

Opportunities and Challenges on our way to piloted driving

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DID YOU

KNOW



Mobility behaviour



Gathering **all driving hours**,
we spend **two years**
and **six months**
in the driver seat.

Parking



Searching for a **parking space**
in Germany on average takes
almost **10 minutes**,
which means driving around
on average **4.5 kilometers**

Source: Presseportal

<http://www.presseportal.de/pm/9373/2541043/apcoa-parking-studie-die-parkplatz-suche-verschlingt-viel-zeit-und-geld>

Parking



Every driver on average spends

100 hours per year
searching for a parking space

Usage rate

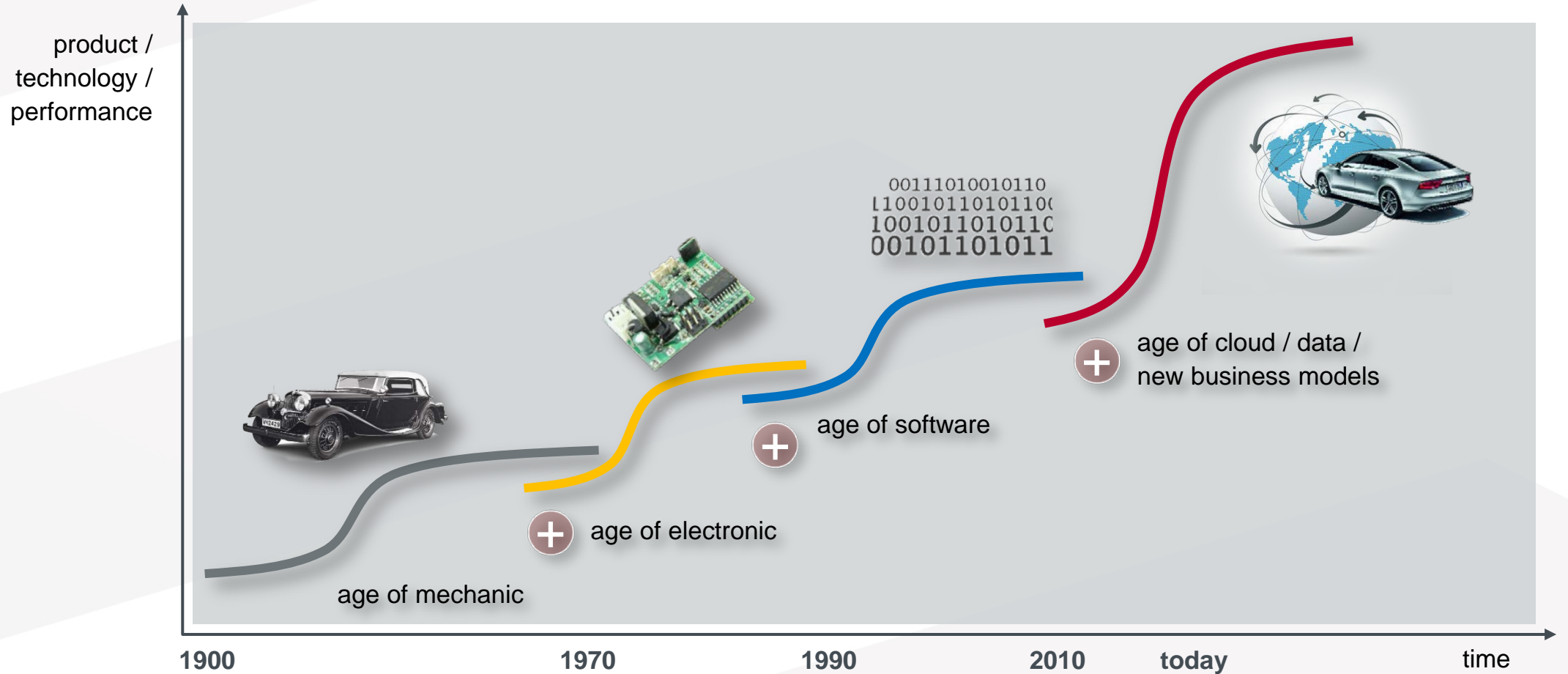
On average every car

is **driven one hour**

and is **parked 23 hours** per day



The automotive business is moving towards a new age of technology



Piloted driving is one of the top three areas of innovation in the automotive industry

1. Electrification



2. Connectivity

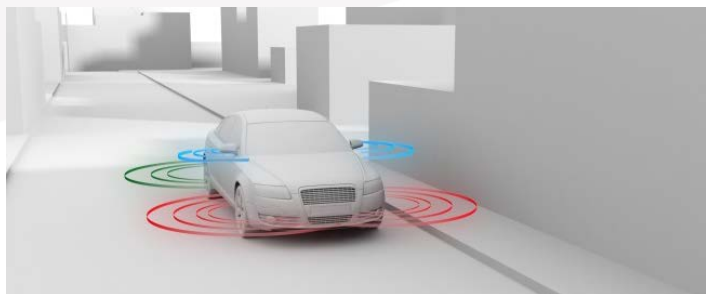


3. Piloted driving and parking

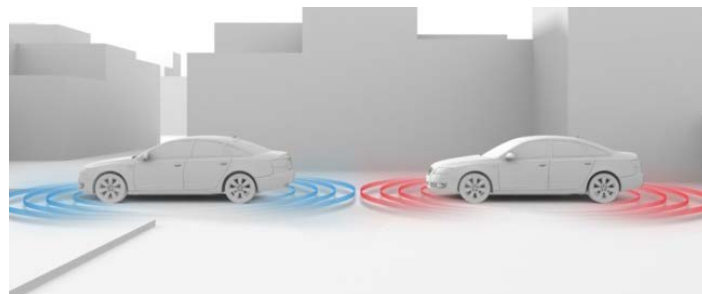


Piloted driving – vehicles learn ...

Safety, convenience, traffic flow management, quality time



... to see



... to communicate



... to decide



... and to drive

Safety, comfort and efficiency are the main goals for piloted driving and parking

1 Improved safety

90% of today's accidents happen due to mistakes of the driver:
» inattention
» miscalculation

2 Environmentally friendly driving

3-5% fuel savings:
» consideration of topology
» preview

Piloted driving

Increase in comfort due to:
» time efficiency
» freedom of choice for available time
» no constraints with narrow parking lots

3 Enhanced customer convenience

Gaining space especially in cities:
» parking garages (up to 30%)
» traffic density (5-10%)

4 Efficient use of transport infrastructure

Automated driving is the next logical step after the development of driver assistance systems

Assistance systems

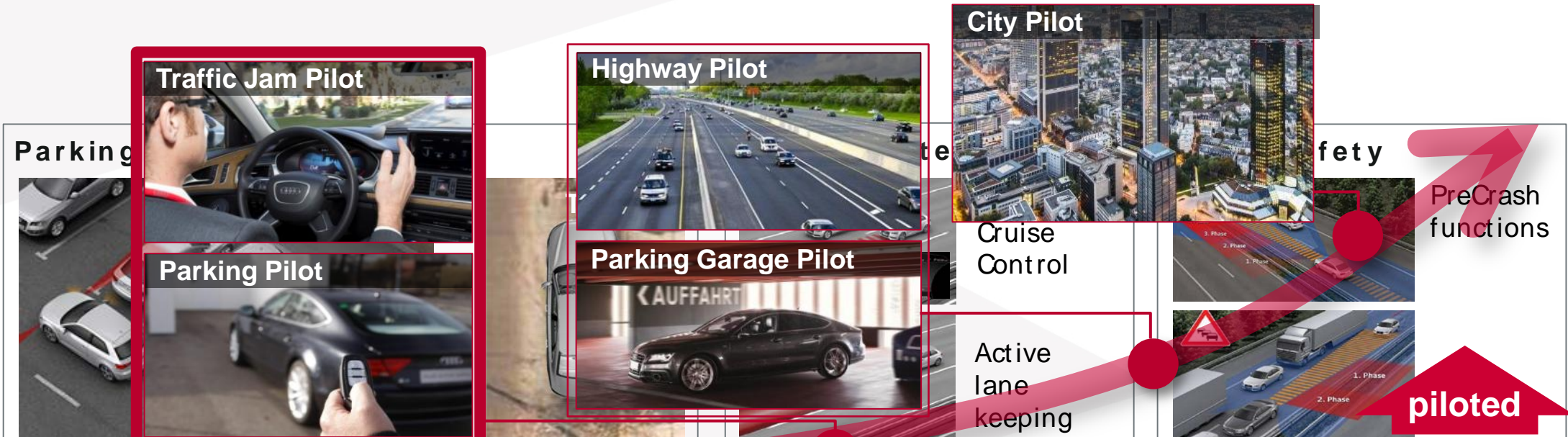
Level 0	Level 1	Level 2
Driver only	Assisted	Partial automation
Driver permanently in charge of longitudinal and lateral control	Driver permanently in charge of either longitudinal or lateral control Driver is ready to take over immediately	Driver permanently monitors Driver is ready to take over immediately
	Vehicle takes charge of the other function	Vehicle takes charge of longitudinal and lateral control for a certain time and in certain situations
Today's driver assistance systems		Next generation

Piloted (automated) systems

Level 3	Level 4	Level 5
Conditional automation	High automation	Full automation (driverless)
Driver does not need to monitor the dynamic driving task nor the driving environment at all times but be attentive to take over.	Driver is not required during defined use case.	System performs the lateral and longitudinal dynamic driving task in all situations encountered during the entire journey.
Vehicle takes charge of longitudinal and lateral control for a certain time and in certain situations	Vehicle takes full charge of longitudinal and lateral control in defined use case	No driver required.
Need to take over is announced with sufficient advance warning, ancillary activities offered by vehicle can be performed	The system is capable of establishing a risk-minimized state in all situations, all ancillary activities possible	Vehicle does not have steering wheel or pedals.
New area of activity Piloted driving and parking		

Source: SAE

The market introduction of ADAS and piloted driving will follow an evolutionary approach



Information and warning

Nightview

Lane change assist

Traffic sign recognition

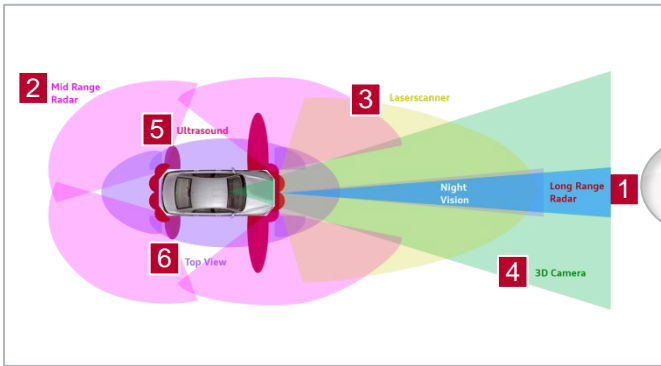
Light functions

Future assistance functions

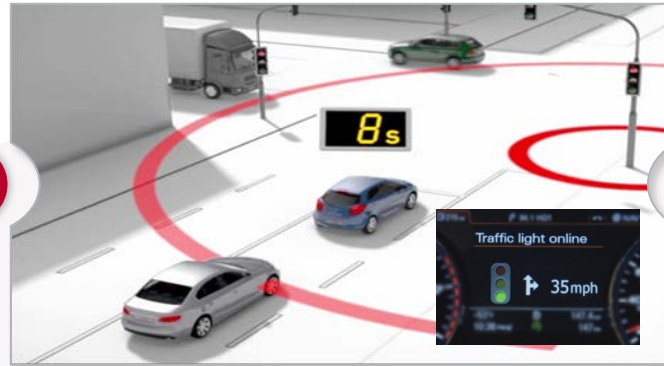
High beam

Action required for implementing automated driving and parking

1. Technology



2. Infrastructure

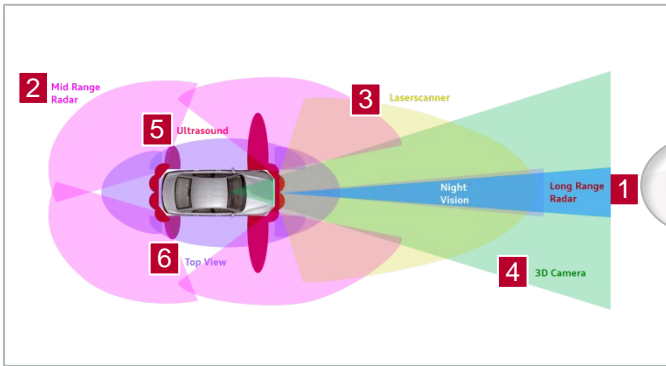


3. Regulation

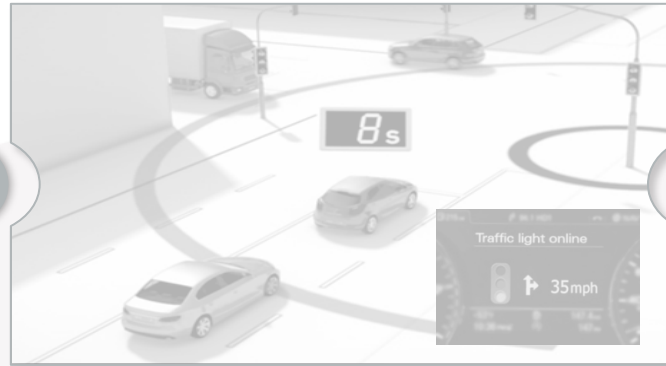


Action required for implementing automated driving and parking

1. Technology



2. Infrastructure



3. Regulation



- ▶ Sensors
- ▶ Safety architecture
- ▶ Functions
- ▶ Redundant actors such as brakes
- ▶ High-performance computer
- ▶ User interface
- ▶ Validation concepts

The human control loop

Perception



Processing the information



Action

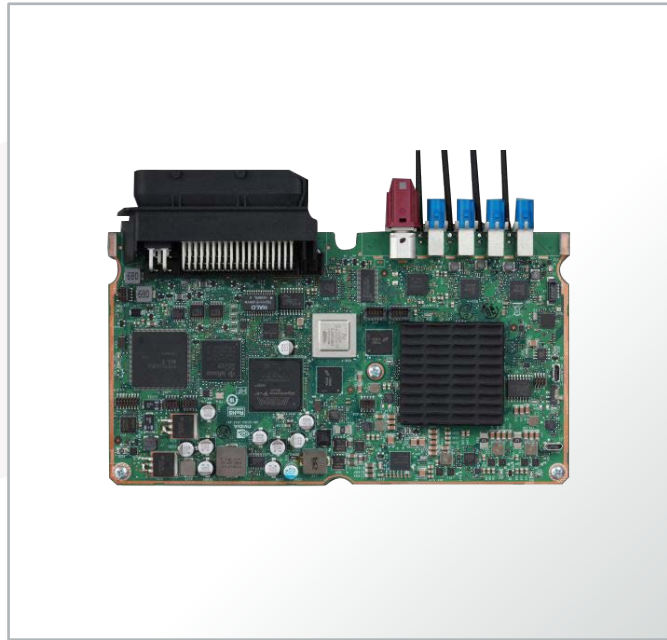


Piloted driving control loop

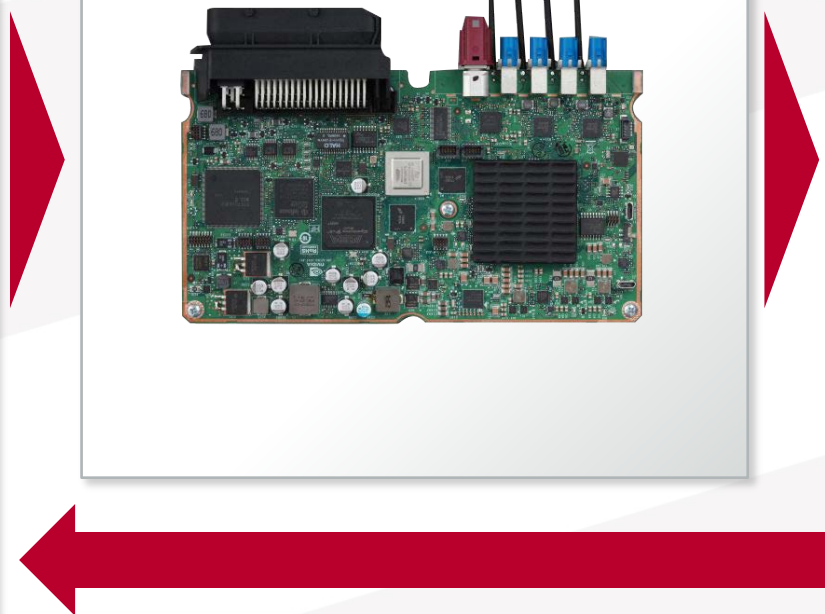
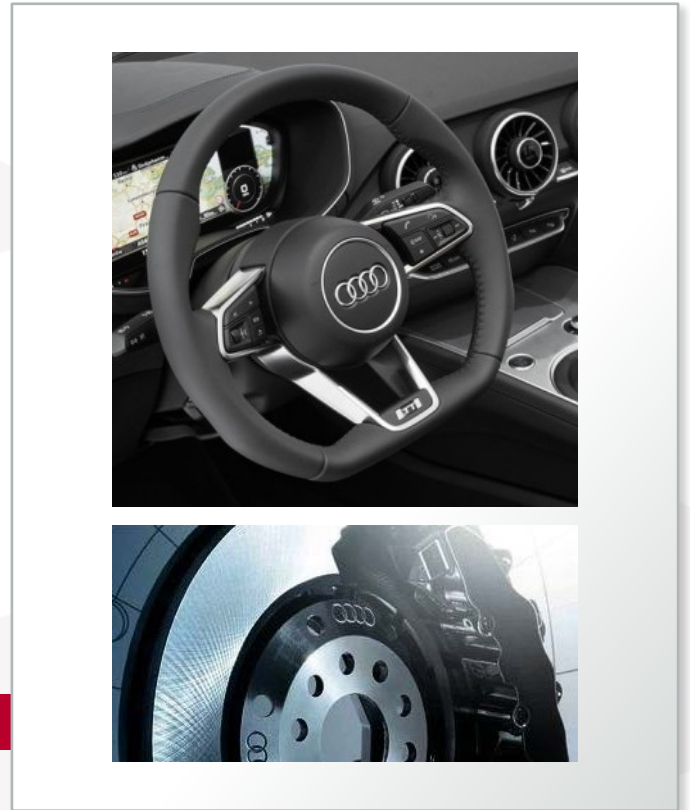
Environment detection



Data processing



Actuators



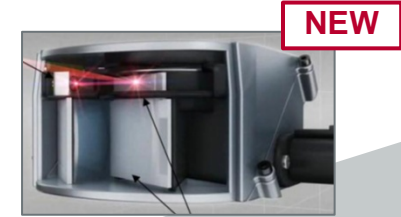
A large number of sensors and redundant sensor technologies ensure the surroundings are reliably identified

Mid Range Radar

Ultrasound

Top View

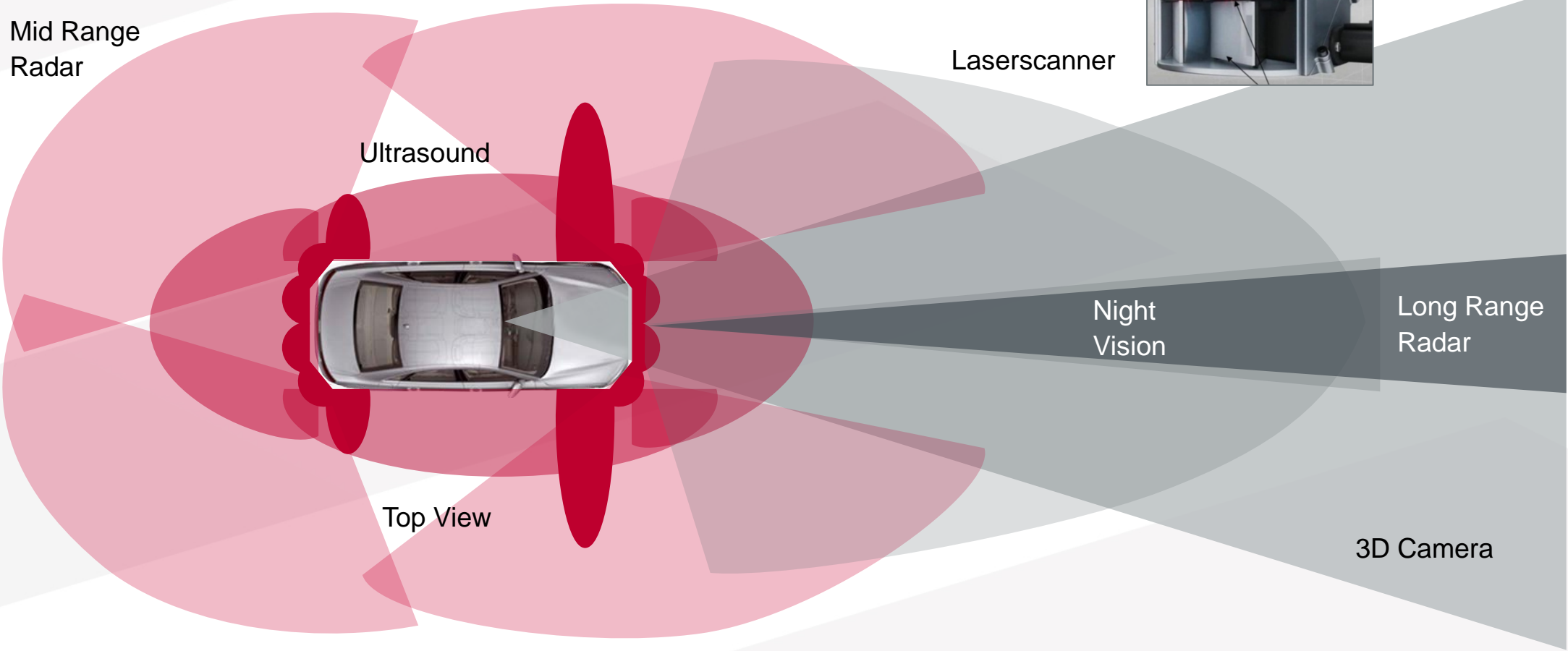
Laserscanner



Night Vision

Long Range Radar

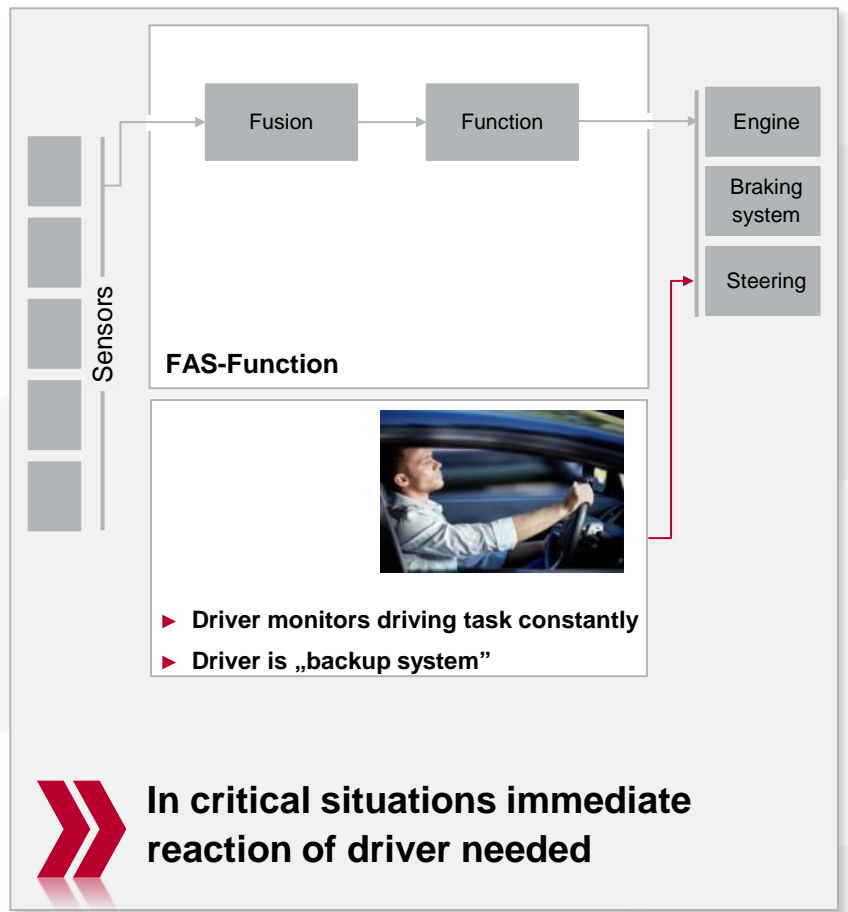
3D Camera



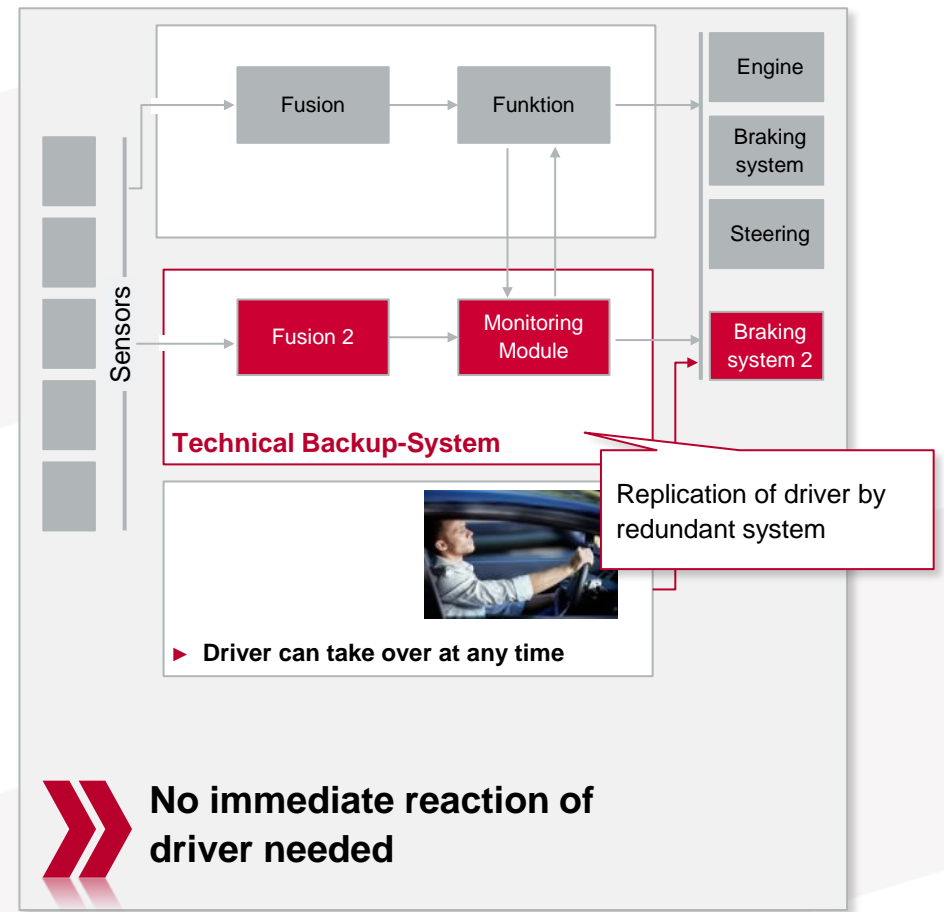
A redundant technology layer is build in piloted systems to make sure the system is operating properly

System architecture piloted driving simplified

Assisted driving (Level 0-2)



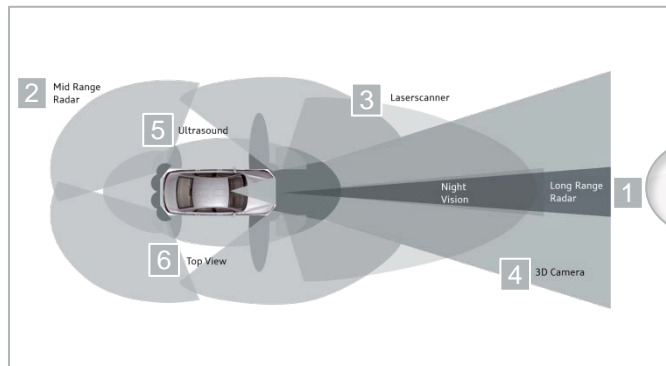
Piloted driving (Level 3-5)



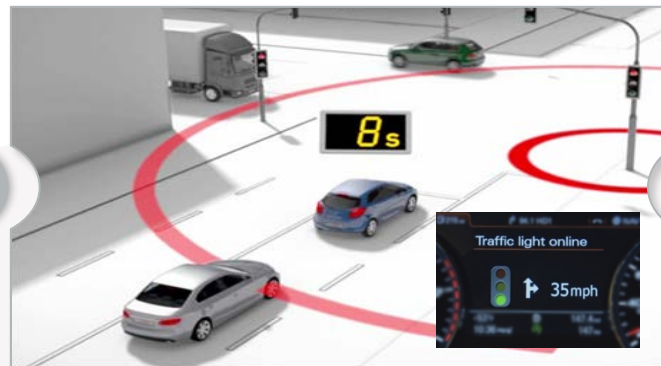
Action required for implementing automated driving and parking

In general | worldwide

1. Technology



2. Infrastructure



3. Regulation

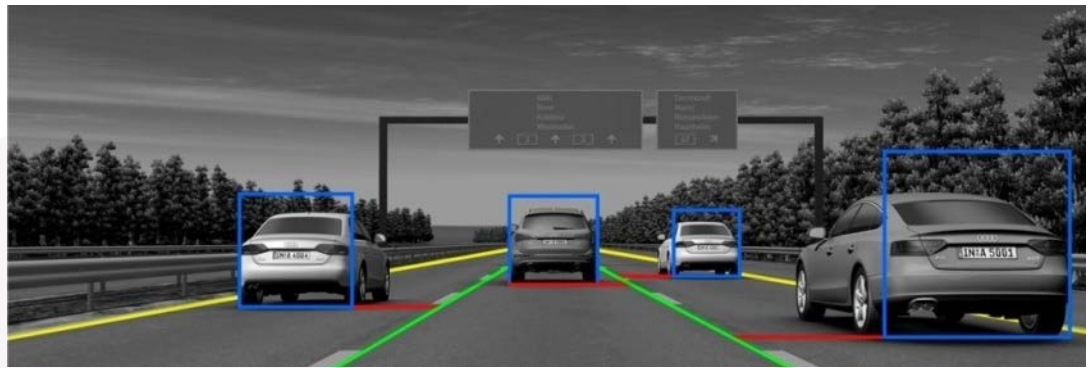


- ▶ Maintaining and expanding infrastructure
- ▶ Implementing standards
- ▶ Implement standards for additional a-priori knowledge
 - ▶ Temporary use of traffic areas, construction areas
 - ▶ Sudden danger information, construction sites, accidents, traffic jam, etc.

The requirements of piloted driving towards infrastructure can be clustered in two steps

Step 1: maintenance of current infrastructure (examples)

- Road markings present and clearly visible (contrast)
- Emergency lanes present and usable
- Wildlife fences present and intact



Step 2: potential for future infrastructure (examples)

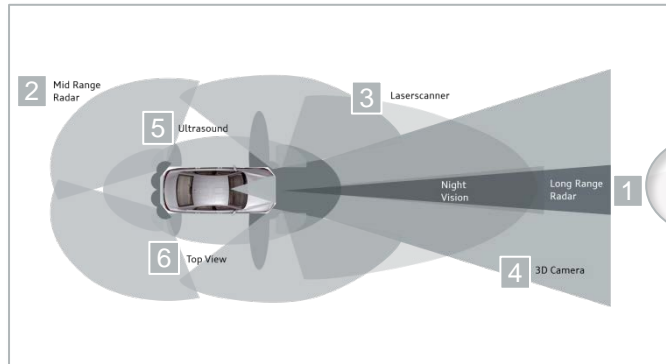
- Traffic lights, roundabouts, complex crossroads
- Temporary use of traffic areas, construction areas
- Accidents, sudden hazards



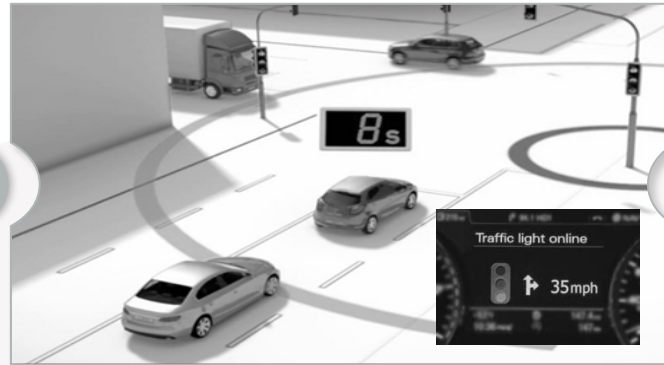
Action required for implementing automated driving and parking

In general | worldwide

1. Technology



2. Infrastructure



3. Regulation



- ▶ Vehicle registration regulations
- ▶ Regulatory law (Vienna Convention, highway traffic regulations)
- ▶ Liability

Audi has a long heritage in piloted driving ...

2009
Audi TT
Salt lake
Bonneville

2010
Audi TT
Pikes Peak

CES 2013
Park pilot & traffic jam pilot
Permission to test piloted driving in **Nevada**

Aug. 2014
Permission to test piloted driving in **Florida**

Sept. 2014
Permission to test piloted driving in **California**

Oct. 2014
The world best performing piloted driving prototype in the world at the **Hockenheimring**

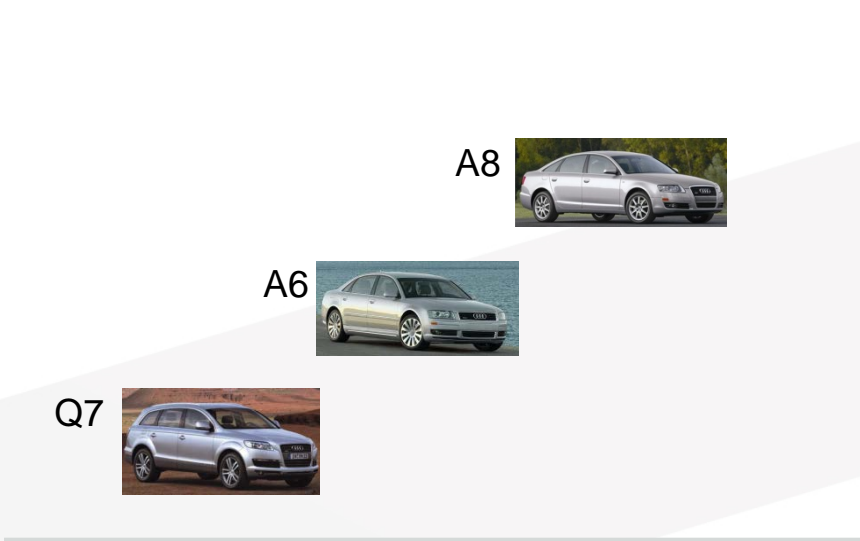
Jan. 2015
Drive from **San Francisco to Las Vegas** with Jack (Highway Pilot)

Jun. 2015
Traffic Jam Pilot in **Shanghai**

Piloted driving: **R**evolution?

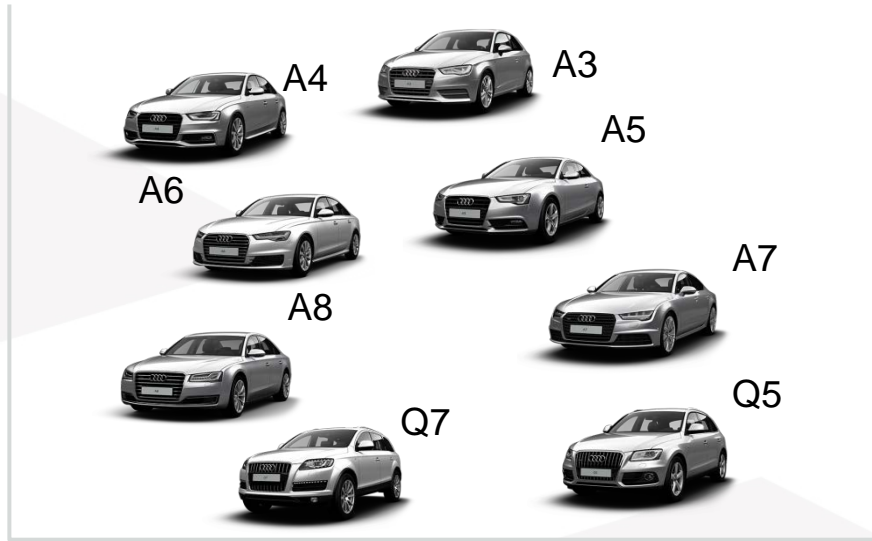
In the last 10 years the driver assistant systems penetrated top down up to the A segment (e.g. Adaptive Cruise Control, ACC)

Models with ACC – 2005



6,600

Models with ACC – 2014



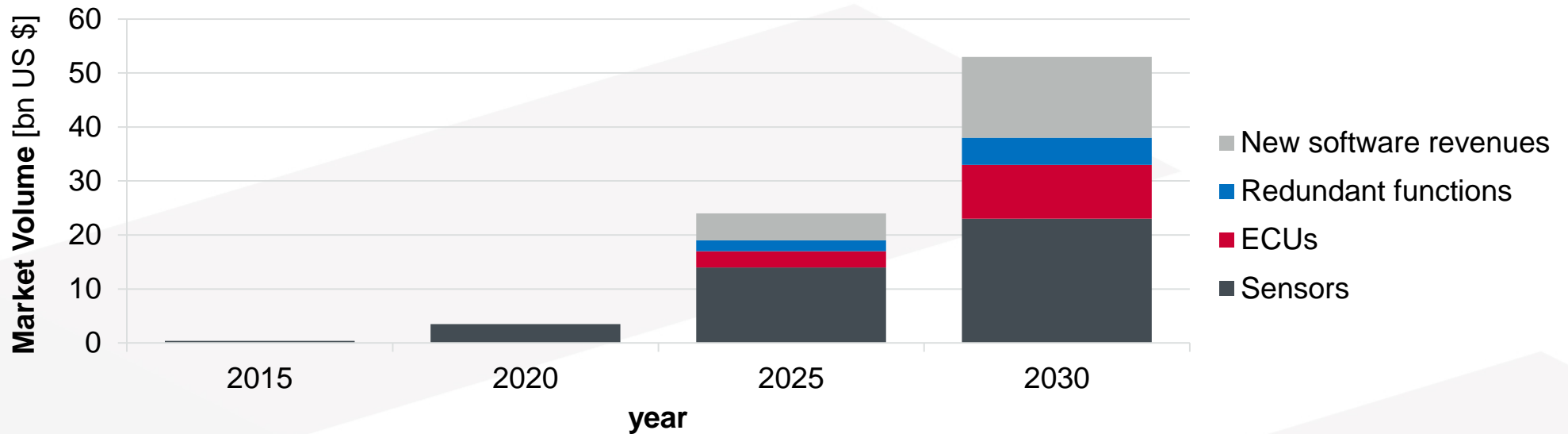
141,500

number of cars equipped with ACC

The installation rate of Adaptive Cruise Control ACC in the Audi A8 increased in the last 12 years from 2% to 65%

The development of different technologies for autonomous driving will boost the growth of the ADAS market

Market size arising out of autonomous driving technology (in addition to current DAS)



By 2030, the new opportunities from autonomous driving will be around
USD 40-60 bn

In a nutshell....

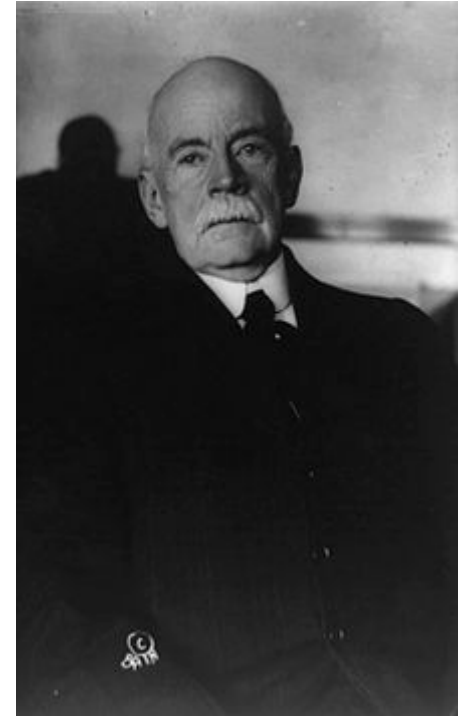
Piloted driving will experience
an evolutionary development,
but has the long-term
potential to revolutionize mobility

The automotive business is moving towards a new age of technology

“In my opinion, all previous advances in the various lines of invention will appear totally insignificant, when compared with those, which the present century will witness.

I almost wish, that I might live my life over again to see the wonders, which are at the threshold.”

[Charles Holland Duell, 1902]



Charles Holland Duell (April 13, 1850 – January 29, 1920) was the commissioner of the United States Patent and Trademark Office in 1898 to 1901, and was later a United States federal judge.

Source: www.wikipedia.de

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