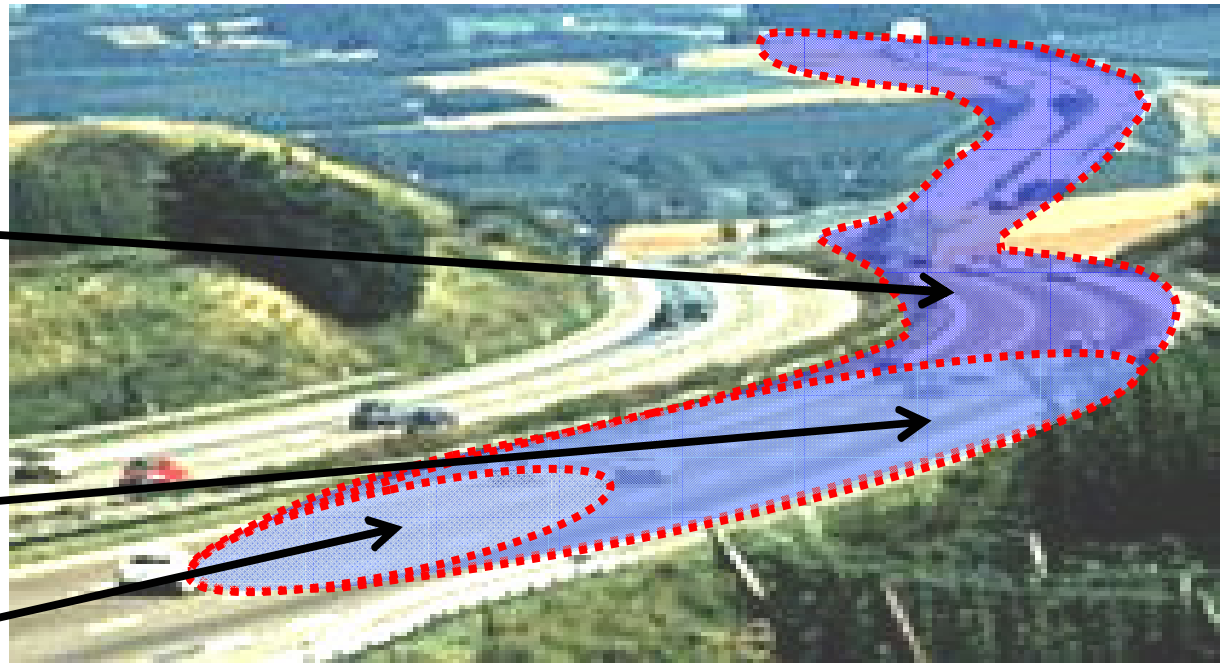
Car-to-car communication: Extension of vehicle sensors

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

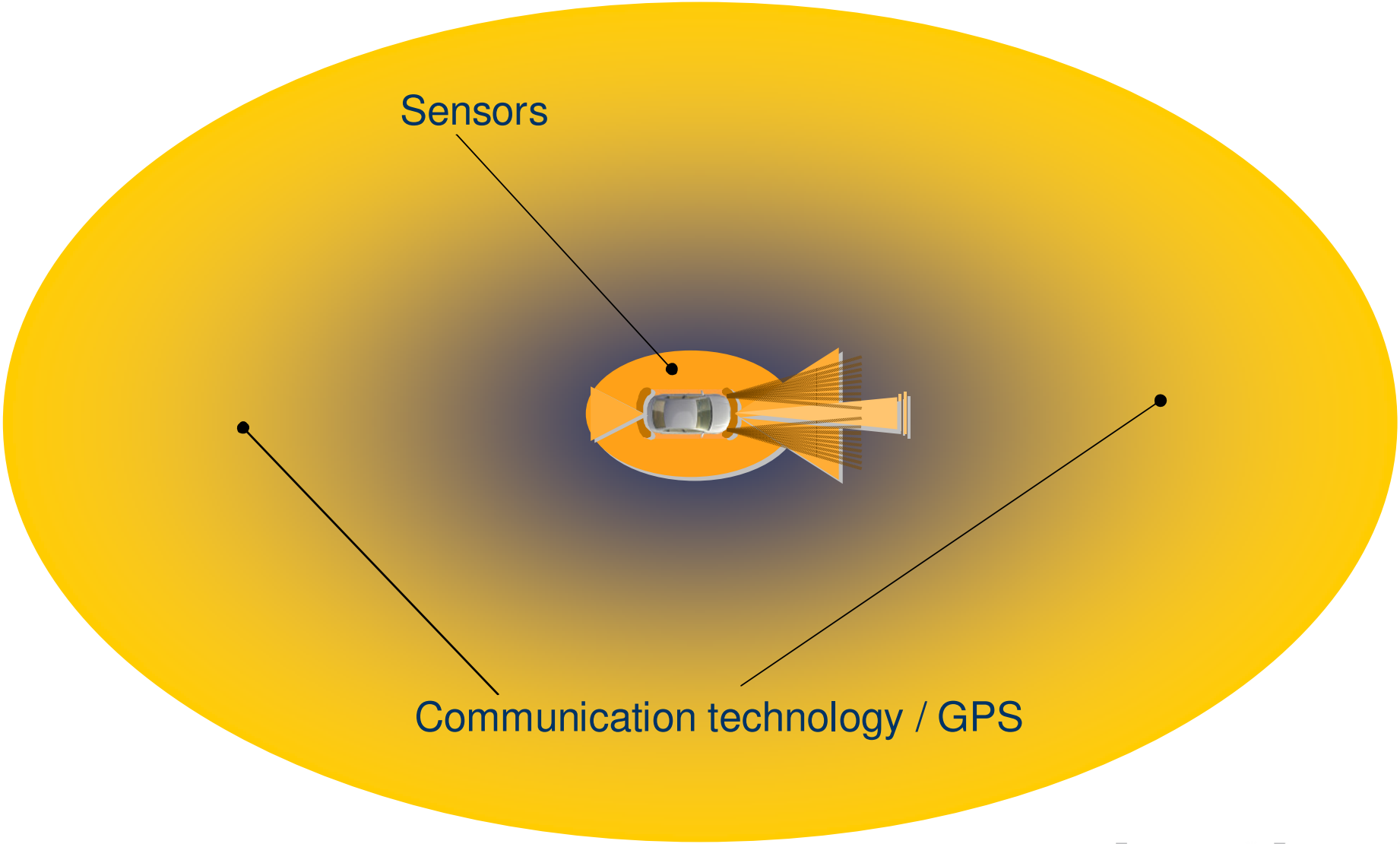
communication
better than the driver



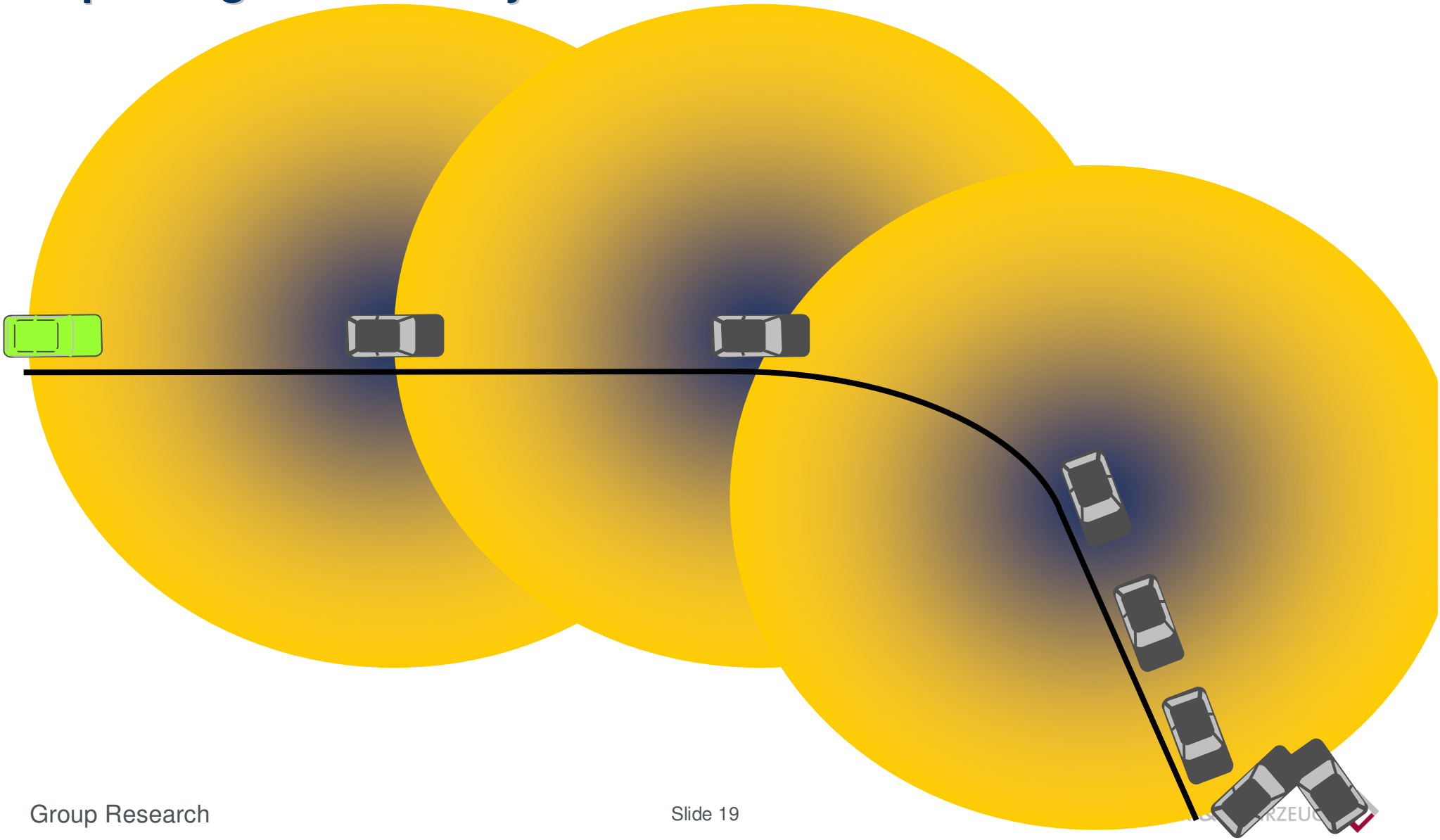
sensors
as good as the driver



Increasing the effective range: "Car-to-X"



Improving traffic safety



Improving traffic safety: Warnings and driver assistance

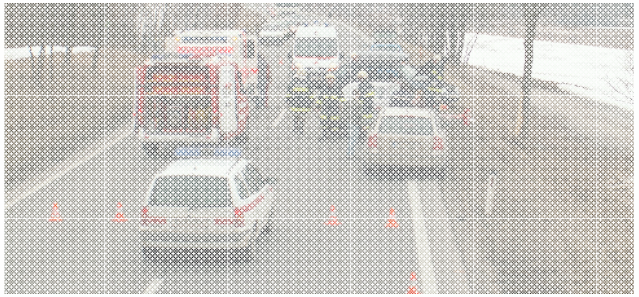
Information from an ambulance

Warning of disregarded traffic signs

Bad visibility

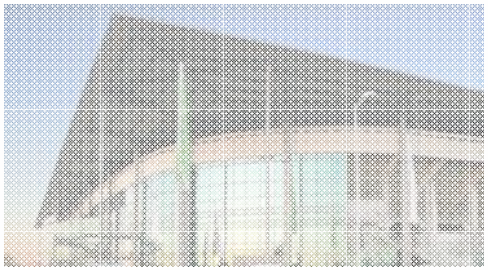
Road works

Motivation for integrating communication into vehicles



Improving road safety

Improving traffic efficiency



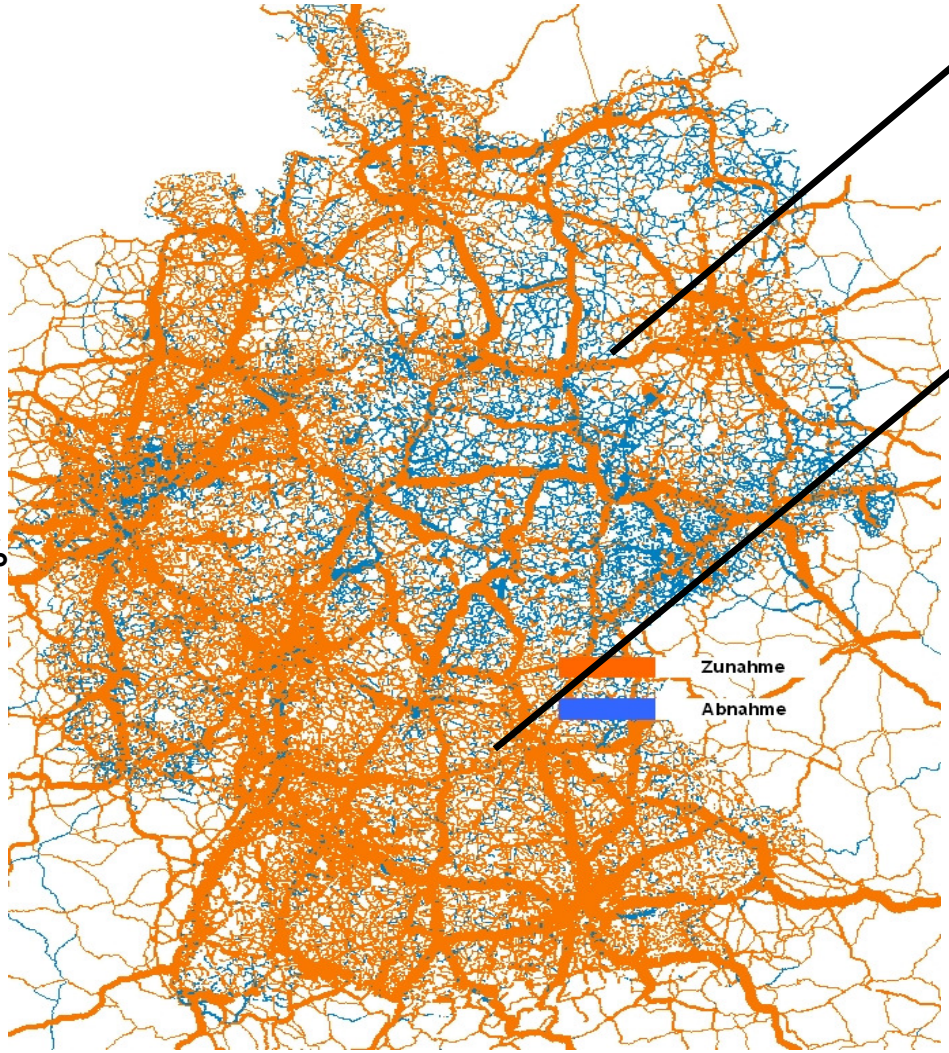
Providing up-to-date information services

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:

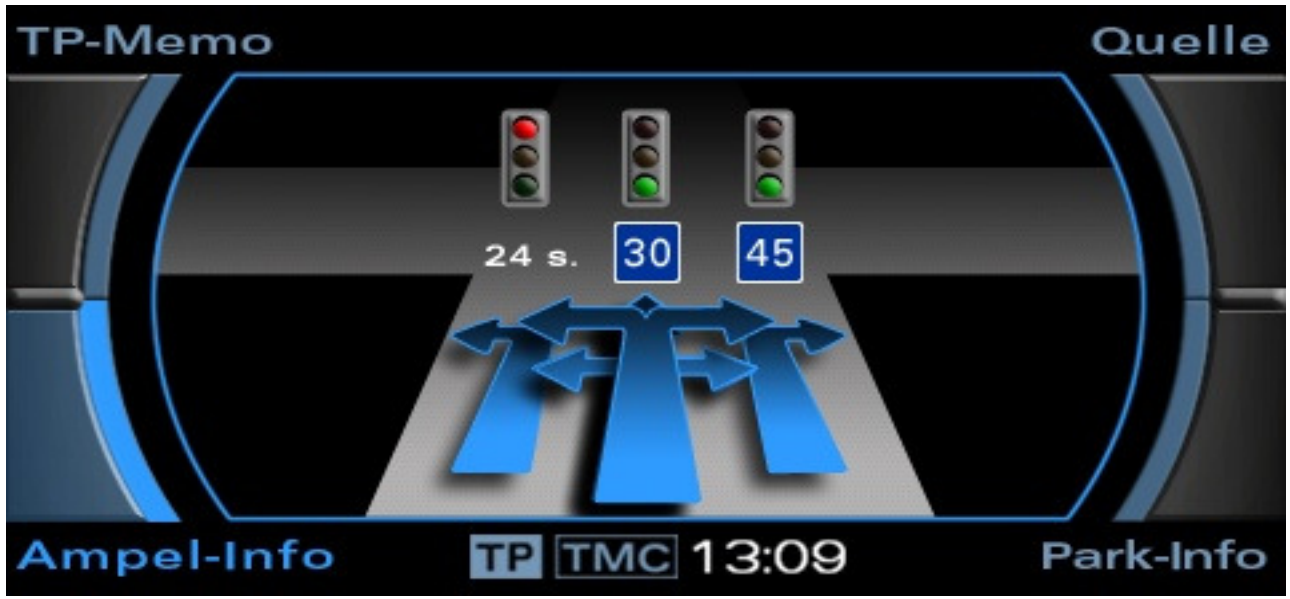
- Reliable and efficient guidance to every destination
- Touch screen
- Up-to-date traffic information via RDS / TMC
- Import of music from PC via SD card
- Sophisticated help system with avatar “Carla“
- Wireless operation of mobile

Future connected navigation systems:

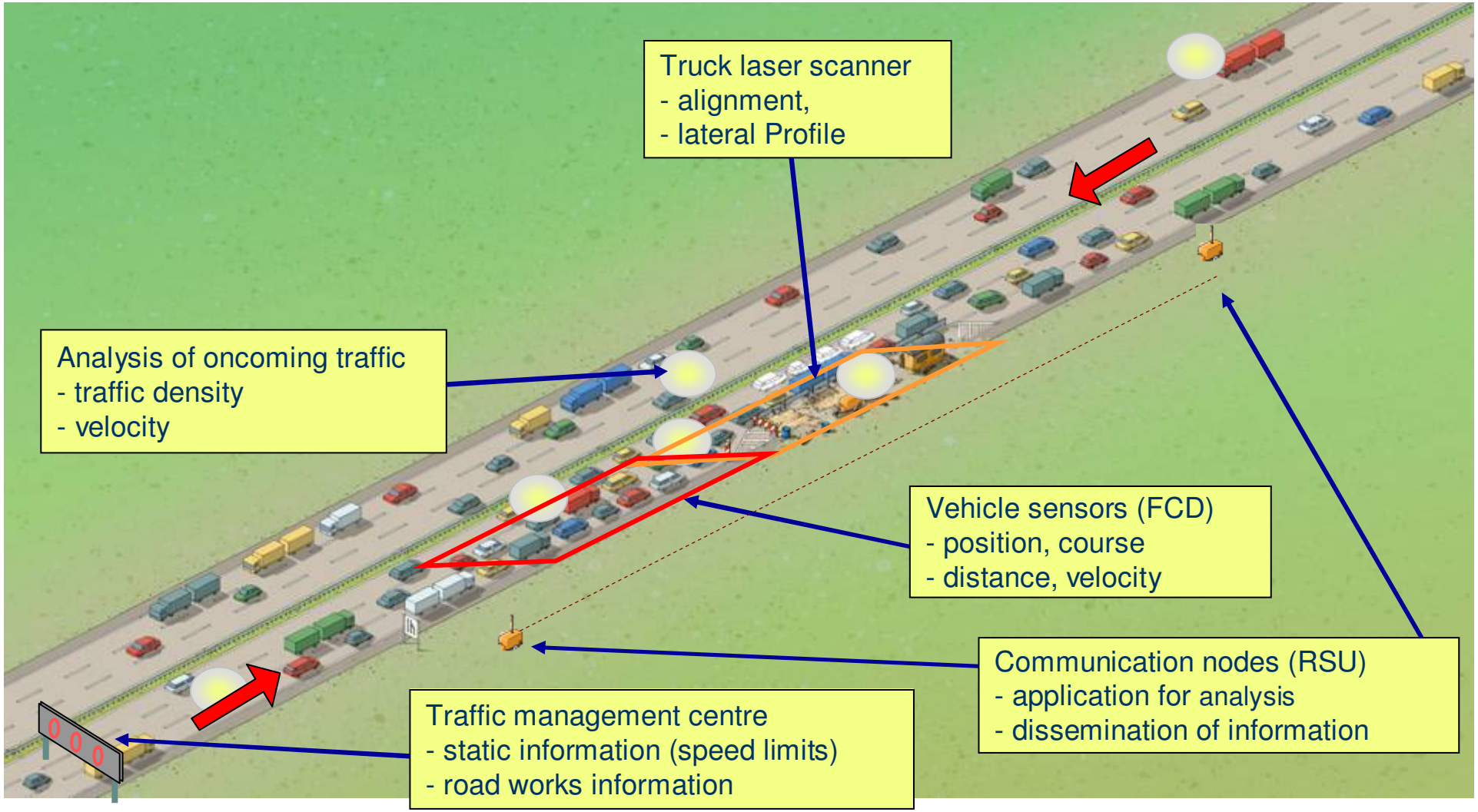
- Receive information from many cars out of the vicinity to avoid and prevent traffic congestion
- Improve routing by highly dynamic and detailed traffic information
- Combine navigation with POIs and events dynamically from the Internet
- Act also as up-to-date travel guide and shopping assistant
- 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



Traffic Guard: Information processing

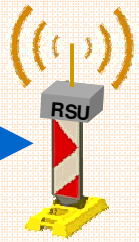
Vehicle at **end of section**

Recording of own sensor data

Communication **outflow-RSU**

TCP/IP

Data analysis in **outflow-RSU**



Evaluation of
- road path (GPS)
- number of lanes (GPS)
- traffic situation (speed)

Vehicle tour through road works

RSU connection

Vehicle at **start of section**

Pre-adjustment of traffic-optimised ACC

Communication **inflow-RSU**

Broadcast

Inflow-RSU

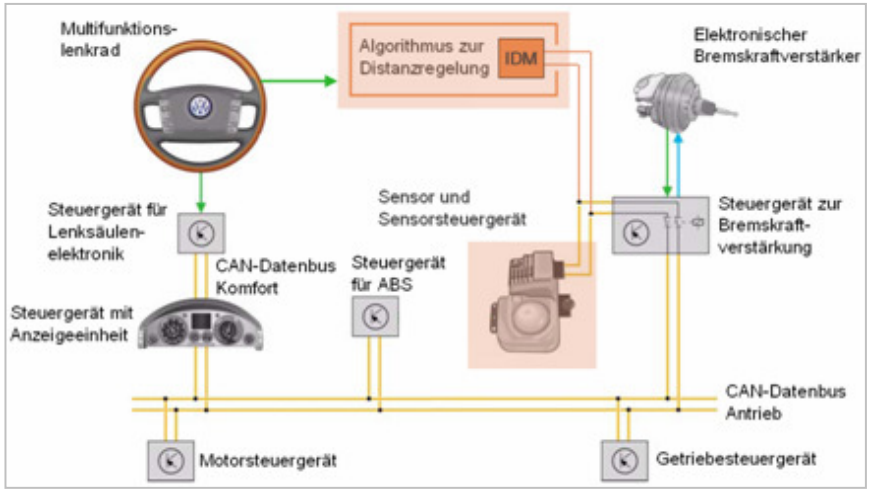
Aggregated information

Display of precise information to driver

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

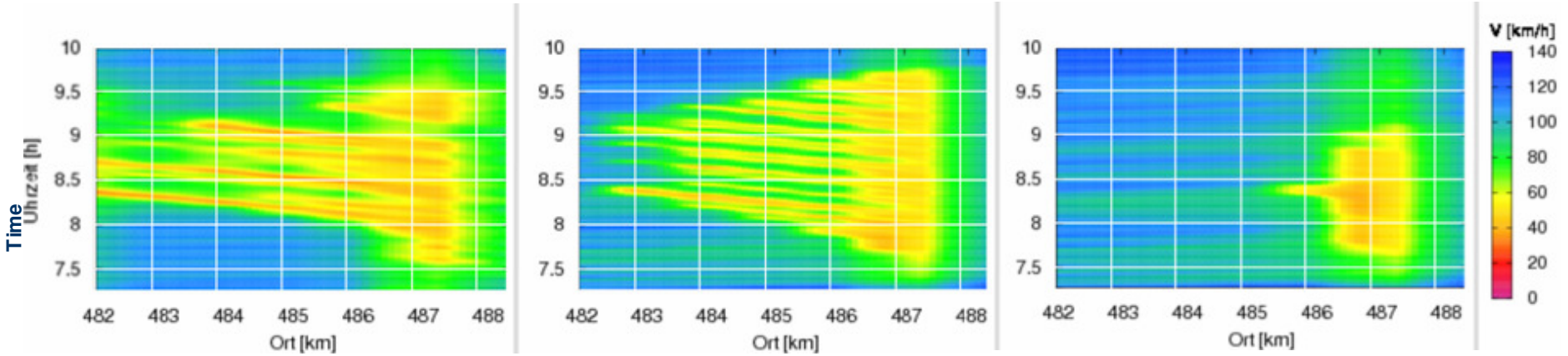
Avoidance of congestion by car-to-x communication

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*



Location **Location** **Location**

Significant reduction of traffic congestion!

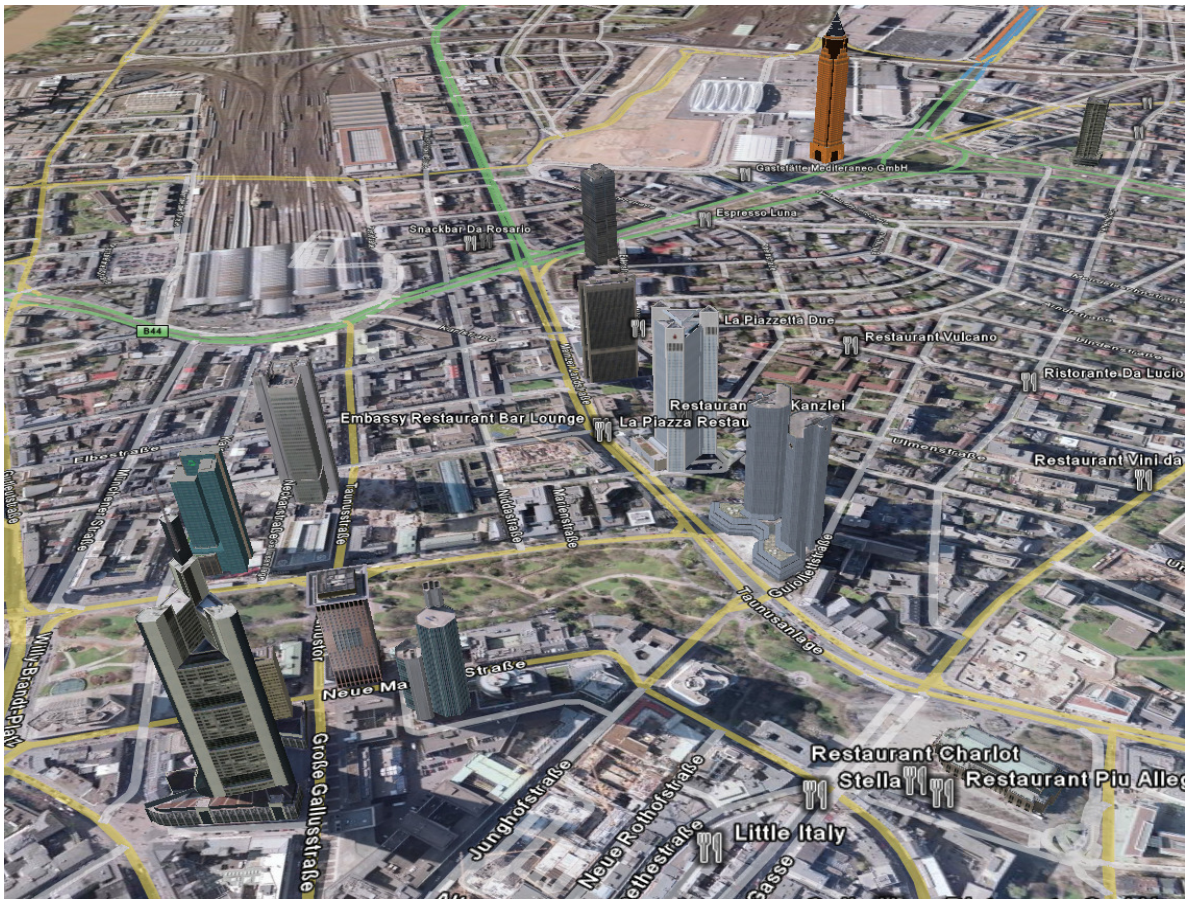
Motivation for integrating communication into vehicles

Improving road safety

Improving traffic efficiency

Providing up-to-date information services

Integration of online Internet services



Traffic information

Fuel prices

Time tables

Restaurants and hotels

Tourist information

Current events

“auto@web“

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

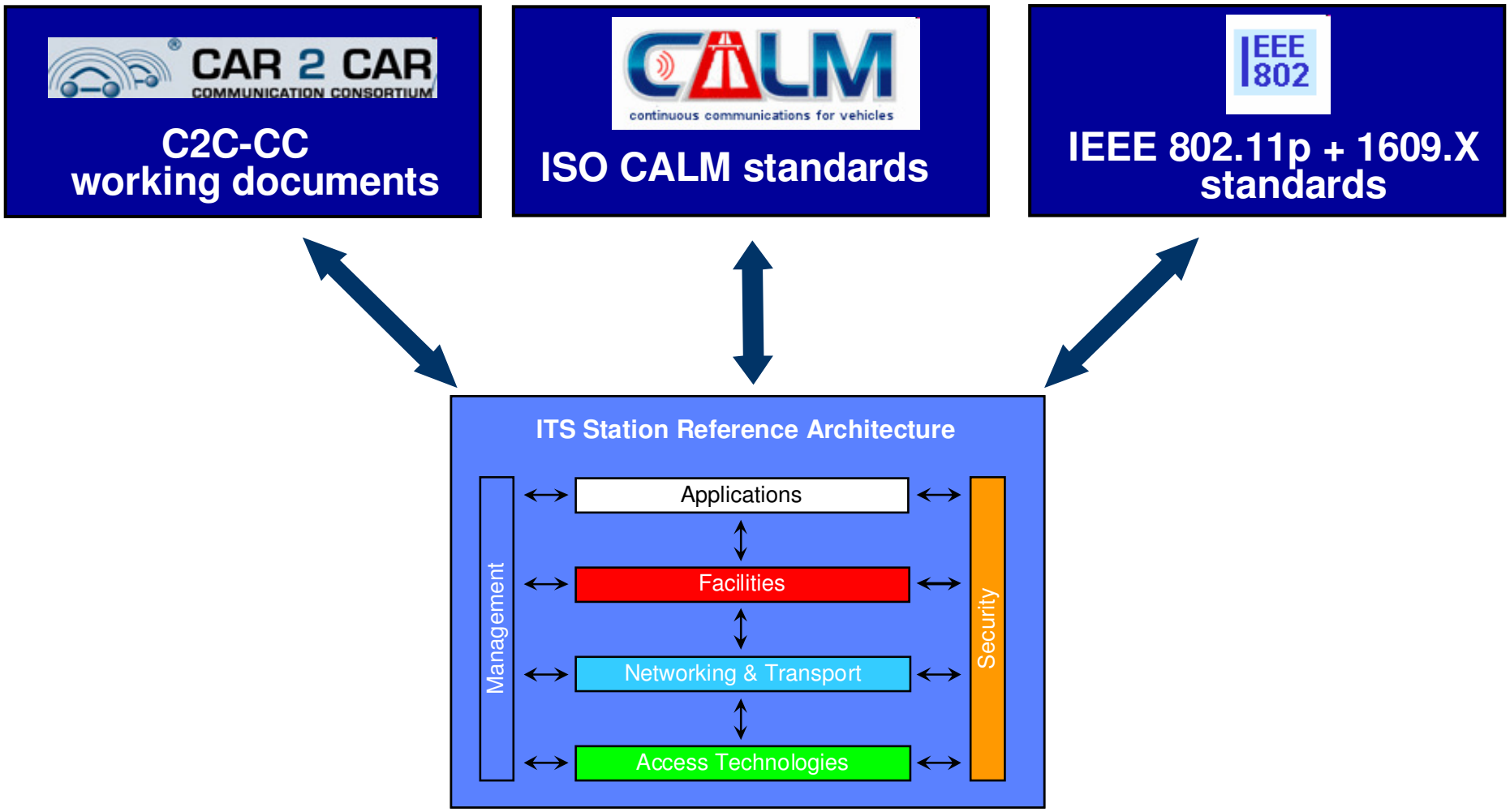
Standardization is the enabler of cooperation

- 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”

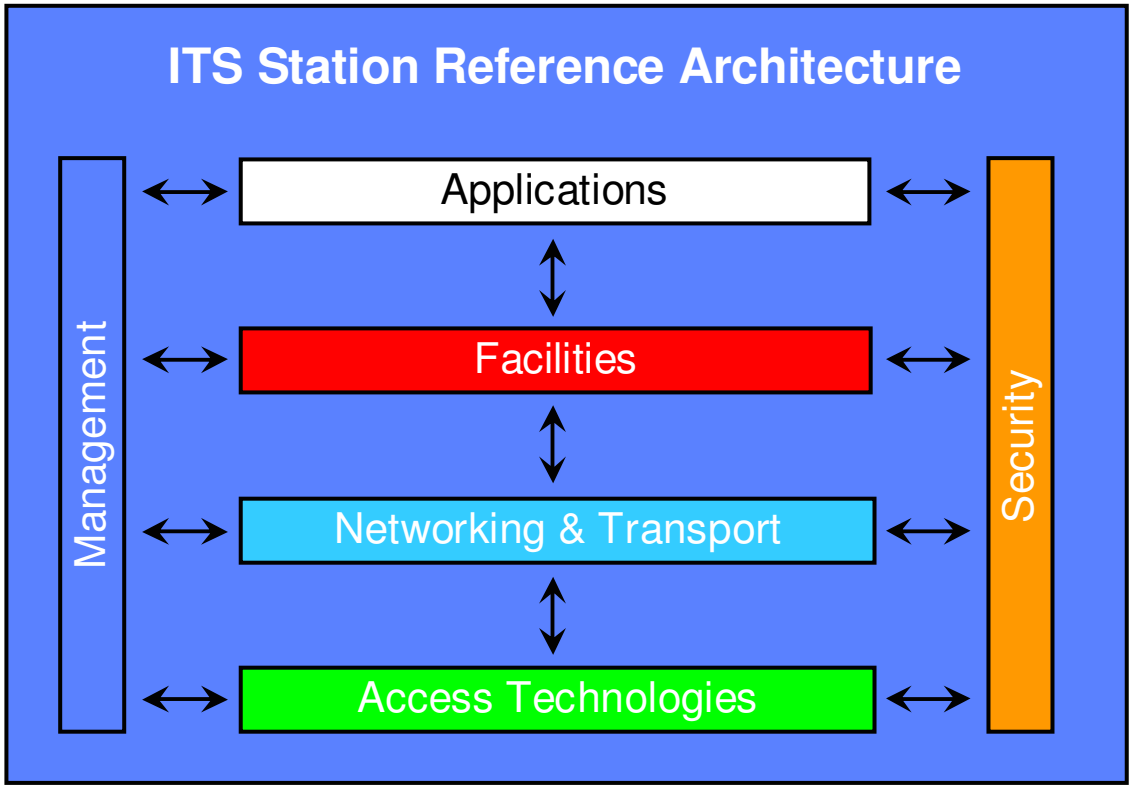
- Freight is global, people are global, Volkswagen is global
  - Proliferation of different standards increases time-to-market and costs

Let’s produce global ITS standards for a global world!

Harmonization of world-wide ITS standards



ITS Station Reference Architecture: "Alphabet" for a common ITS language



Thank you!


Somebody sent me a text ...
What did he write?
Drive, fool!
It's green!