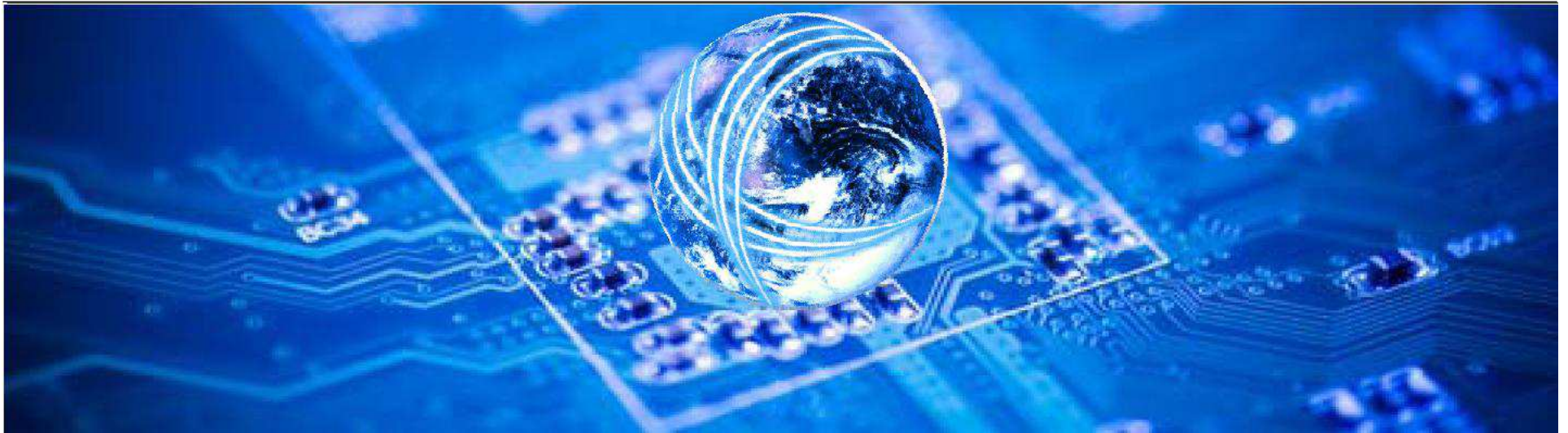


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Looking at Transportation in New Ways

Burkhard Huhnke VWGoA Electronics Research Lab, Palo Alto CA

Hot Chips August 2010



VW Credit Inc.



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Global research and development program



VTT VOLKSWAGEN Group
Technical Representative
Tokyo



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Global research and development program



Worldwide collaboration

- Knowledge network
- Teamwork of experts worldwide
- Driving innovations
- Comparison of concepts
- Best solutions in car

VTT VOLKSWAGEN Group
Technical Representative
Tokyo



VW Credit Inc.



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The ERL is a Bridge



VW Credit Inc.



The ERL is a Bridge

Silicon Valley Engineering

- Out-of-the-box thinking
- Rapid evolution of ideas
- Make do with minimal resources
- Borrow technology from other fields
- “How can we make this work?”

This way to

The ERL is a Bridge

Silicon Valley Engineering

- Out-of-the-box thinking
- Rapid evolution of ideas
- Make do with minimal resources
- Borrow technology from other fields
- “How can we make this work?”

Automotive Engineering

- Focus on safety and manufacturability
- A century of in-vehicle experience
- Vast test and validation resources
- Trusted automotive technology
- “Prove that it works in all situations”

The ERL is a Bridge

Silicon Valley Engineering

- Out-of-the-box thinking
- Rapid evolution of ideas
- Make do with minimal resources
- Borrow technology from other fields
- “How can we

ERL Engineering

- New, bold ideas and technology
- Meeting rigorous automotive requirements

Automotive Engineering

- Focus on safety and manufacturability
- A century of in-vehicle experience
- Vast test and validation resources
- Trusted automotive technology
- “Prove that it works in all situations”

The Electronics Research Lab – Driving The Future



The Electronics Research Lab – Driving The Future

Driver assistance systems



The Electronics Research Lab – Driving The Future

Driver assistance systems



Connected Car



The Electronics Research Lab – Driving The Future

Driver assistance systems



Connected Car



Human Machine Interface



The Electronics Research Lab – Driving The Future

Driver assistance systems



Connected Car



Human Machine Interface



eMobility development



Global Challenges



Lack of space



... in Los Angeles



... in Dhaka

poor or rich
- both have to wait -

Challenges for Society



Decreasing energy resources at a rising cost

Increasingly complex traffic situations

Increasing need for safety

Challenges of the future



- Individual customer requirements
- Income polarisation
- Demographic change



- Urbanisation
- Increasing traffic load
- Seamless mobility

Society

Mobility

Energy

- Climate change
- CO₂
- Peak of oil



Safety

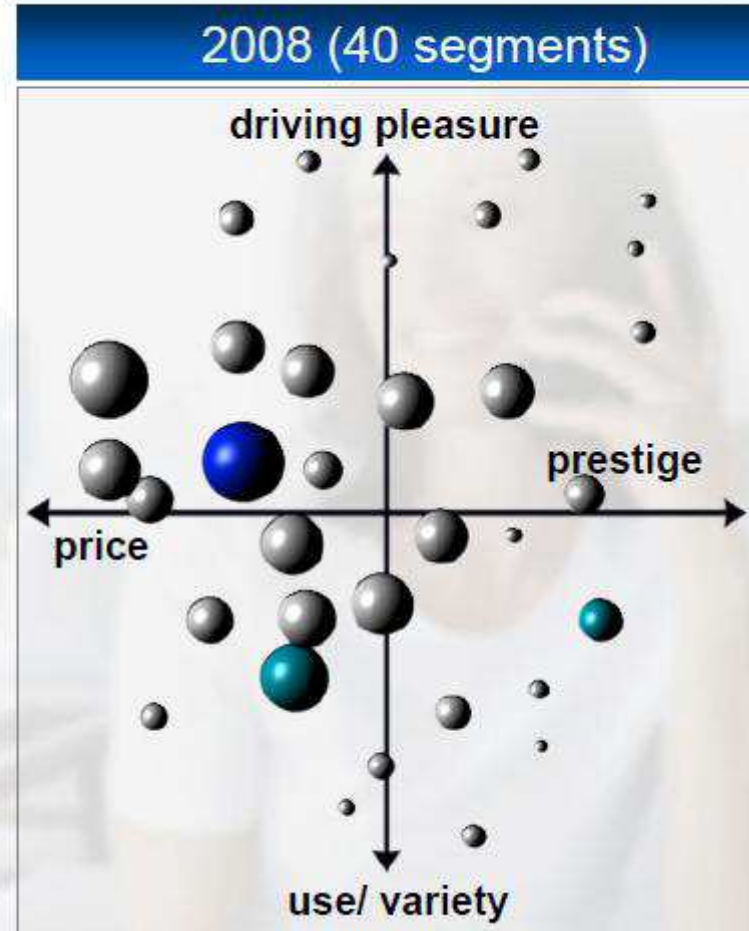
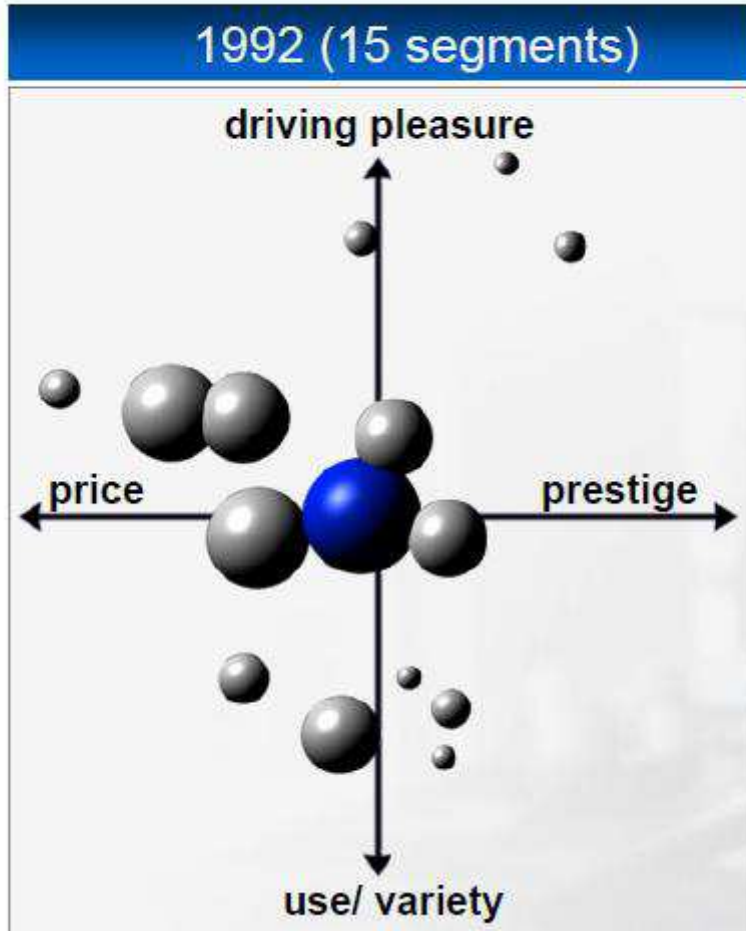
- Increasing vehicle number
- Legal requirements
- New markets



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Increasing vehicle segments and different customer requirements



VW Credit Inc.



Electronics enables new functions but requires a novel interpretation of usability



Driving in the thirties: 30`

- Gas valve
- Fuel
- Outside temperature-> - ignition
 - fuel injection
 - Choke
 - decompress
 - search OT
 - crank
- Control all engine data (watertemp, oiltemp, oil level, oilpressure,...)
- control all engine parameters
- dose cooling air



Driving in the eighties: 80`

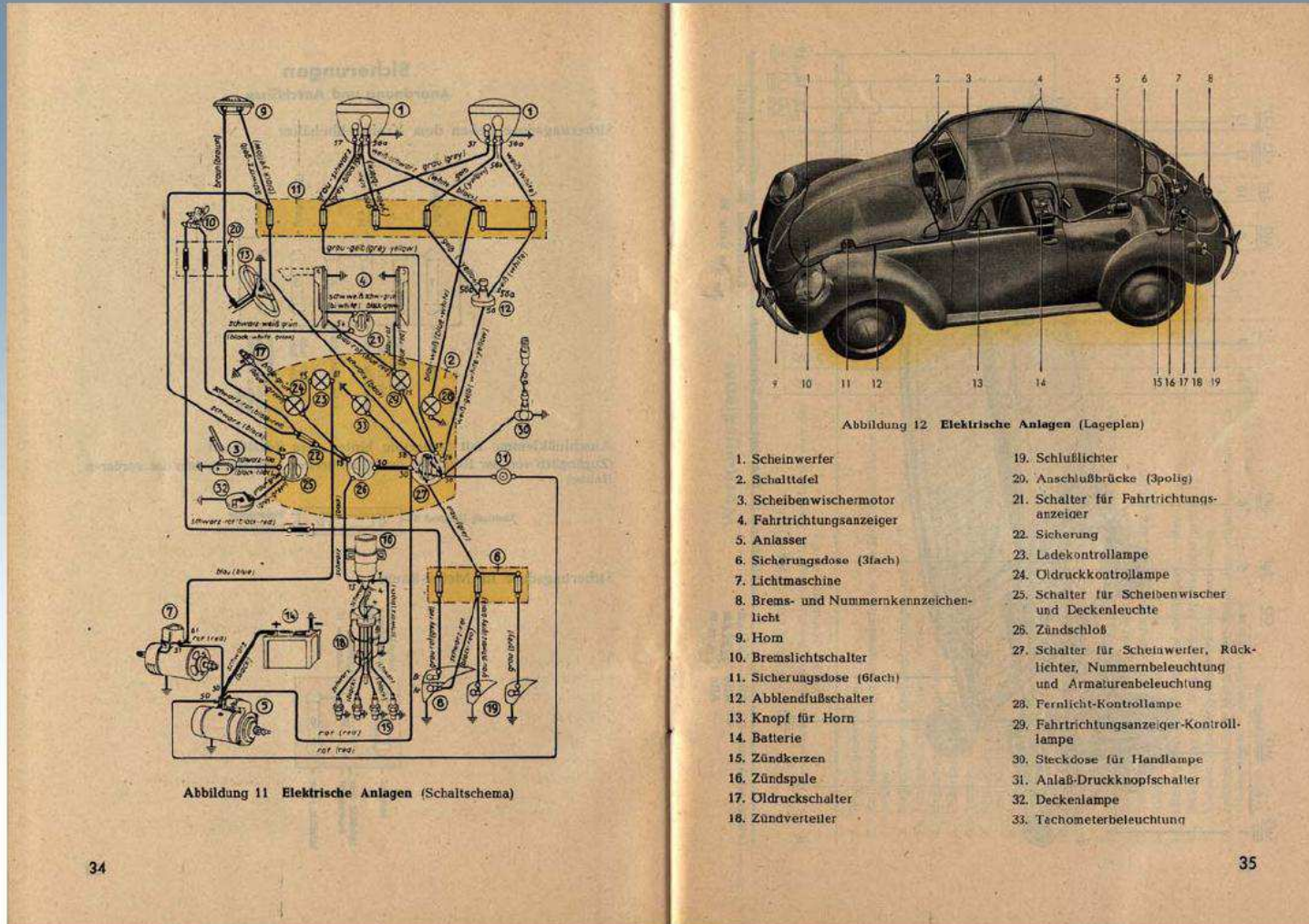
- unlock
- switch on ignition
- turn on radio
- put on safety belt
- start engine
- drive
- no warning = no need to act



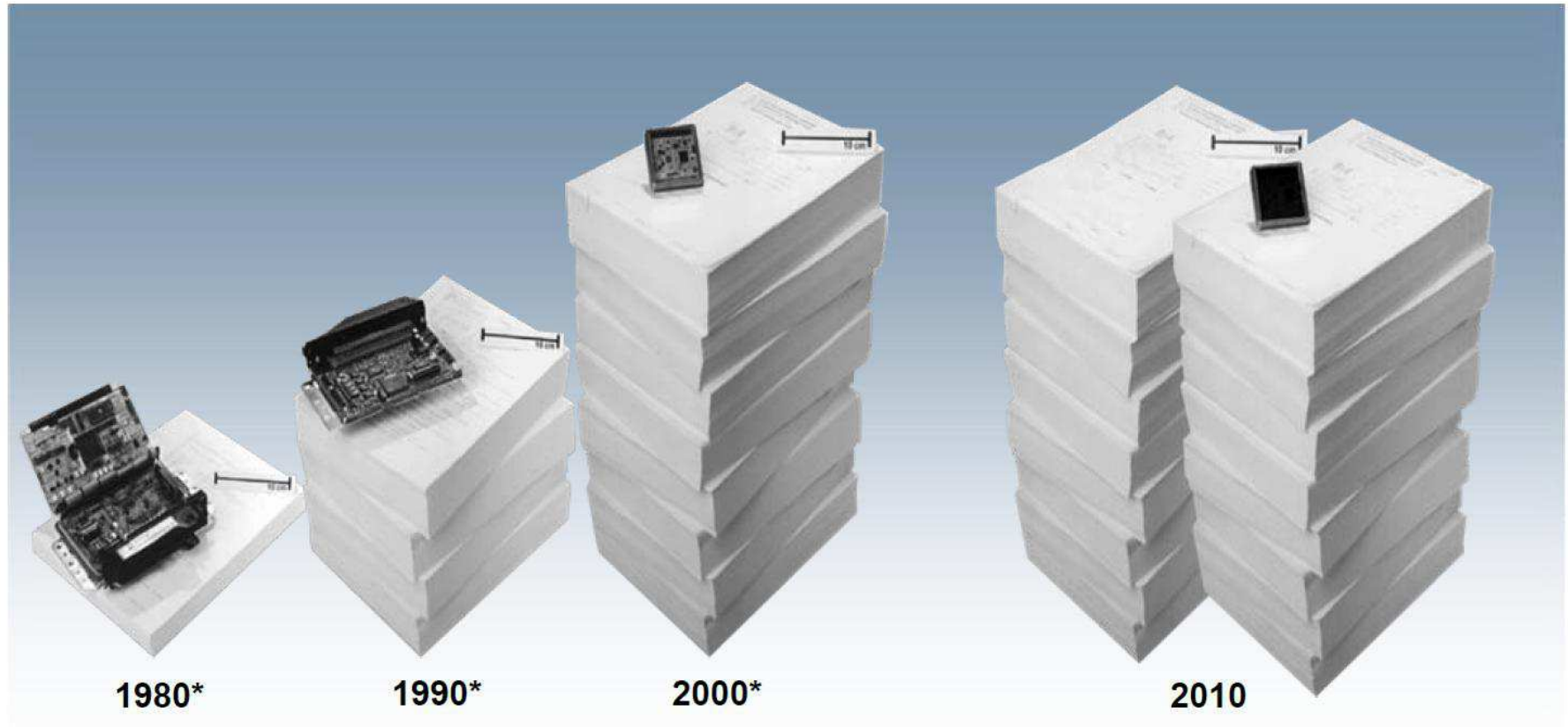
Driving in the 21st century:

- enter
- Input destination
- Select entertainment
- Put on safety belt
- Start engine
- Select and configure assistance
- drive
- Monitor assistance functions
- Follow infotainment suggestions – travel guide, traffic info etc.
- Use mobile devices?

VW Beetle in 1949: a historical E/E architecture



Soft- and hardware evolution



Example: gearbox CPU

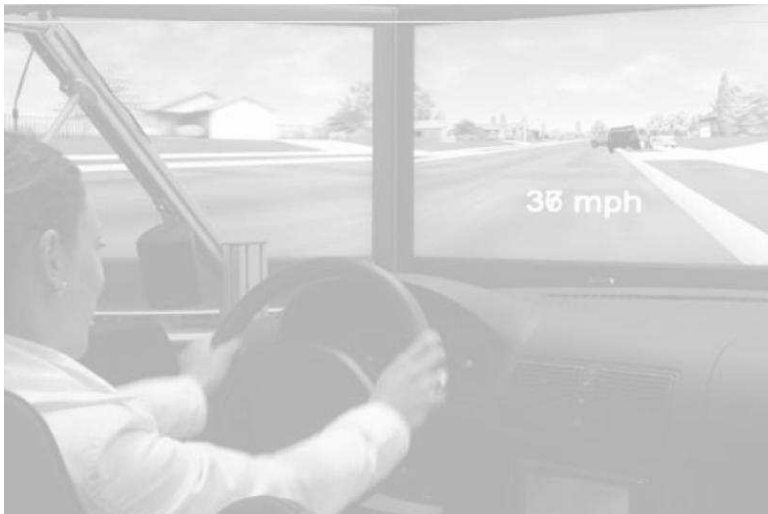
The automobile of the future



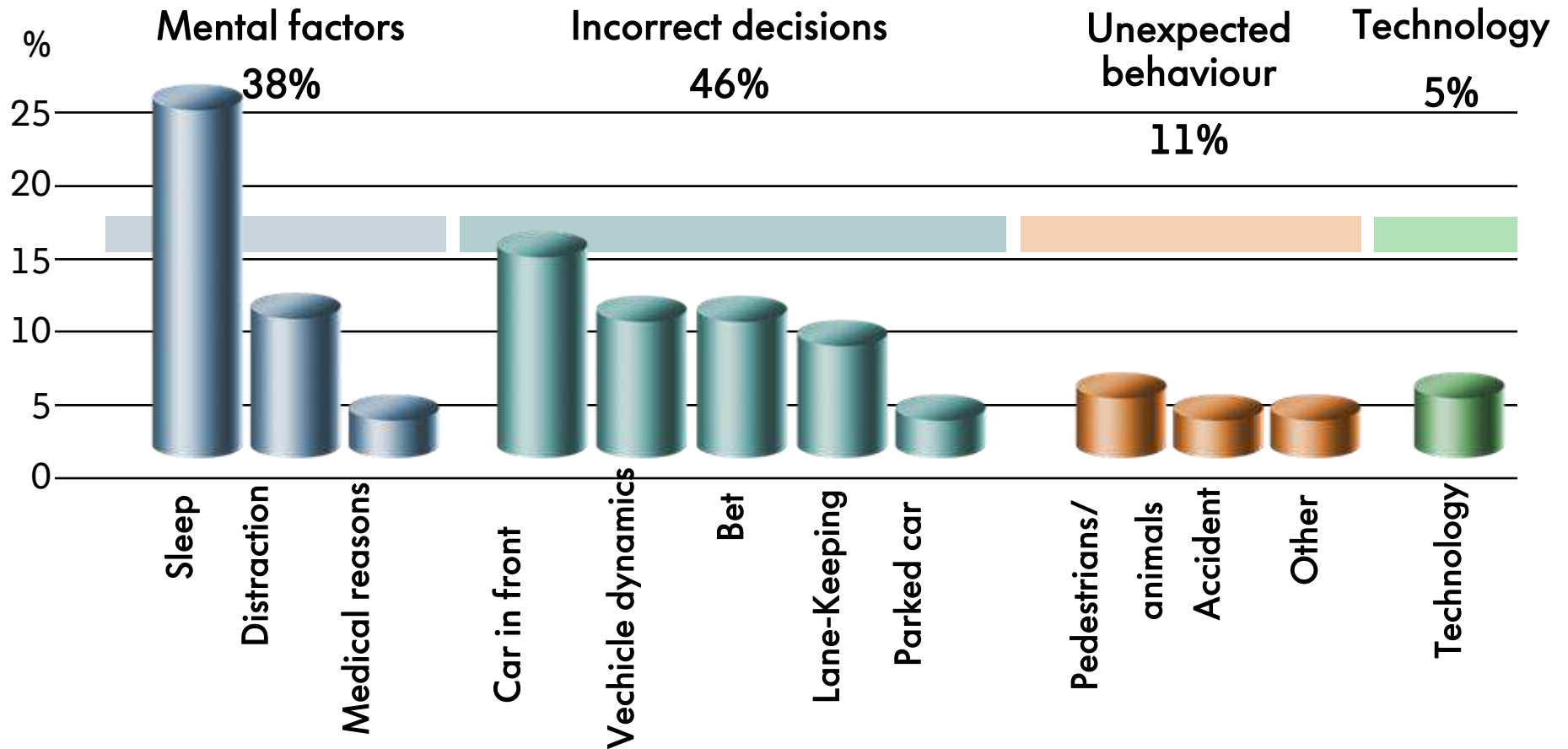
The automobile of the future



Driver assistance systems

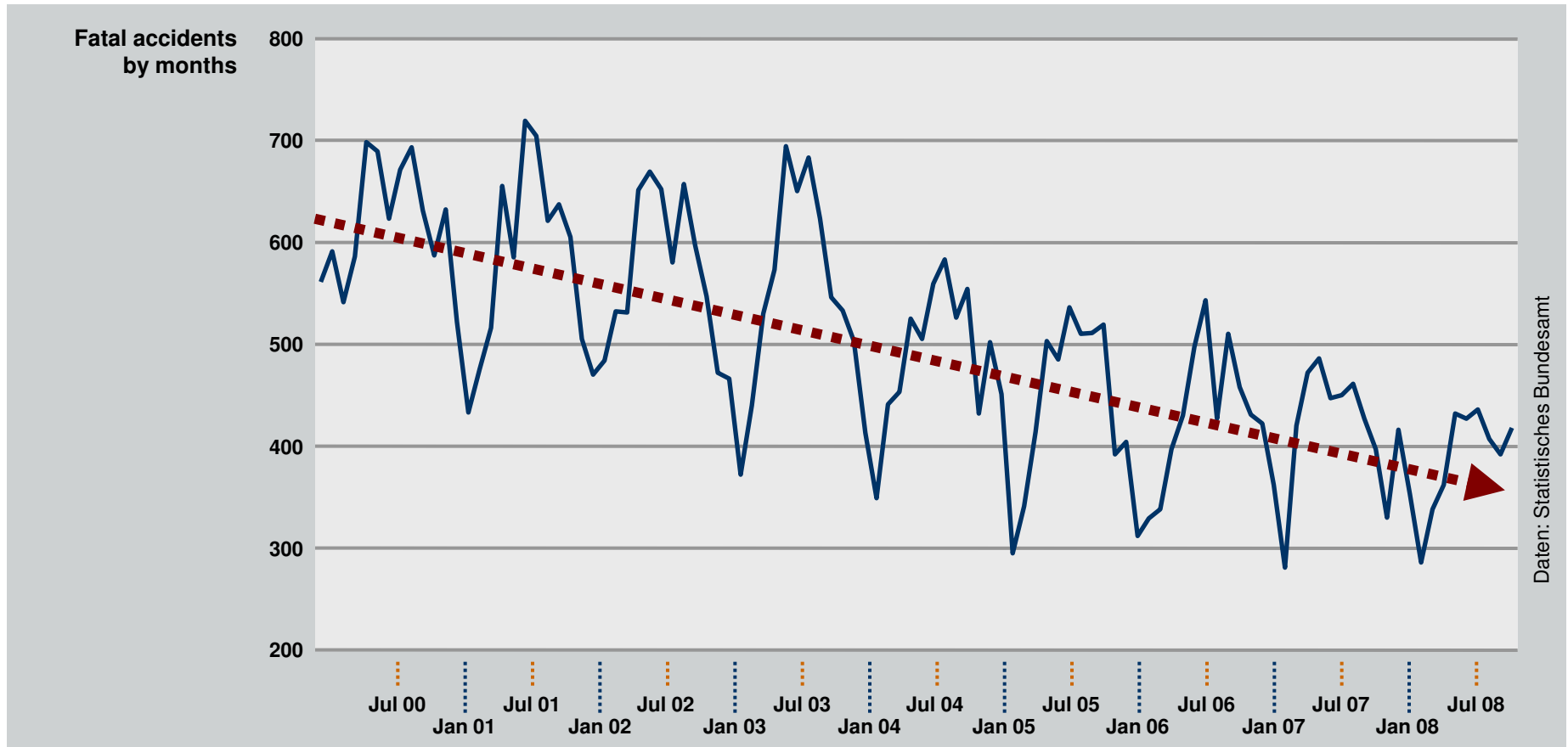


Safety: The Driver as Uncertainty Factor Causes of Fatal Accidents (84% misjudgement)



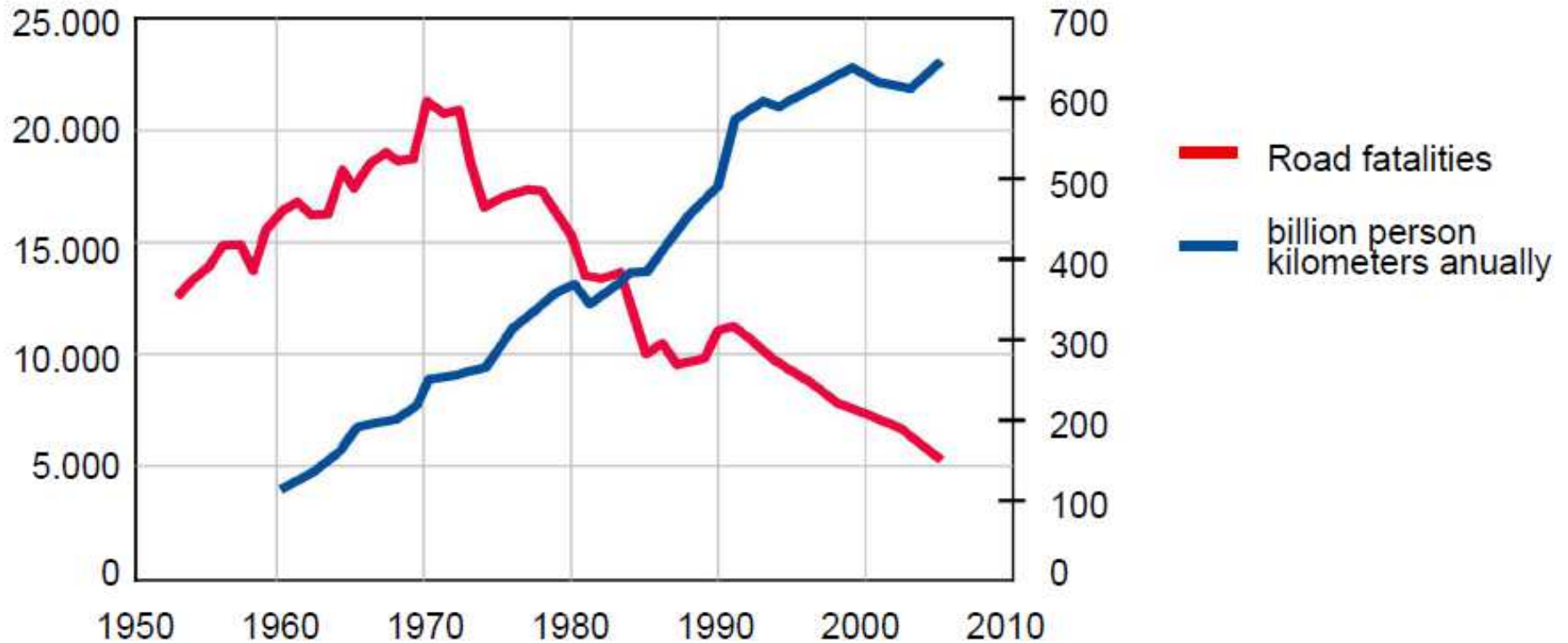
Quelle: GdV, VW Unfallforschung

Vehicle Safety Fatal accidents over time (Germany)



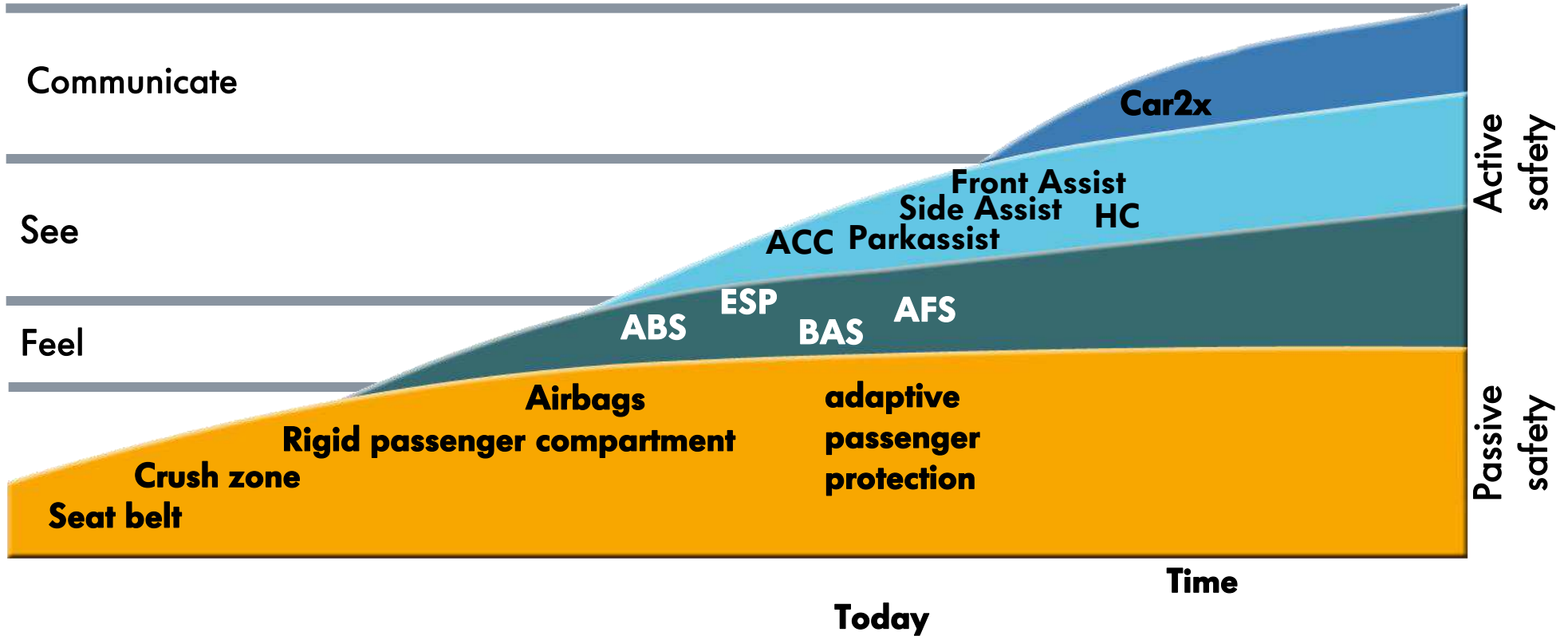
Road safety

Fatal accidents over time in Germany

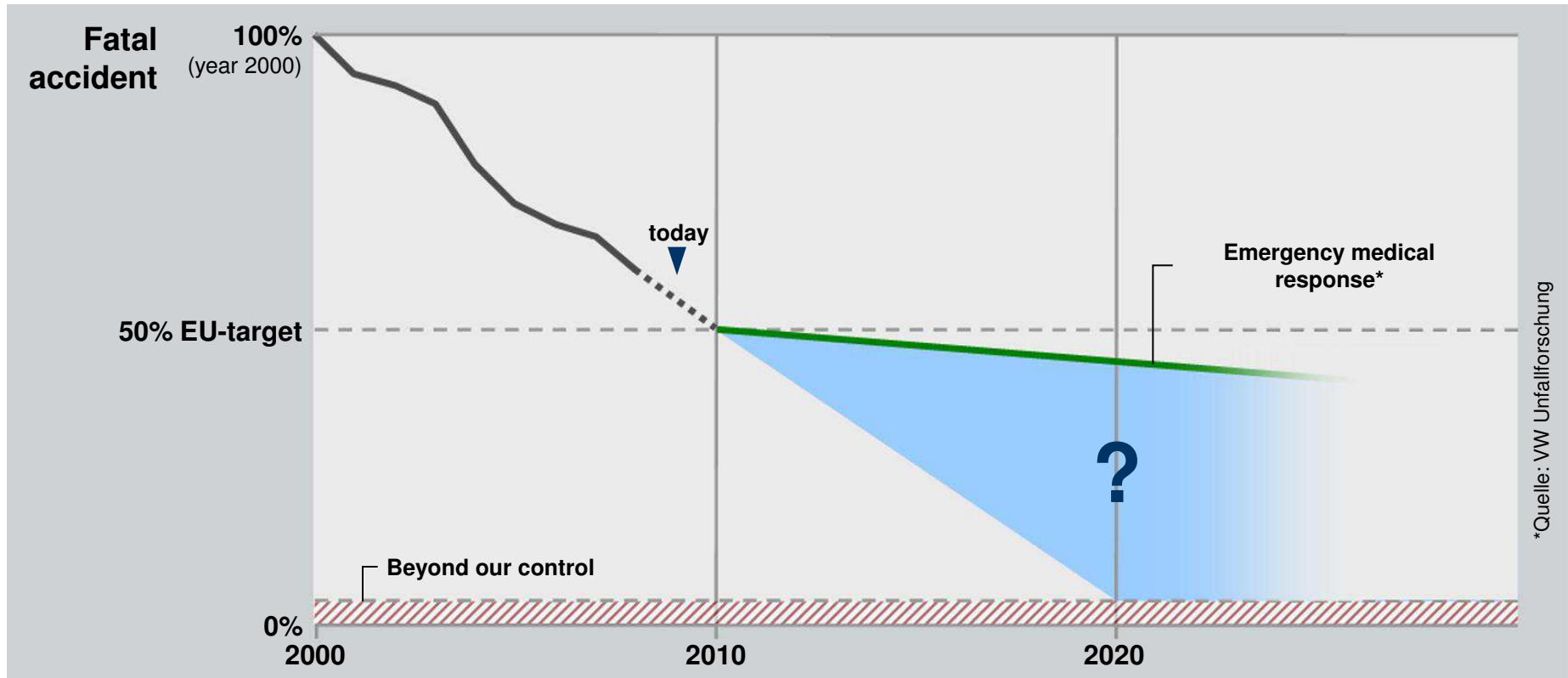


Quelle: Volkswagen AG - Forschung, Umwelt und Verkehr

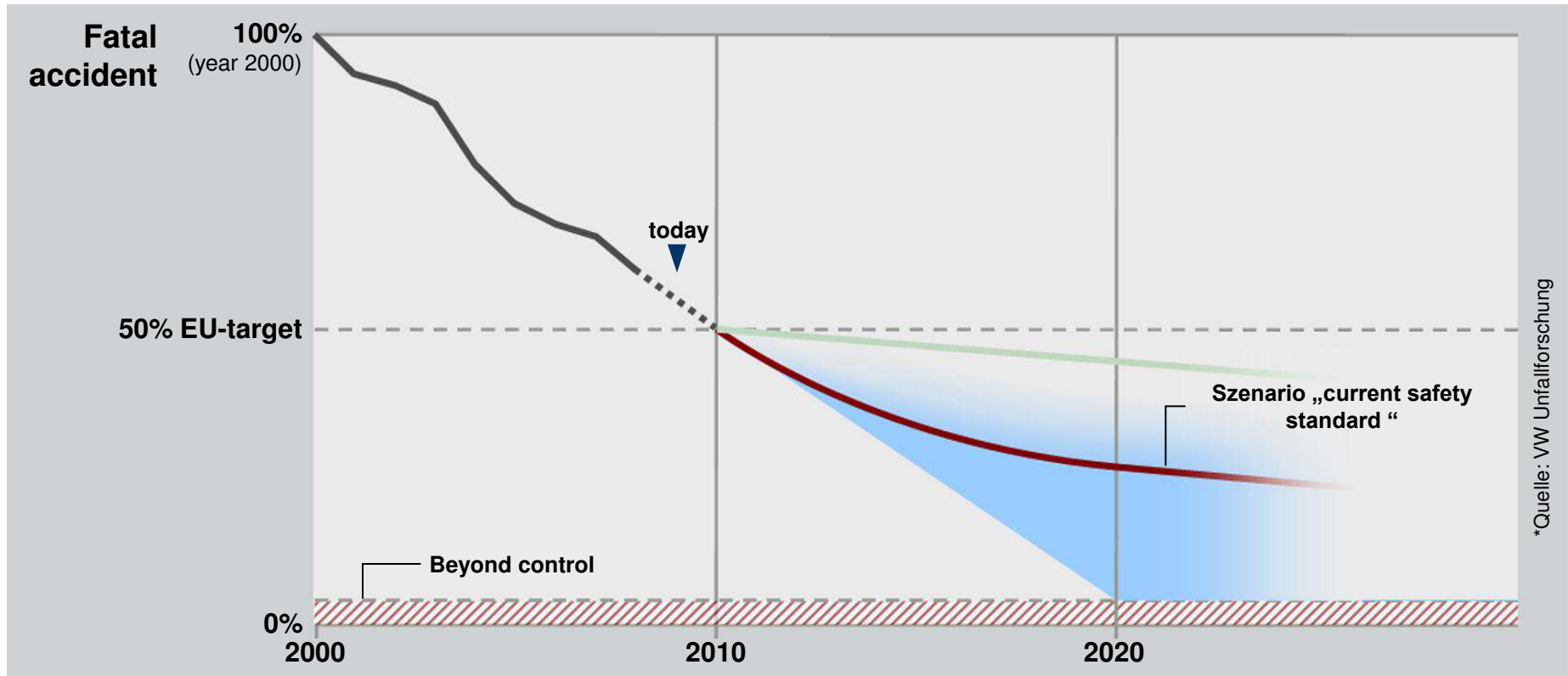
Vehicle Safety - Potential for Protection



Effectivity of current assistance and safety features

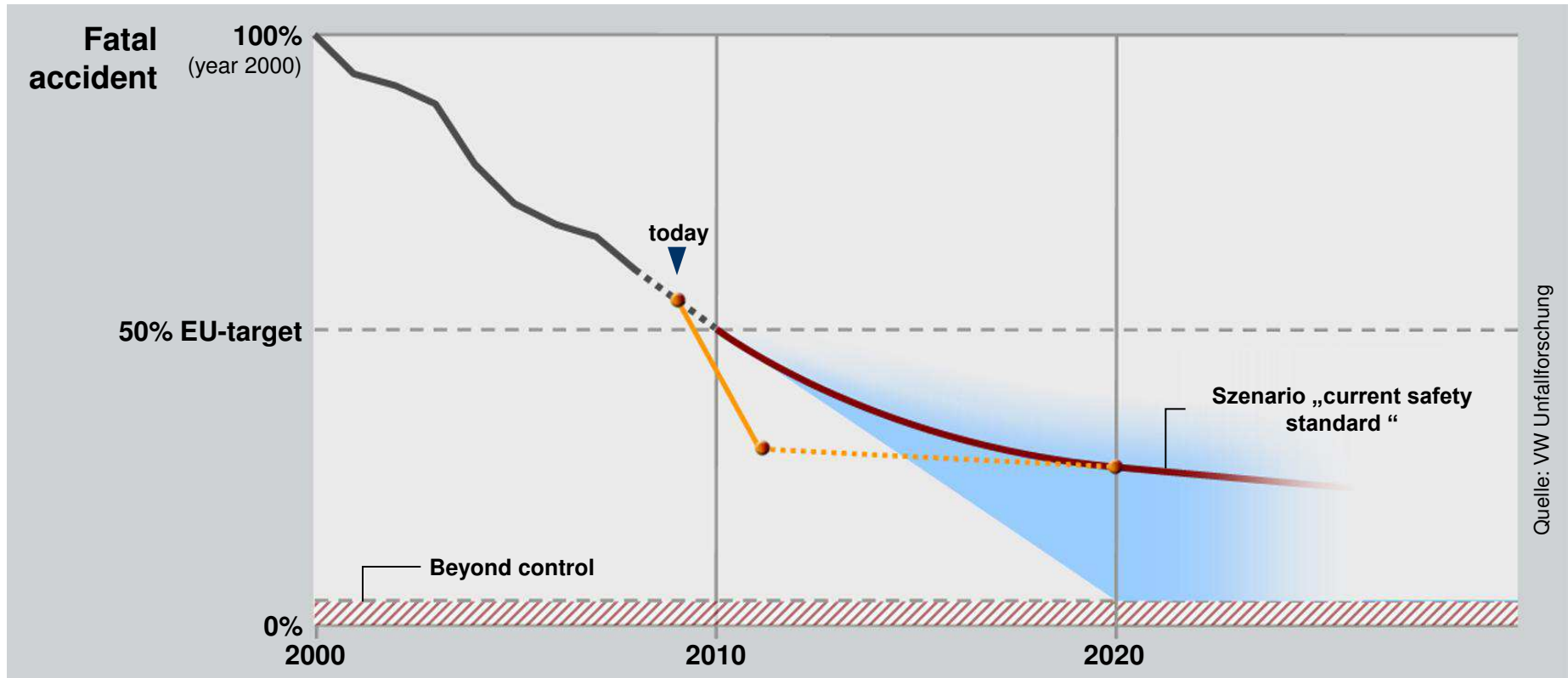


Effectivity of current assistance and safety features



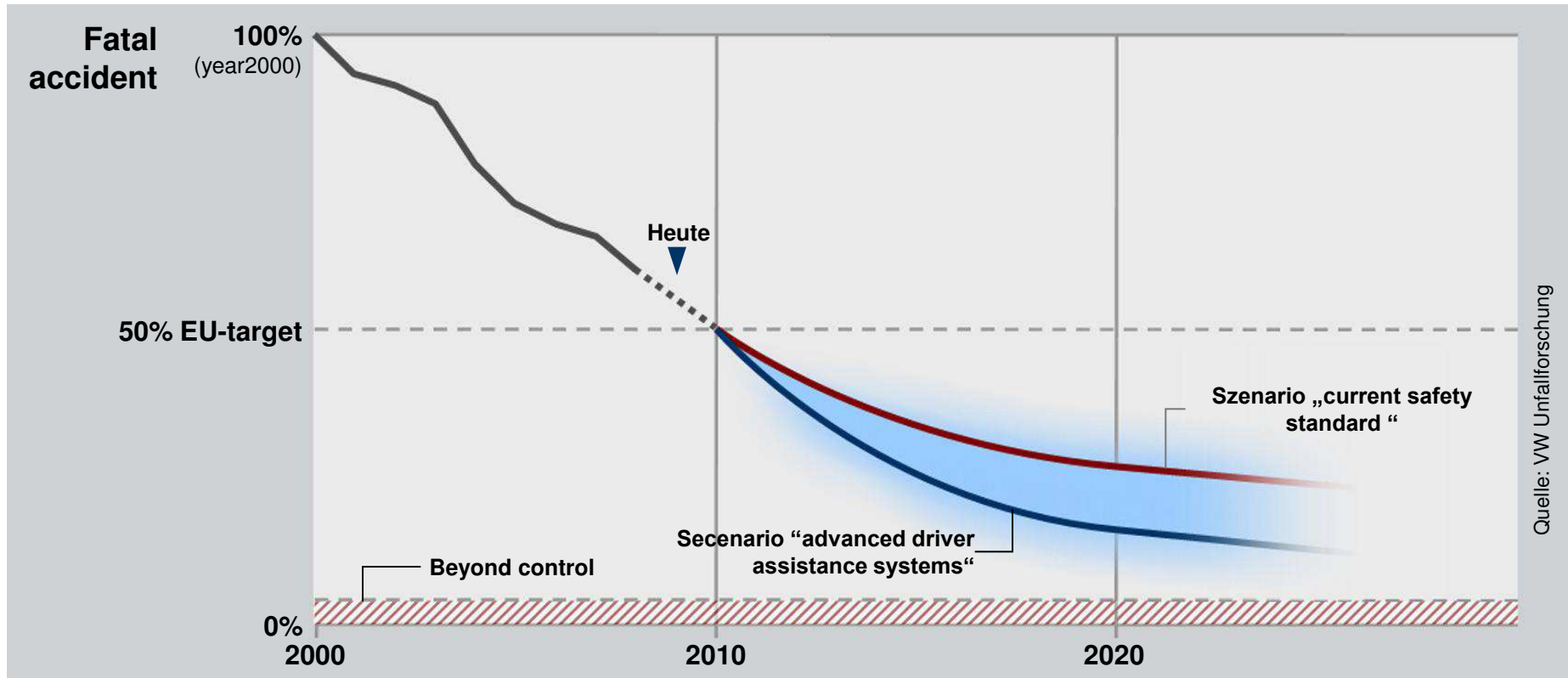
■ With a consequent market distribution of available passive safety technology (Golf platform)

Effectivity of current assistance and safety features



Special effects through incentive programs

Effectivity of current assistance and safety features



■ Additional theoretical potential by 20% - with a consequent market distribution of advanced driver assistance systems

Increasing need for safety

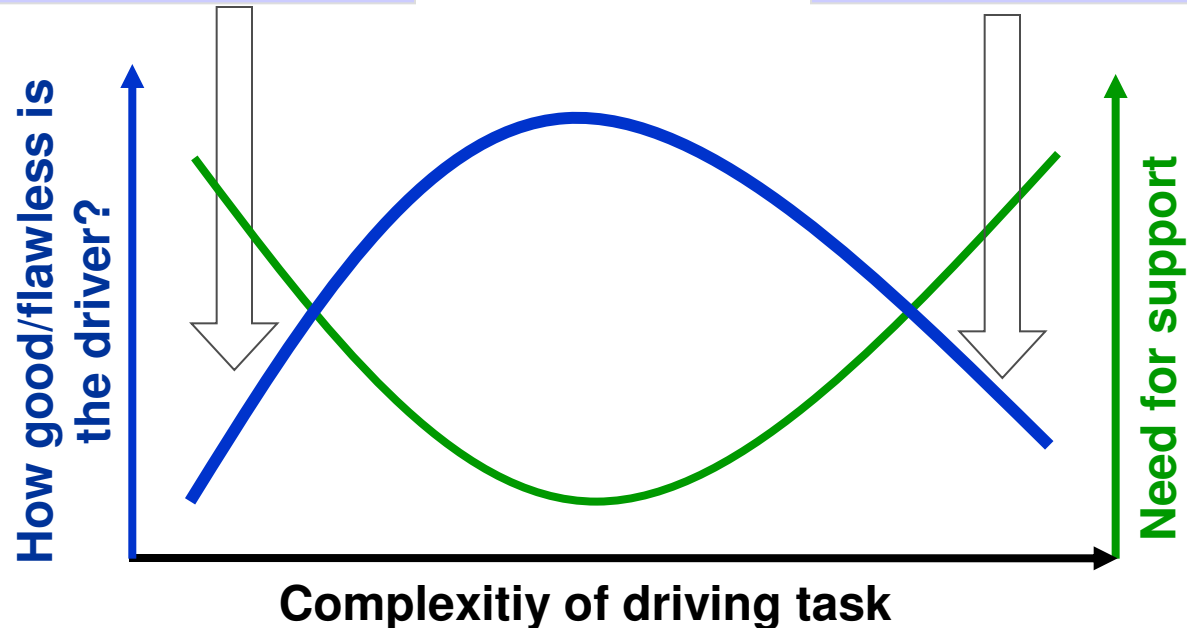
Supporting the driver when he/she is in need of assistance

Under-challenging the driver

- Simple, monotonous driving tasks
- E.g. long distance trips, traffic jams

Over-challenging the driver

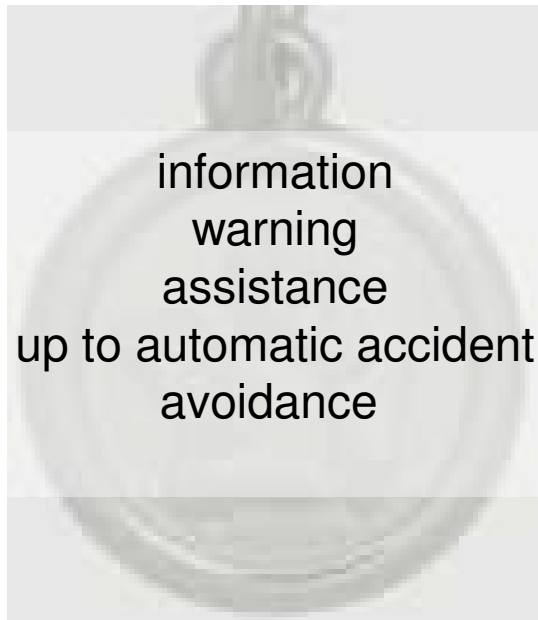
- Complex driving tasks
- E.g. entering a motorway, turning at intersections etc.



Customer Demands

In critical situations the driver needs assistance:

Safety Angel

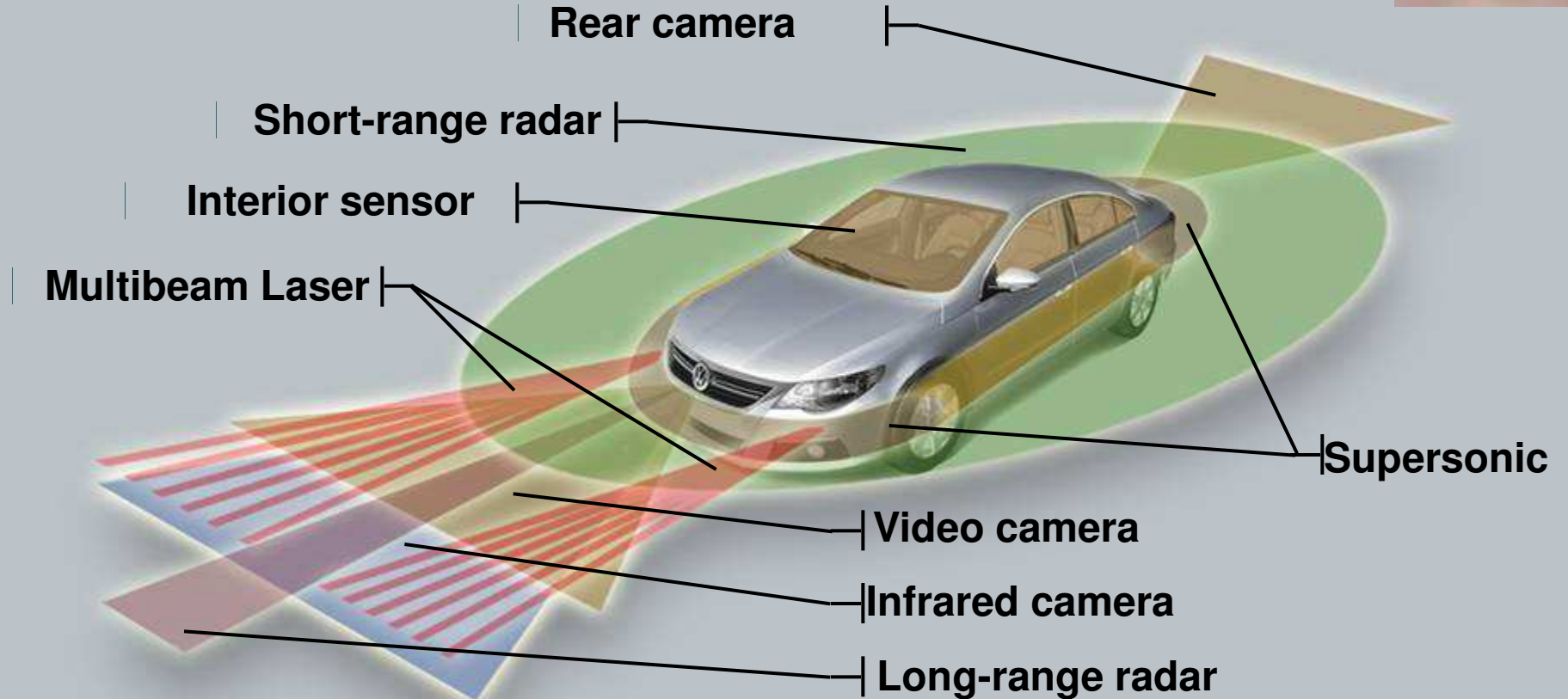


In annoying situations the driver wants assistance:

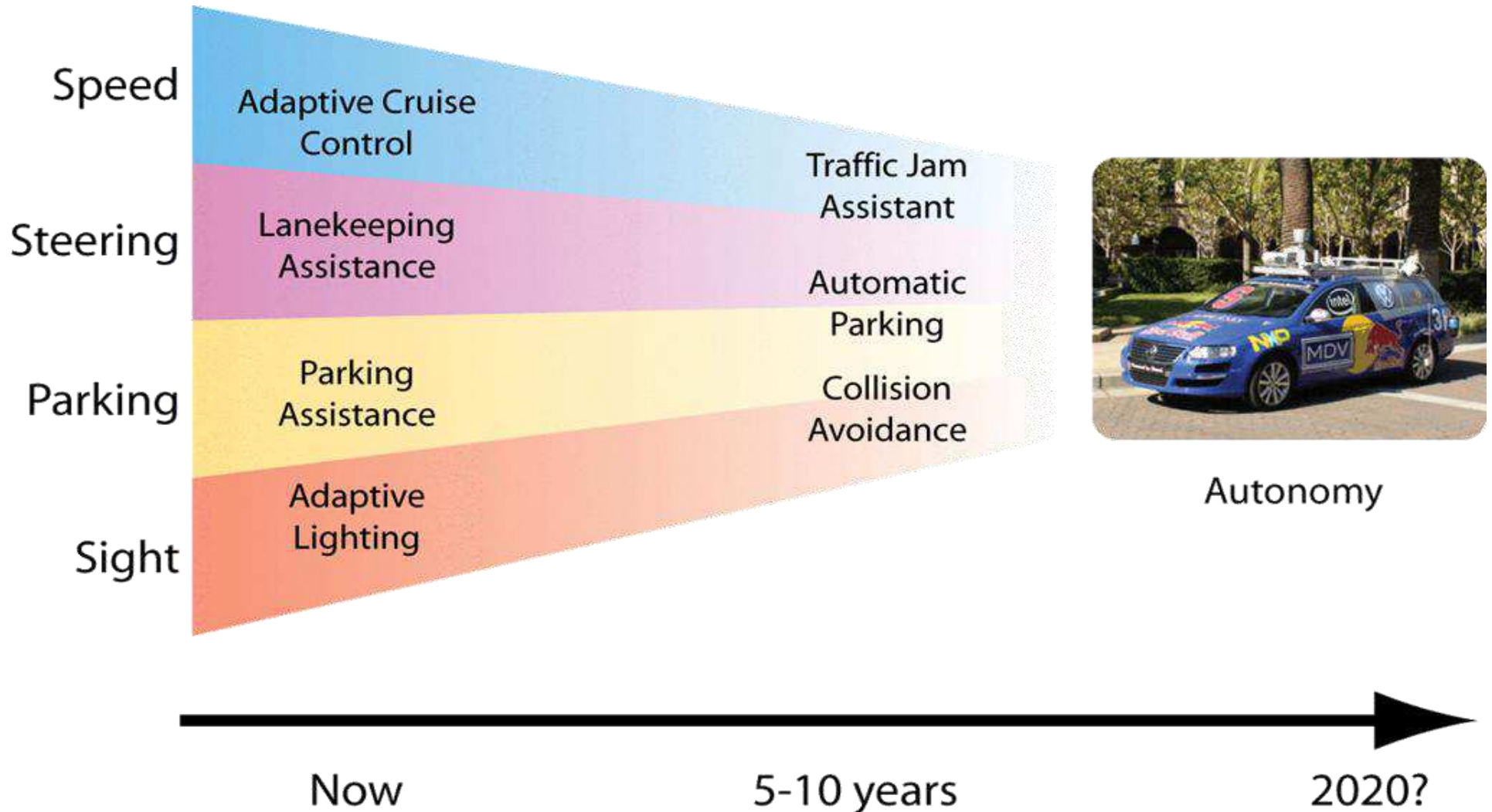
Autopilot



Sensors: Seeing like an Alert Person



Timeline of Driver Assistance



Autonomy

Building Block of Technologies

Driving at the limits of physics



- Vehicle dynamics
- Track coordination



- Drifting algorithm
- High speed

Driving in unknown terrain

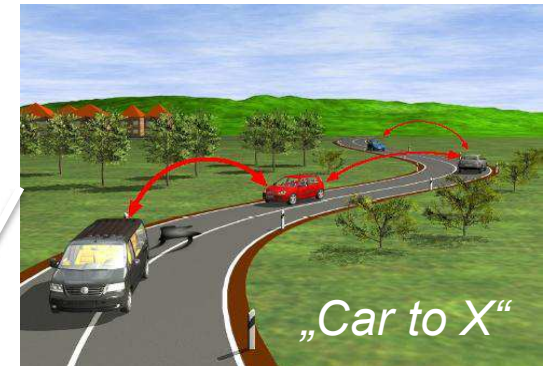


- Recognition of environment
- Locating
- Trajectory

Driving according to traffic regulations



- Driving strategy
- Complex environment



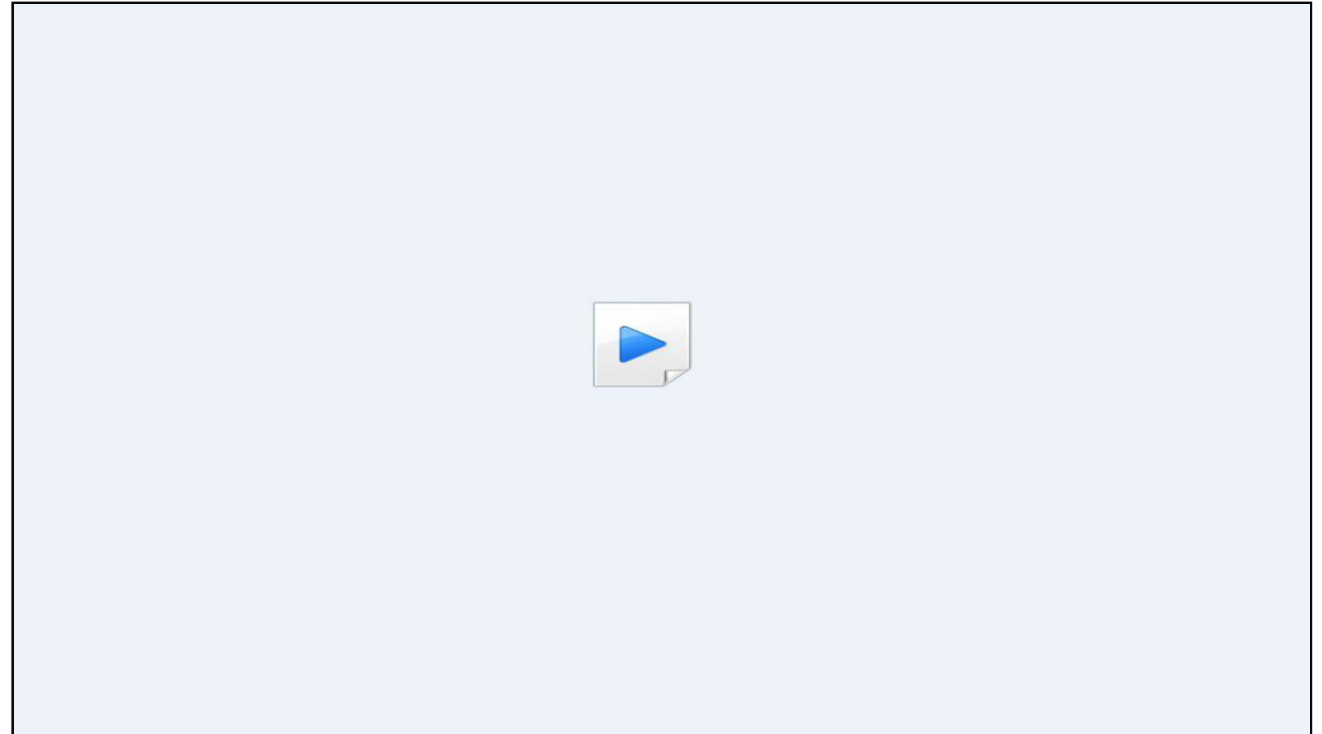
- Expanding the horizon
- Predict danger

Where is this project located

The pikes peak TTS is a key project at the Volkswagen Automotive Innovation Lab (VAIL) located at Stanford University, an initiative dedicated to promote innovation into automotive technologies.

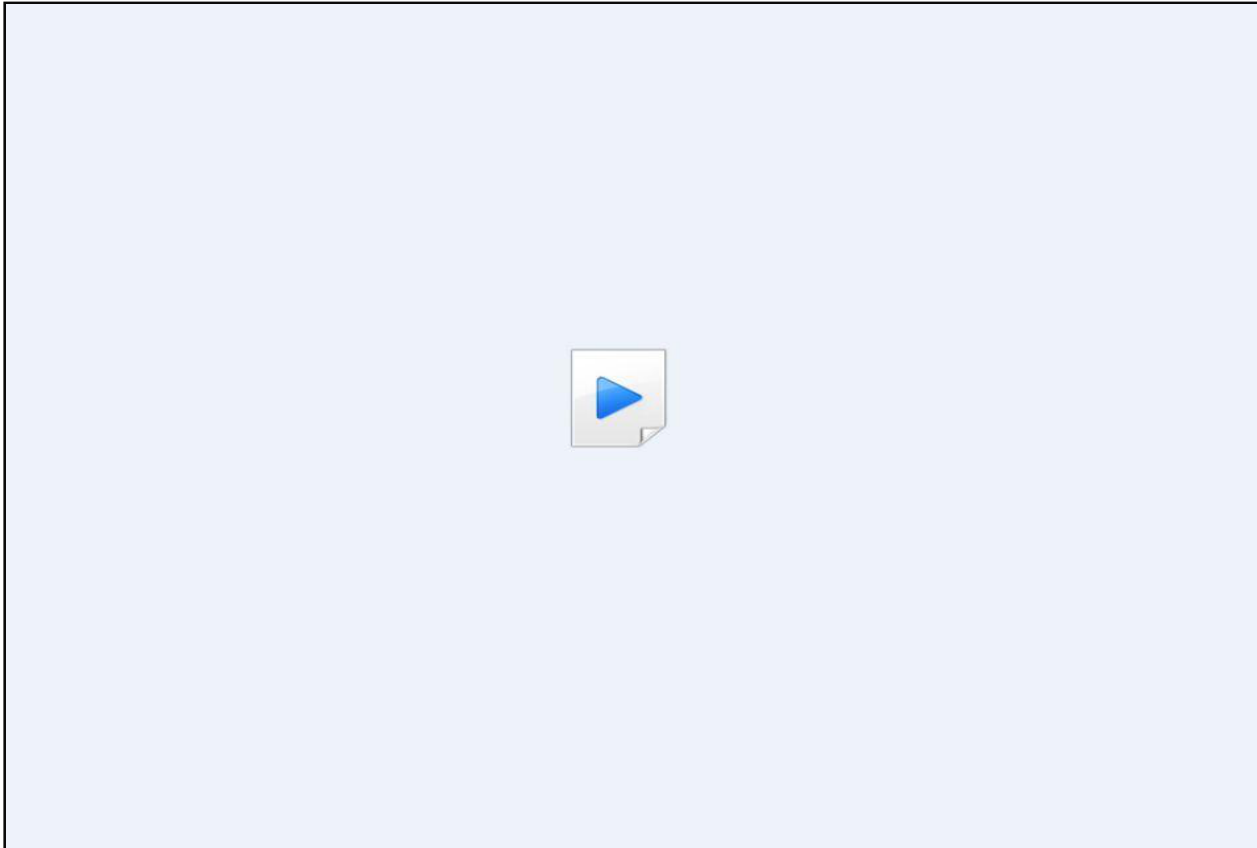


Driving at the limits of physics (2010)



- Drifting algorithm
- High speed

Valet Parking (2010)



Driving according to traffic regulations



- Driving strategy
- Complex environment

Connected Car



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Car to car communication in the past



VW Credit Inc.



Potentials of car to car communications



Improving traffic safety

Information from an ambulance



In-car warning from traffic signs



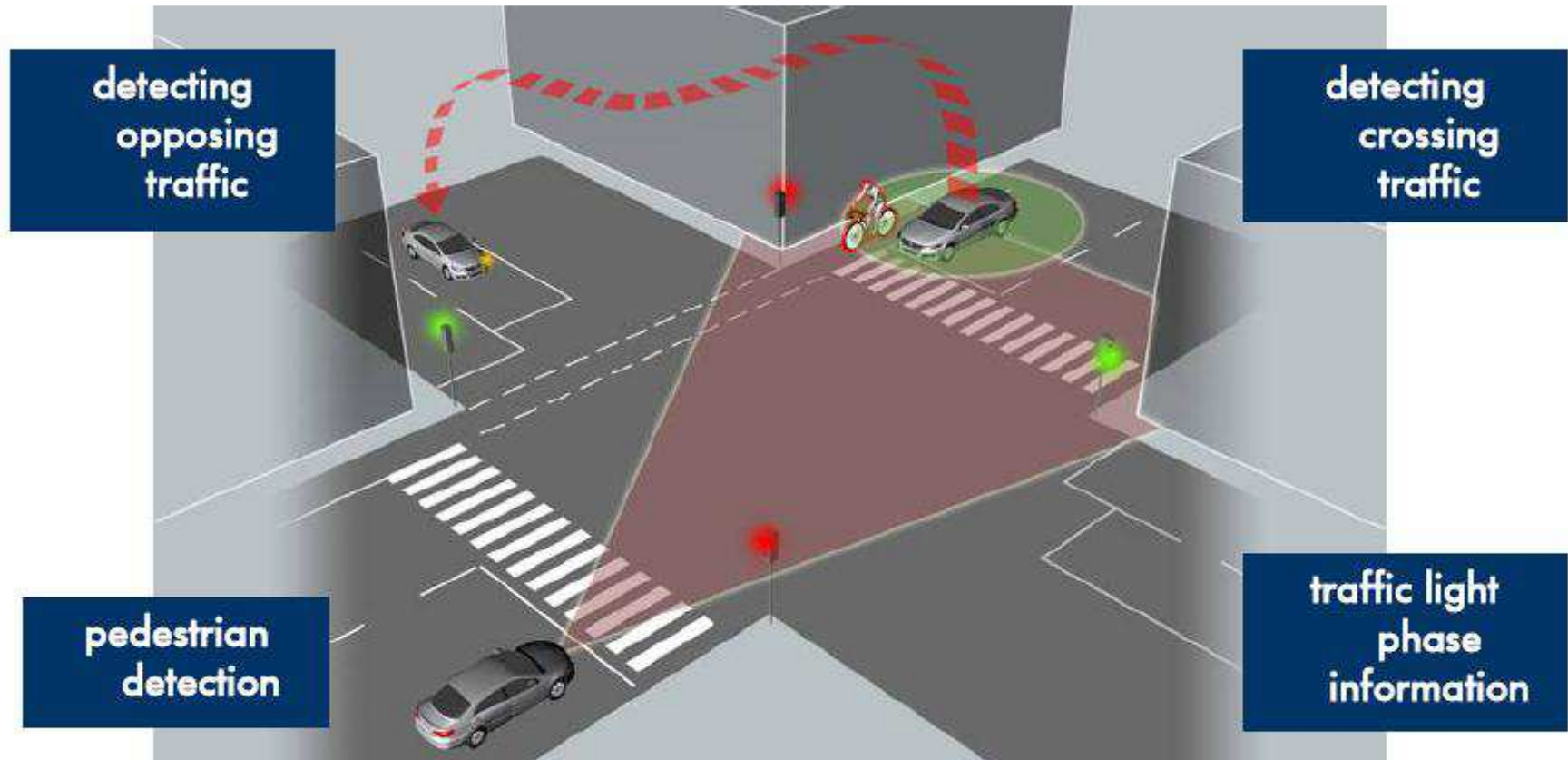
Bad visibility



Road works



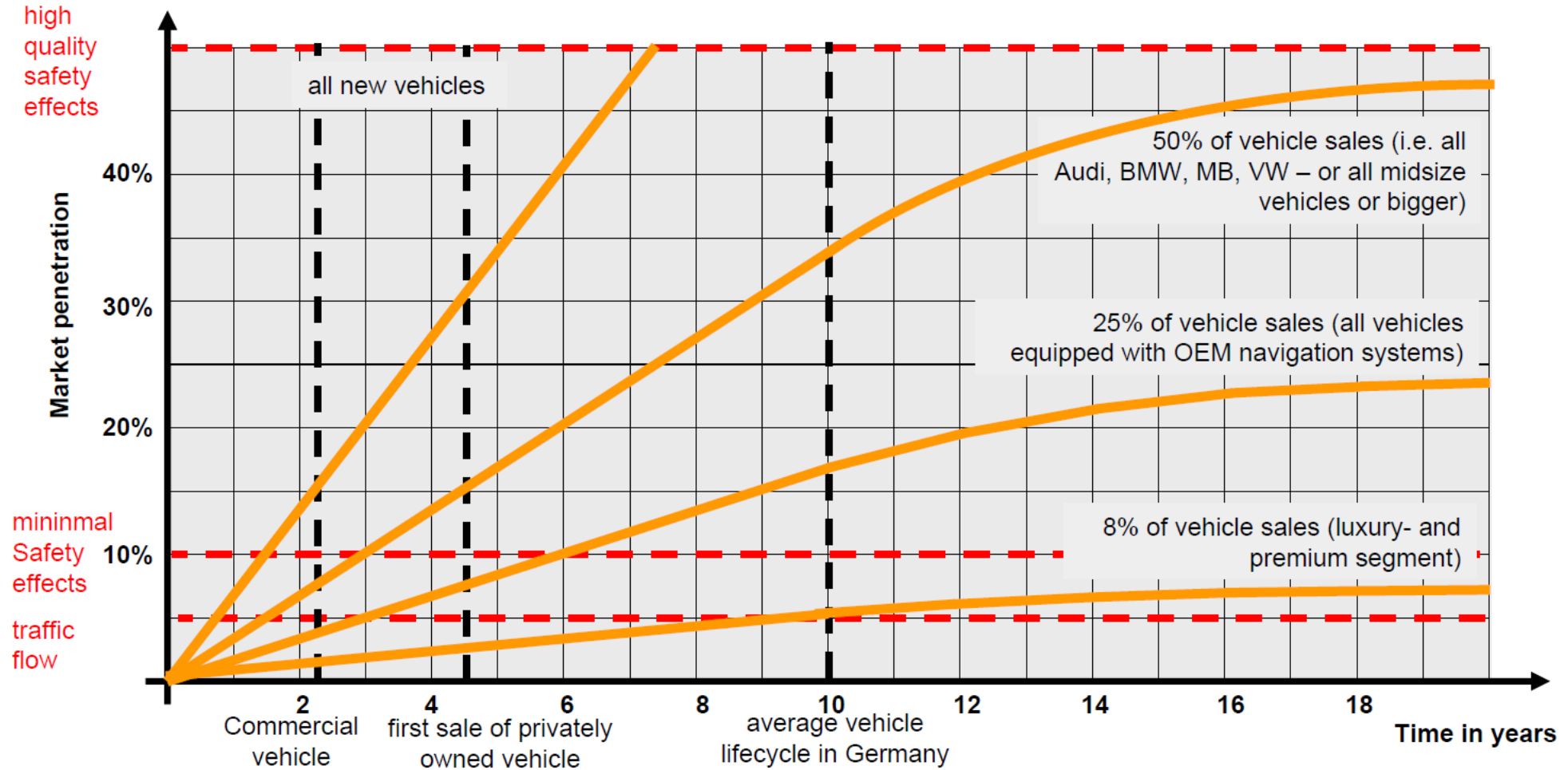
The intersection assistant



Car to x – expanding the horizon

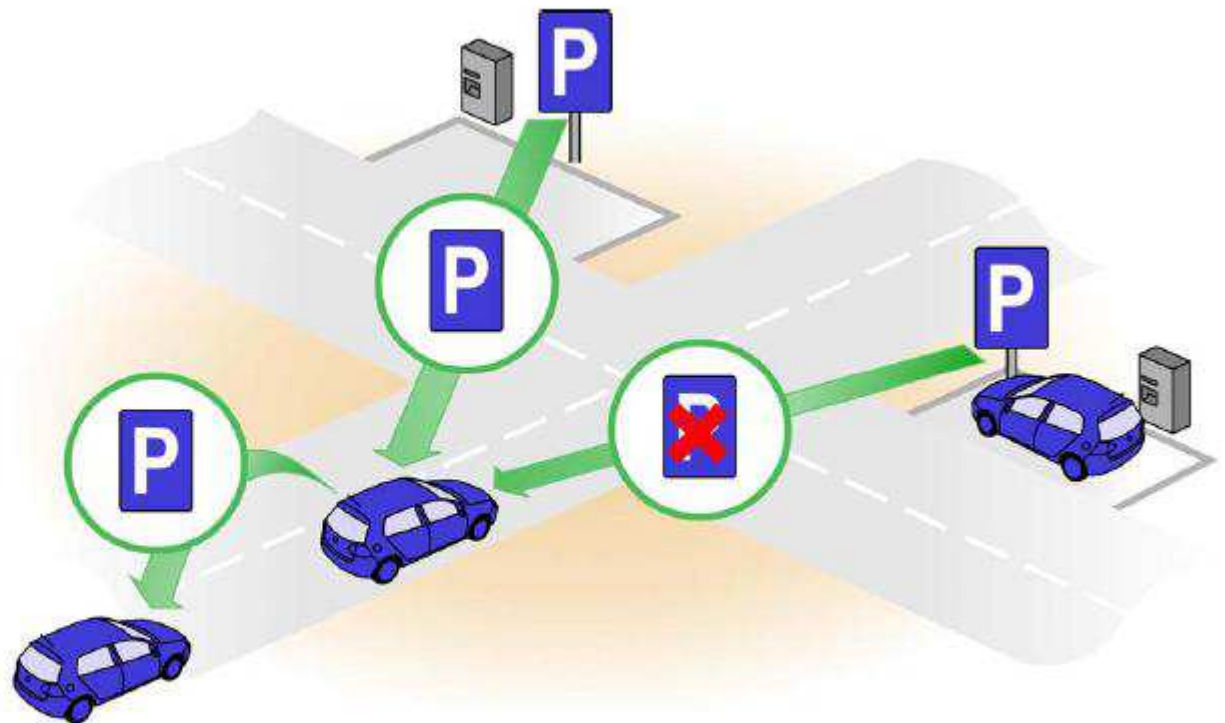


Market penetration is a key factor for car2x - technologies

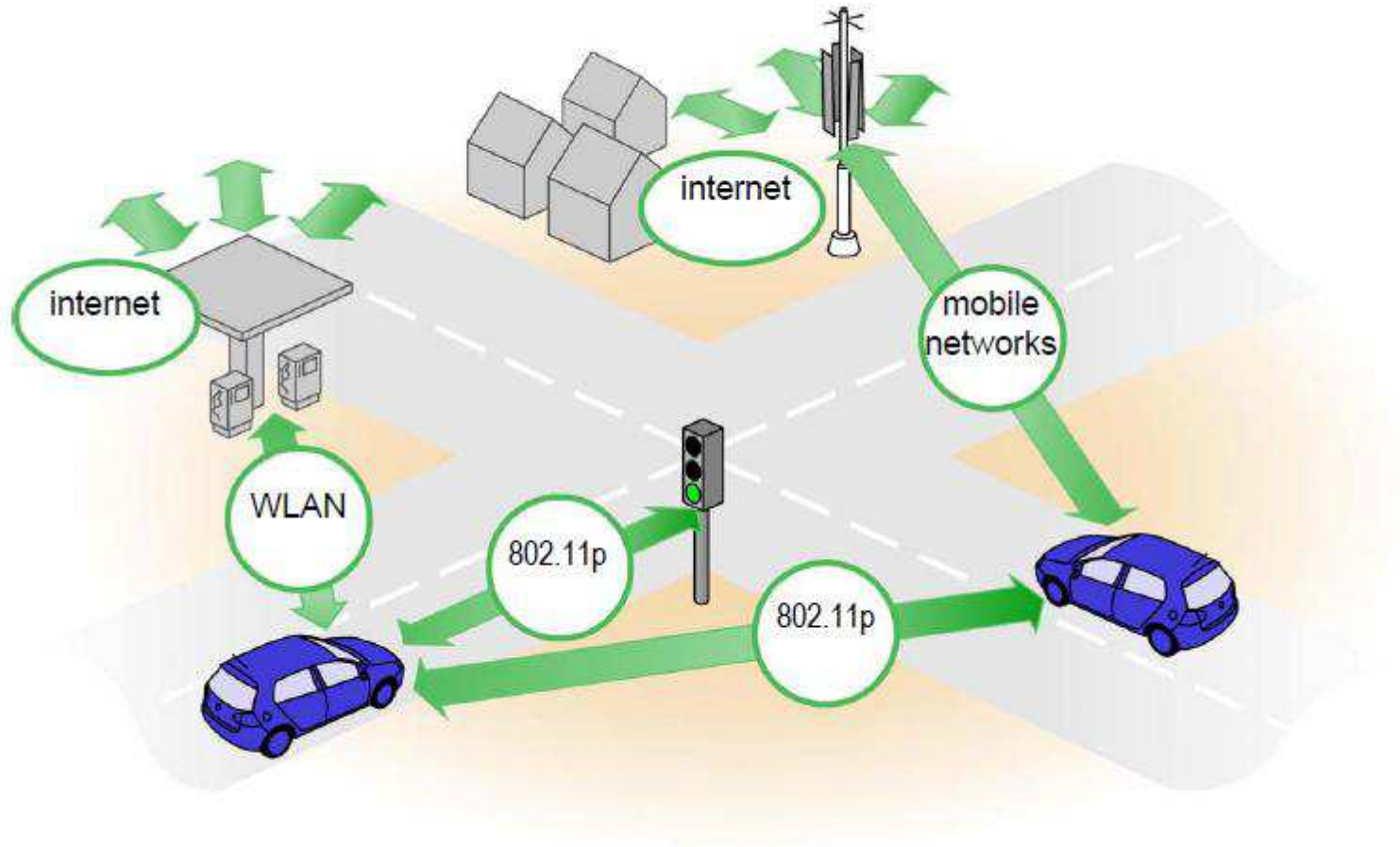


Find your parking lot fast

- Parking monitors transmit real-time parking lot use
- Vehicles transmit information on actual parking lot use
- 5% car2X equipment rate provides sufficient service quality



The vision – heterogeneous networks



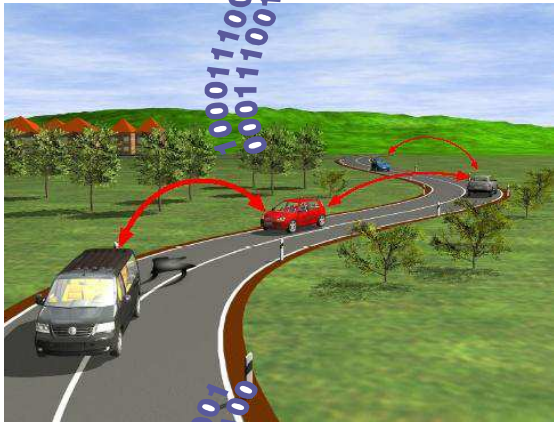
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The Connected Car in a Connected World



10001110011100011001
011100101010111100



100011100111
000111001110



10001110011100011001
00011100101010111100



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00011100101010111100



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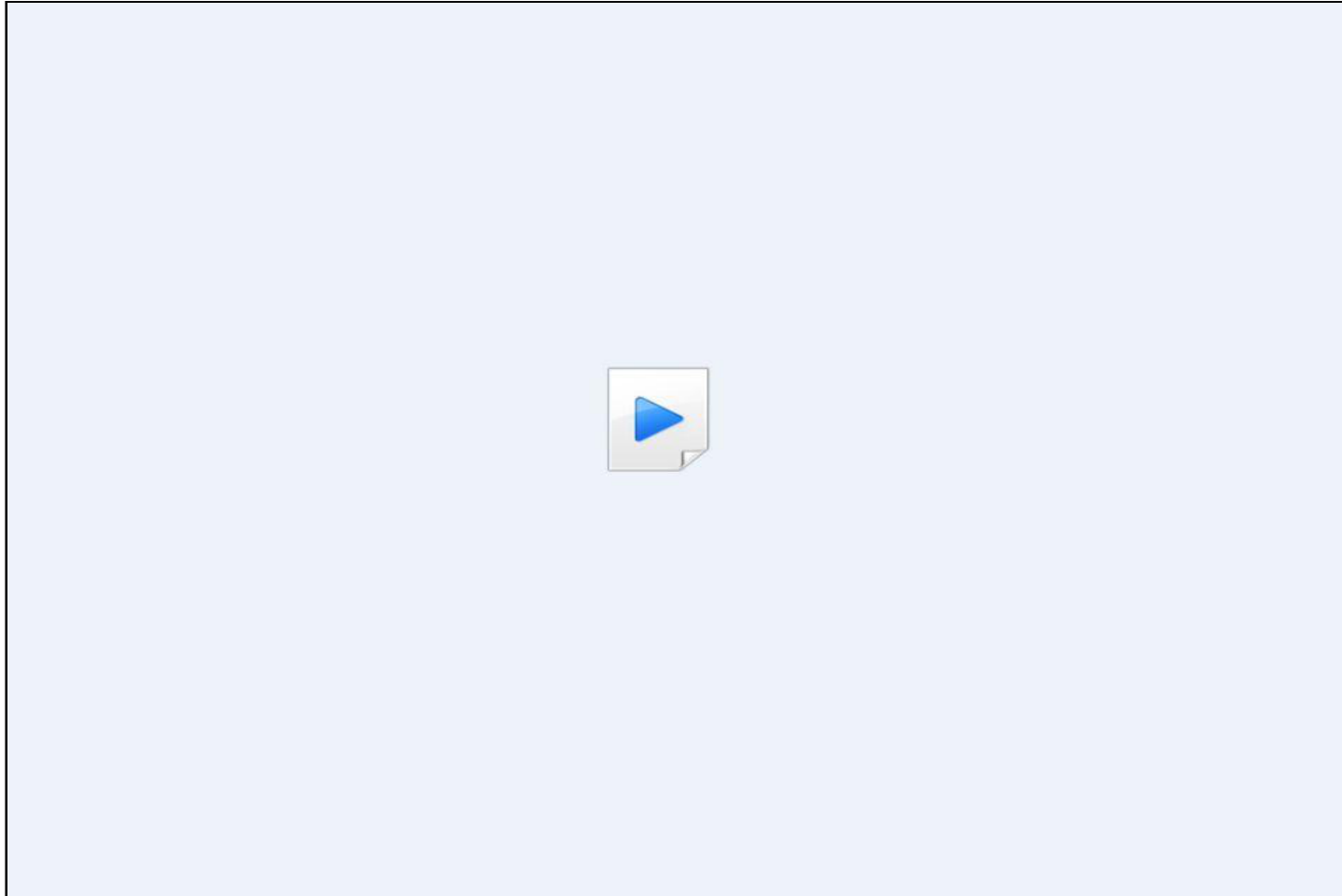
10001110011100011001
00011100101010111100



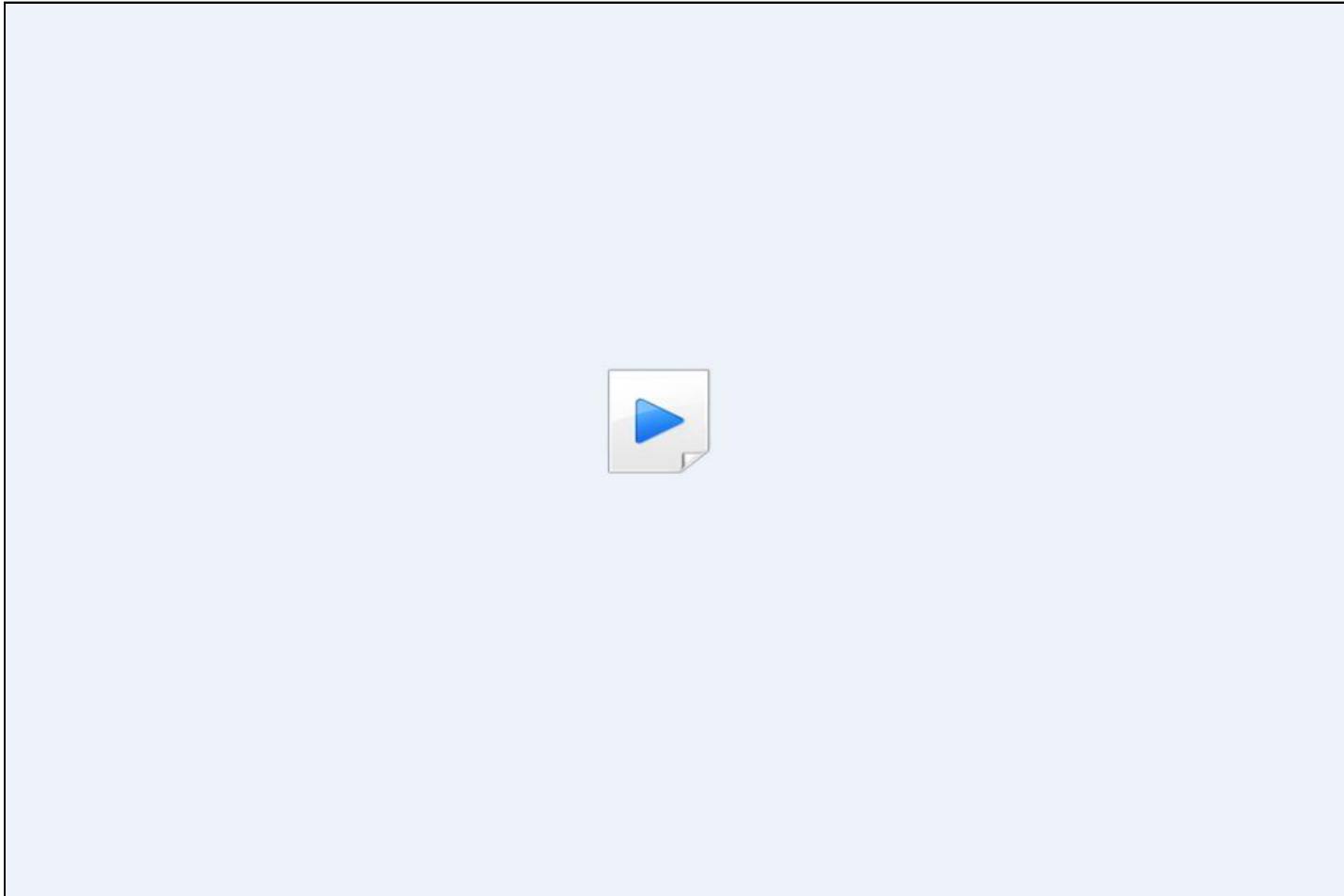
Human Machine Interface






Human Machine Interface – texting while driving



Human Machine Interface – distracted driving



The Future of Human Machine Interfaces

	Customer	Basis	Challenge
	<p>Basic driving functions:</p> <ul style="list-style-type: none"> • well known for decades • learnt in school 	<p>standard</p>	<ul style="list-style-type: none"> automatic driving reliable assistance
	<p>New systems z.B. DAS, hybrid:</p> <ul style="list-style-type: none"> • unfamiliar to customers 	<p>safety relevant</p>	<ul style="list-style-type: none"> differentiation via HMI combination of DAS and DIS
	<p>Infotainment, navigation, audio, telephone, etc. :</p> <ul style="list-style-type: none"> • well known 	<p>High expectations: function, look&feel, interaction</p>	<ul style="list-style-type: none"> new dialog models software/responsibility

Infotainment Evolution

openstreetmap.org

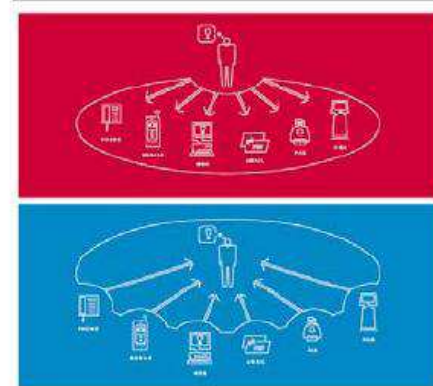


plazes.com



facebook.com

It's all about relationships



location based services

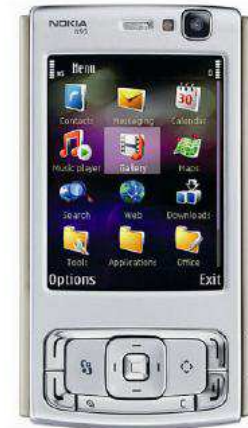


social networks

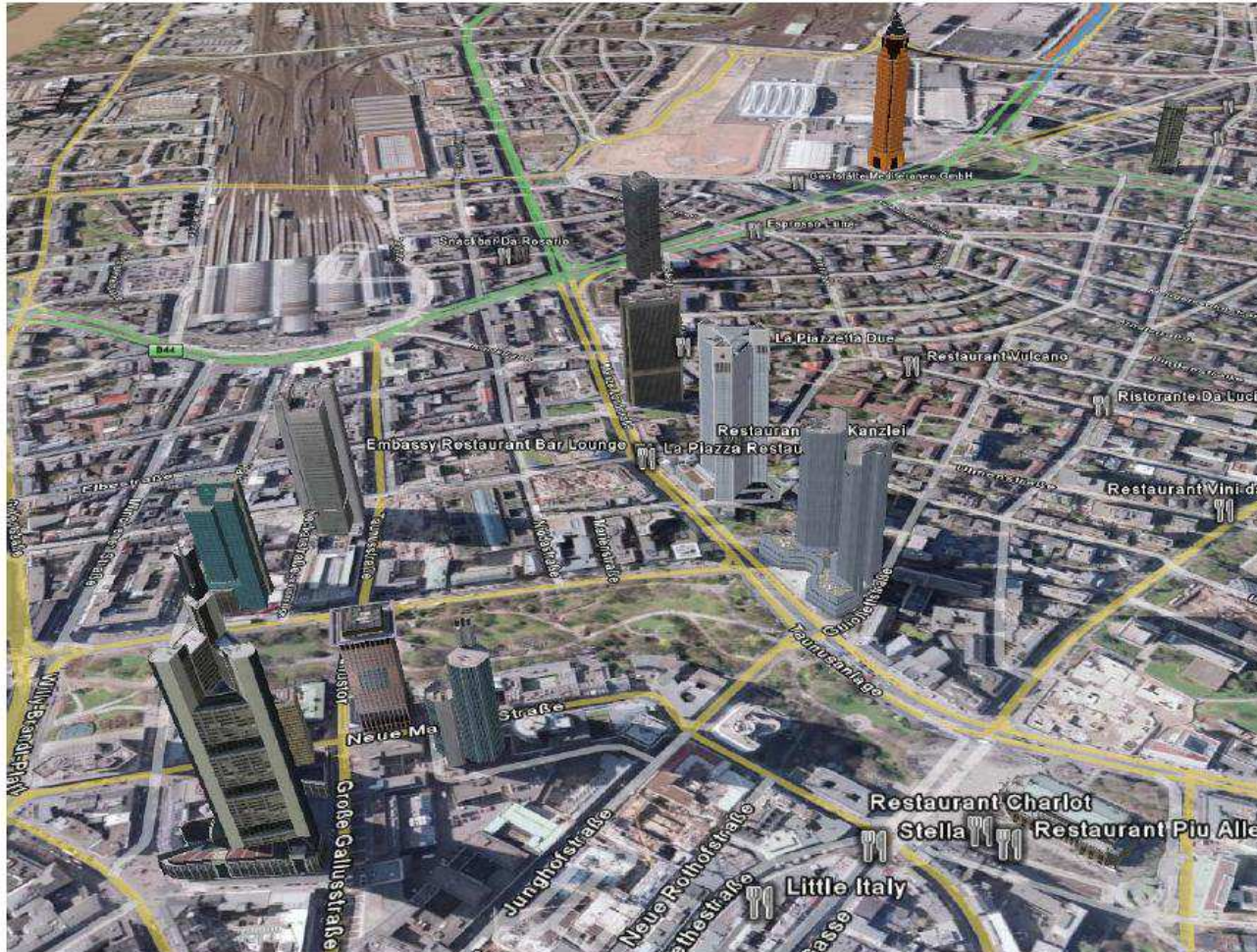
Who is the competition?



new technologies



Integration of online internet services



Traffic
information



Fuel
prices



Time tables



Restaurants
and hotels



Tourist
information

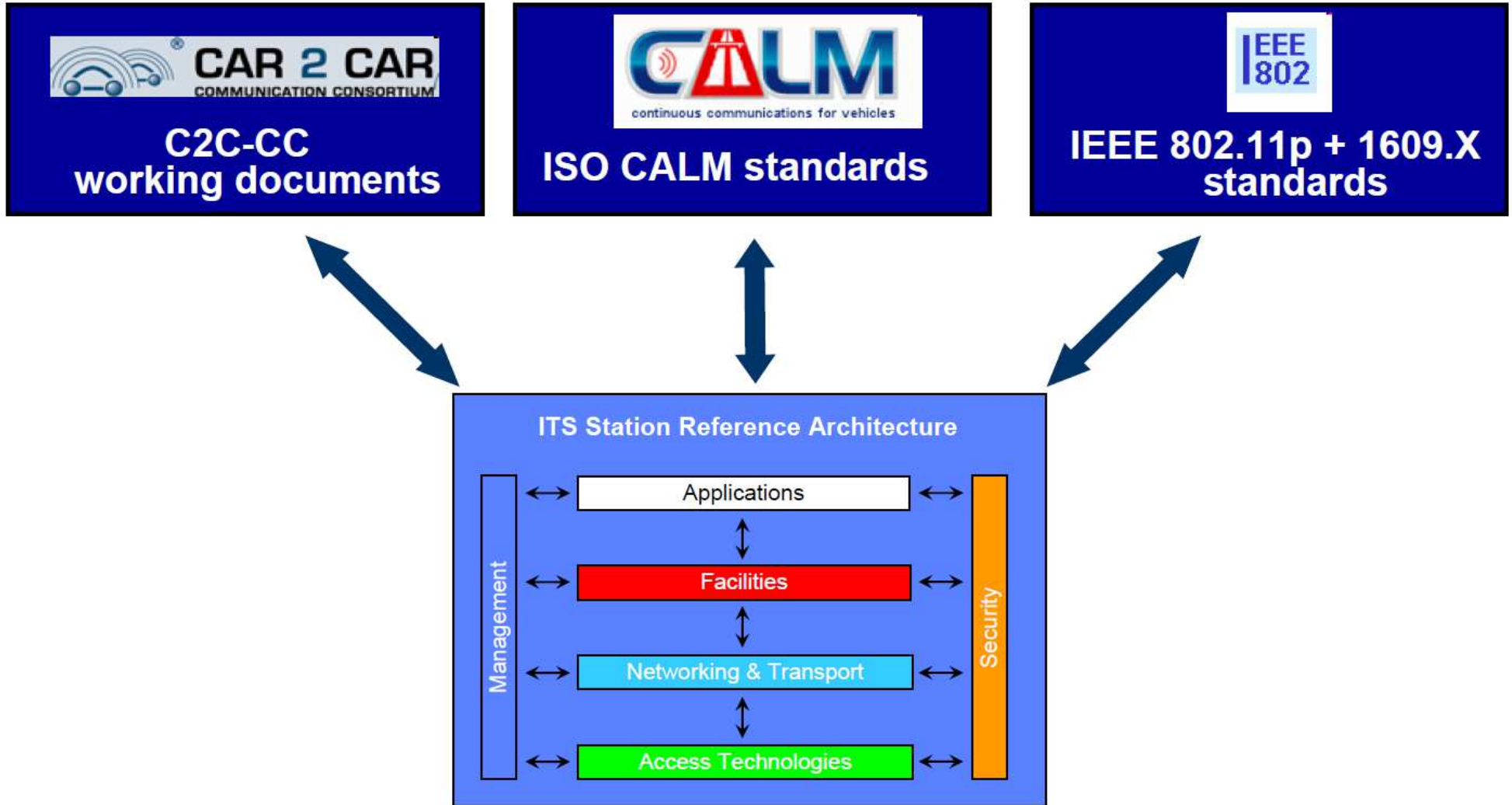


Current
events

Driver information with backend services

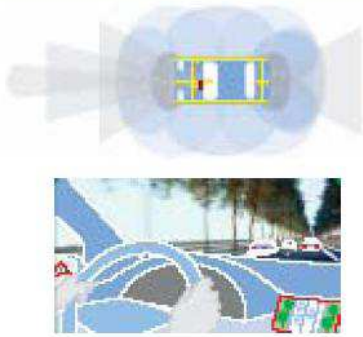


Harmonization of world wide ITS standards is mandatory

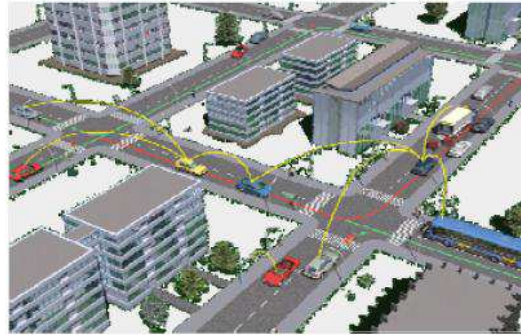


Only integrated systems will provide an acceptable solution

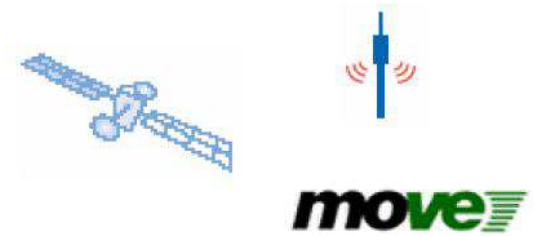
intelligent vehicles



communication (Car2X)



efficient
traffic management



Traffic of the future

intelligent infrastructure



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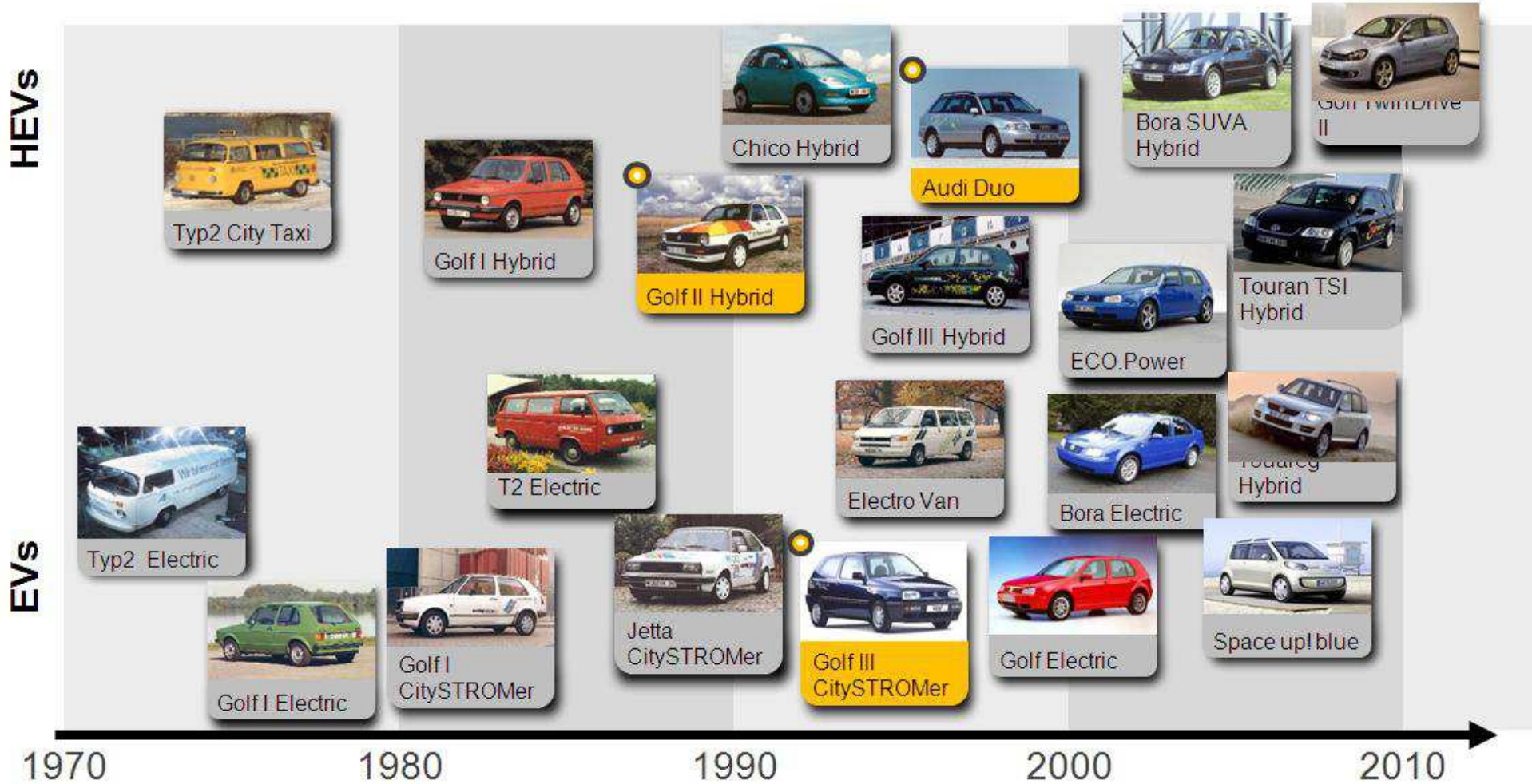
VW Credit Inc.



eMobility



EVs and HEVs



eMobility

1973 VW electrical bus



- BEV
- Electric power 17 kW

1993 VW Golf City Stromer



- BEV
- Electric power 25 kW

1991 Study VW Chico



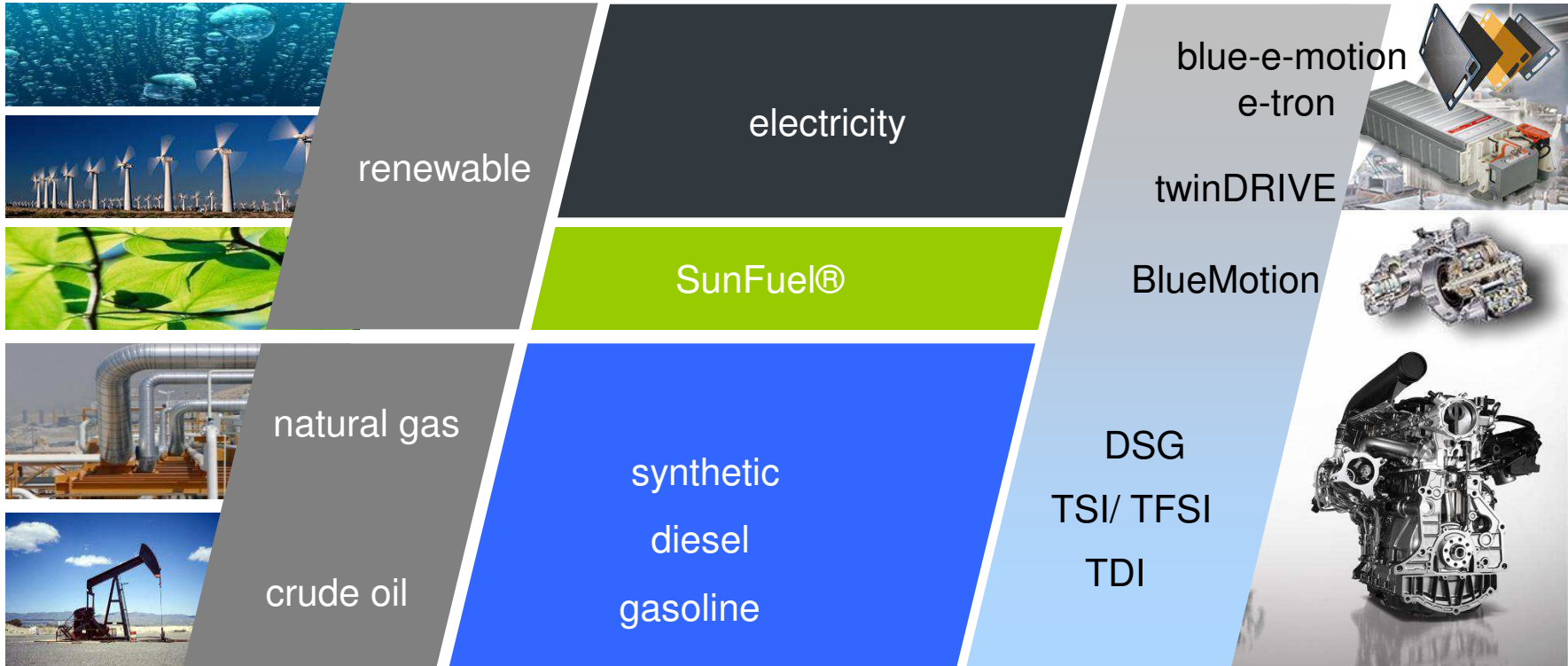
- Hybrid
- Electric power 25 kW + 7 kW

2007 Study VW Space Up! blue

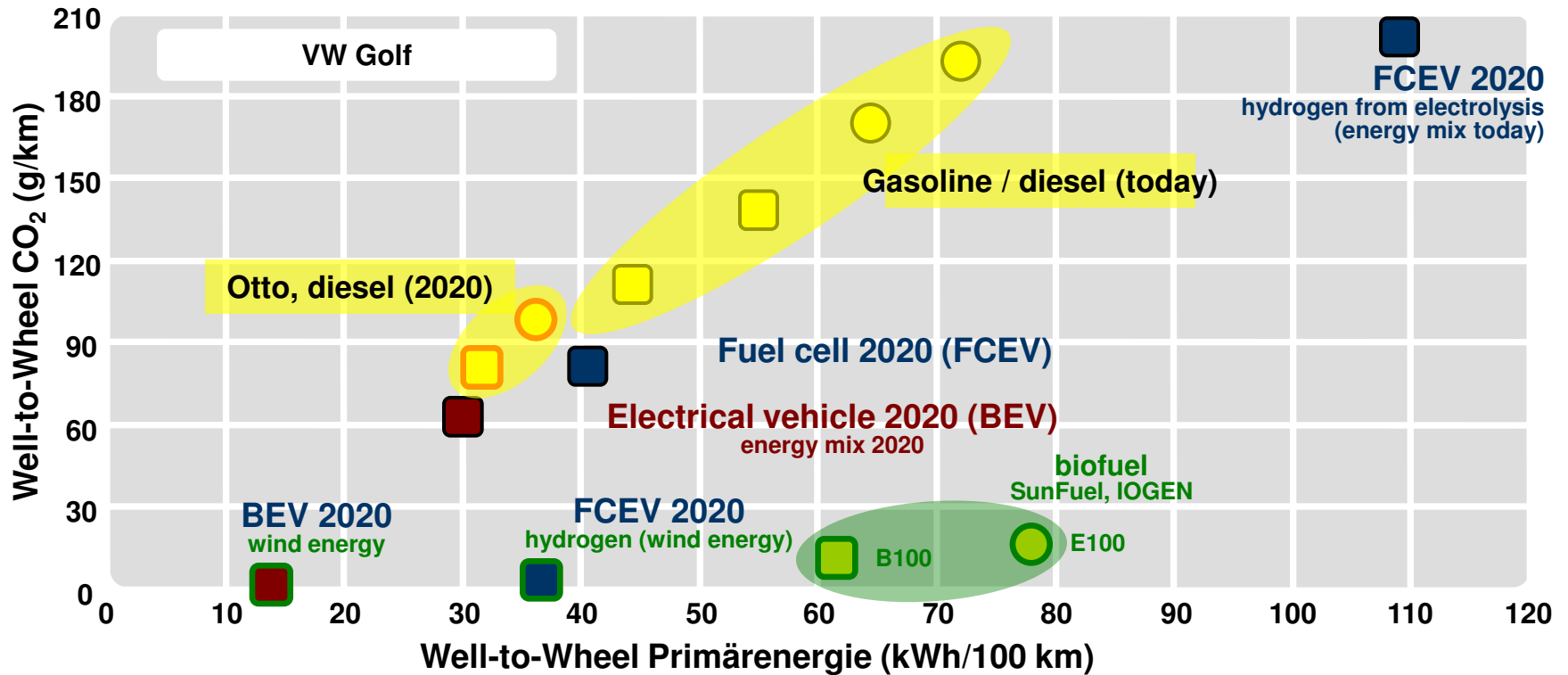


- Fuel cell
- Electric power 45 kW

Drive train and fuel strategy



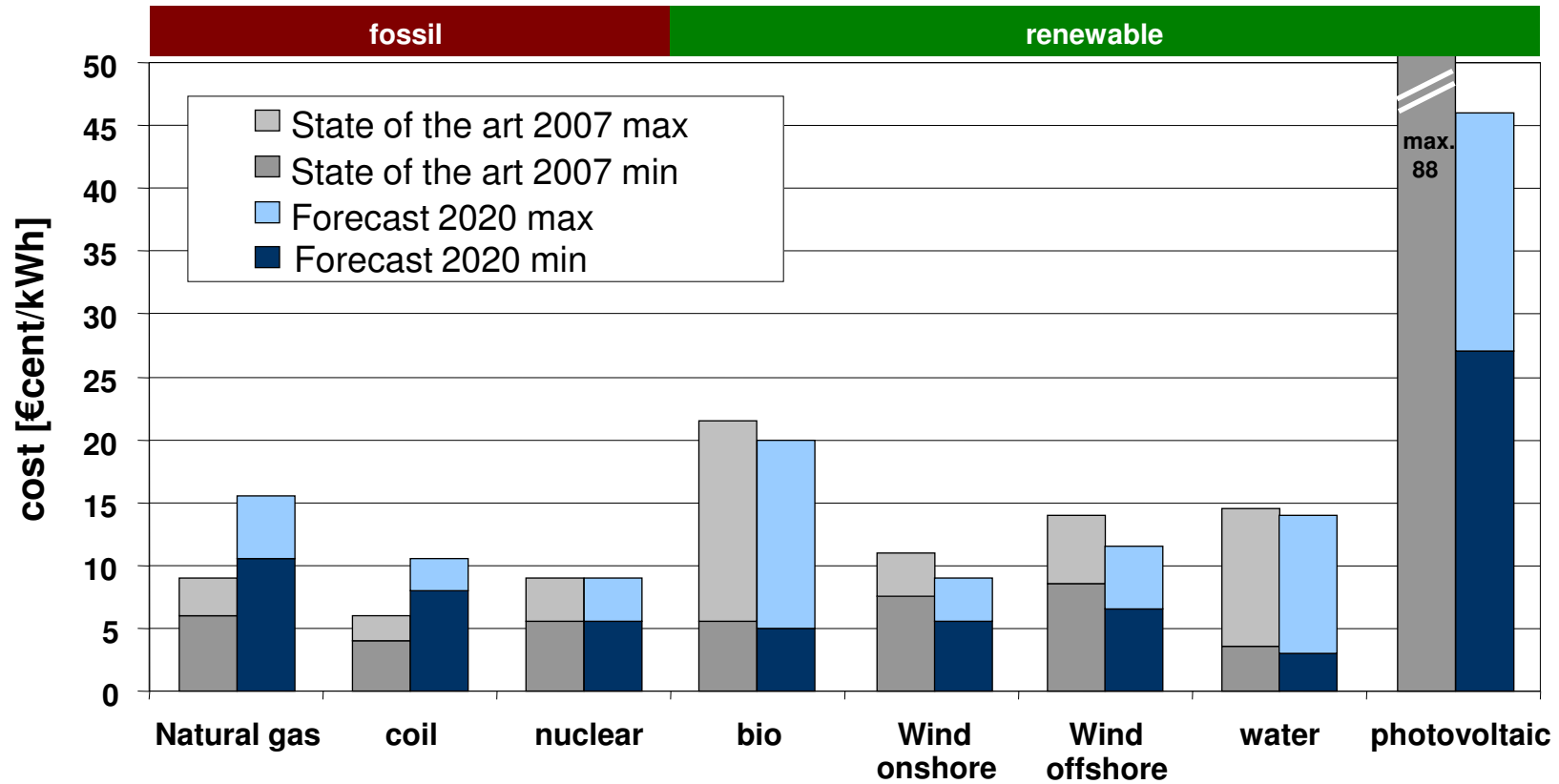
CO₂- and energy efficiency (power train) (until 2020)



Electrical vehicles - highest potential concerning CO₂- & energy efficiency depending on the energy generation process







Energy Cost

Energy cost fossil / renewable 2007/2020



Quelle: Joint Research Centre (EU-Kommission) 2008

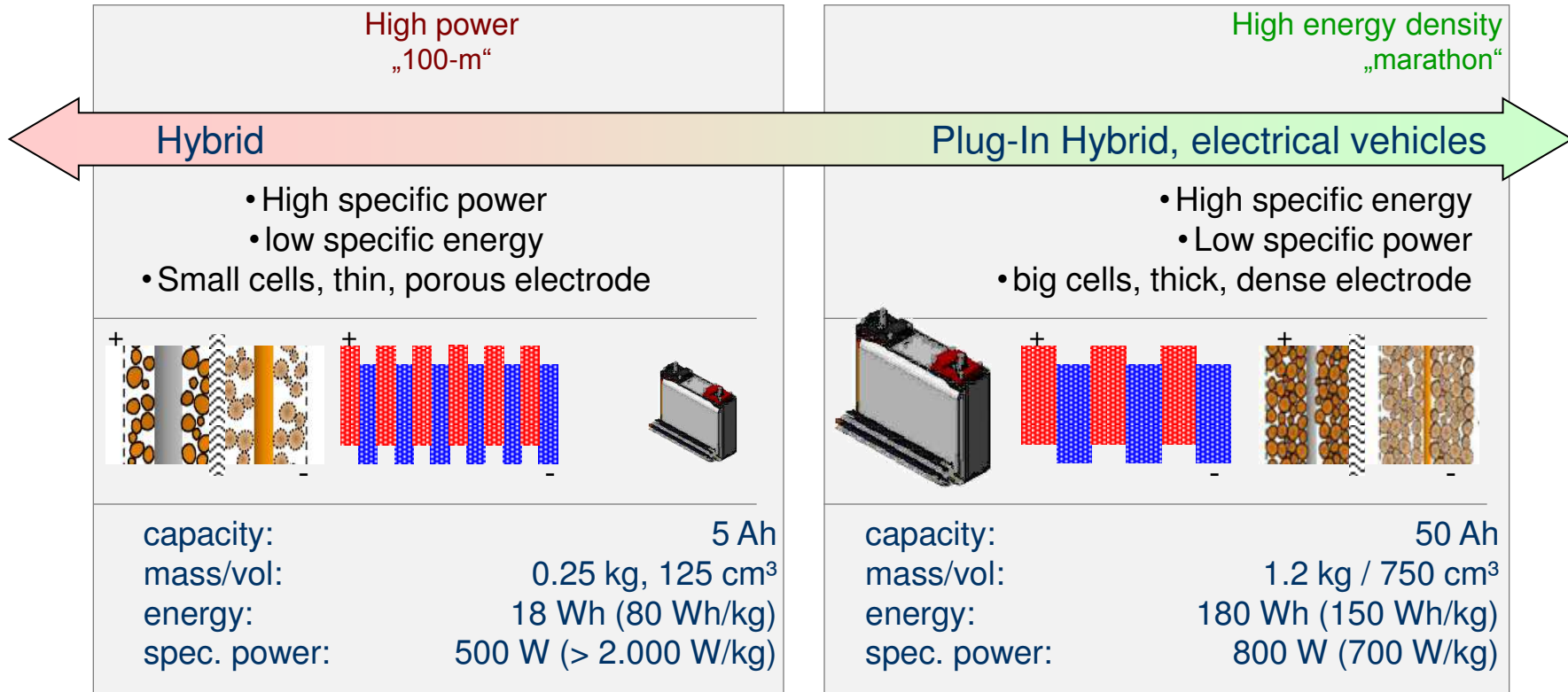
electrification

Combustion engine	Mild hybrid	Full hybrid	Plug-in hybrid	Electrical vehicle
<ul style="list-style-type: none"> • 1.2 77 kW TSI 	<ul style="list-style-type: none"> • start/stop system • recuperation  	<ul style="list-style-type: none"> • Touareg Hybrid 	<ul style="list-style-type: none"> • Golf twinDRIVE 	<ul style="list-style-type: none"> • Up! <p>blue-e-motion</p> 

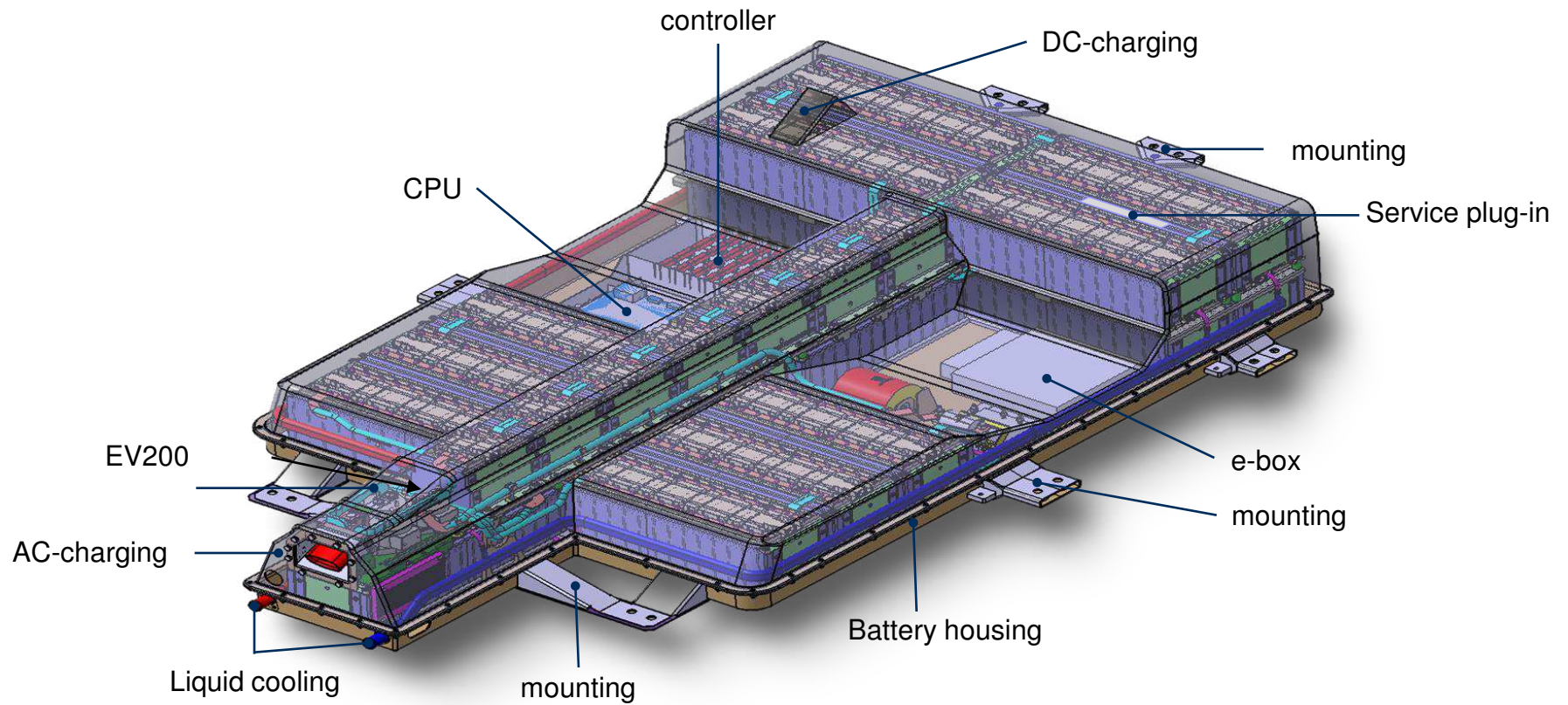
Energy storage: technologies and requirements

	Combustion engine	Mild Hybrid	Full Hybrid	Plug-in Hybrid	Electrical vehicle
Energy storage	<ul style="list-style-type: none"> • Start engine 	<ul style="list-style-type: none"> • start-stop • recuperation (boost) 	<ul style="list-style-type: none"> • start-stop • recuperation (boost) • (e-Drive, 2 km) 	<ul style="list-style-type: none"> • start-stop • recuperation (boost) • e-Drive, 20 km 	<ul style="list-style-type: none"> • e - range > 100 km
Electric power	~ 2 kW	~ 6 kW	~ 15 kW	~ 30 kW	~80 kW
capacity		< 1kWh	1 – 2 kWh	10 – 15 kWh	>25 kWh
voltage		12 V	< 60 V	> 60 V	>> 60 V
durability		5 years	8 - 10 years		>10 years
Technology					
Lead acid					
Nickel metal hydride					
Lithium-Ion					

Cell format



Battery system



Volkswagen Group is evaluating several battery concepts

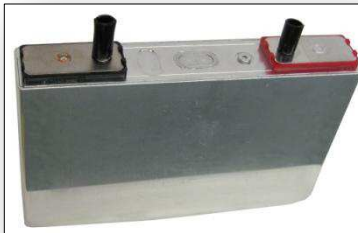
18650
Cells



Large
Cylindrical
Cells



Large
Prismatic
Cells



Large
Pouch
Cells



Performance
Vehicles



High-volume
Production
Vehicles



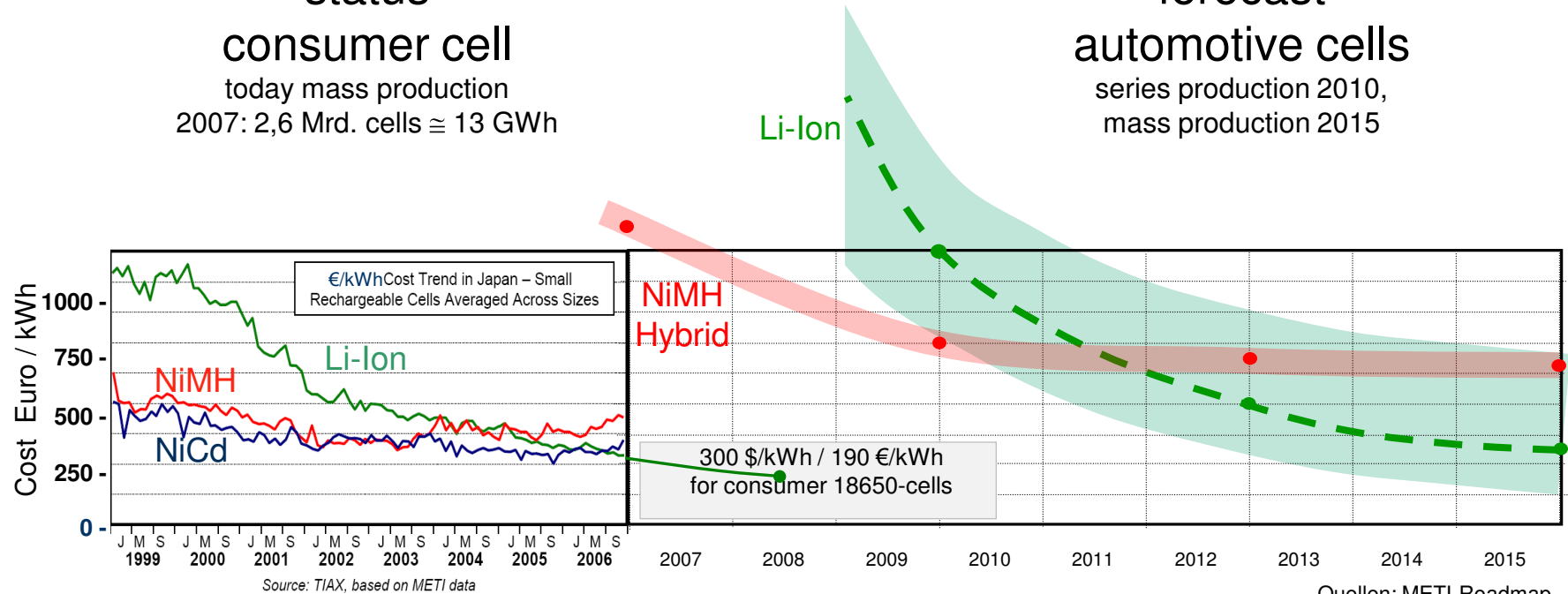
New City
Vehicles



market and cost – li ion cells

status
consumer cell
today mass production
2007: 2,6 Mrd. cells \cong 13 GWh

forecast
automotive cells
series production 2010,
mass production 2015



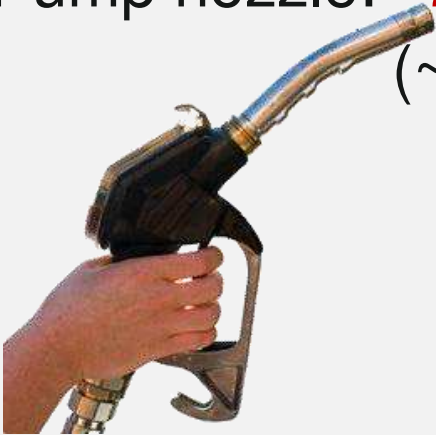
Quellen: METI-Roadmap, AABC,

Exchange rate
1,50 USD = 1 €

Challenge: charging time

Gasoline

Pump nozzle: **27.000 kW**
(~ 50 l/min)



→ 1 minute = 1000 km
driving range

VS.

electricity

Three-phase: **10 kW**



→ 1 minute charging = 1 km
driving range

concept Golf! blue-e-motion

Vehicle data

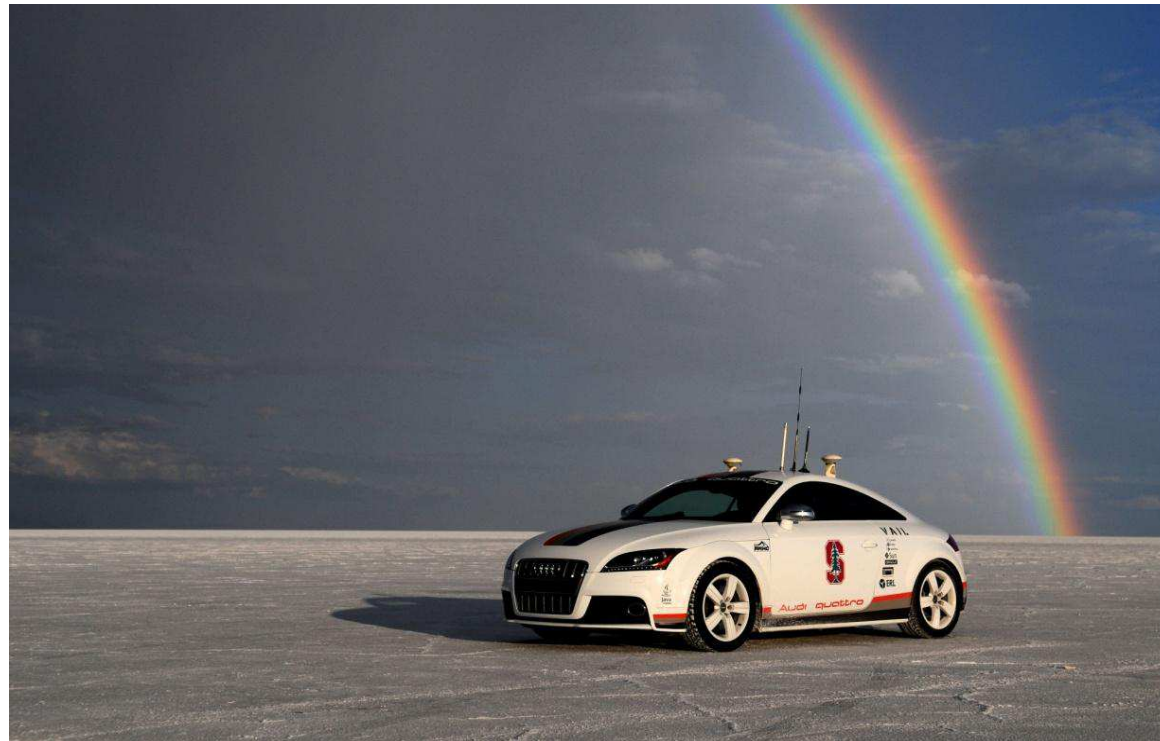
Vehicle weight	1545 kg*
* 205 kg more than Golf Blue Motion TDI with DSG	
Dimensions L/ B/ H	4199/ 1786/ 1480 mm
Gearbox	EQ 210 (1-Gang-Getriebe)
Maximum speed	135 km/h
Acceleration (0-100)	11,8 s
elektr. Driving range	up to 150 kilometer

Power train

E-motor	85 kW / 115 PS
battery	26,5 kWh (Li-Ion)
voltage	324 V
torque	270 Nm



Thank you for your attention!



Pikes Peak TTS: „Autonomous Hill Climbing“