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HIGHLY AUTOMATED DRIVING.

BARCLAYS INVESTOR CONFERENCE, LONDON.
SEPTEMBER 4TH, 2015.

HIGHLY AUTOMATED DRIVING WILL IMPROVE DRIVING COMFORT AND STILL ADMIT DRIVING PLEASURE.



Source: Sueddeutsche.de

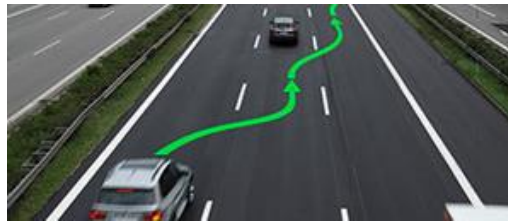
- Is HAD consistent with BMW's aspiration to provide customers with sheer **driving pleasure**?
- **Yes!** Progressing urbanization and increasing car densities in cities lead to traffic congestion on an unprecedented scale. Car drivers will presumably **be happy to hand the driving task over to the car and utilize the gained time differently** (personal productivity/relaxation).
- **HAD-enabled cars still admit „driving pleasure“ where possible** (e.g., outside congested city centres), while freeing the driver from inconvenient tasks.

FROM RESEARCH TO REALITY: THE BMW GROUP HAS LONG-TIME EXPERIENCE IN VEHICLE AUTOMATION.

**BMW Track Trainer
(2006)**



**Emergency stop
assistant (2009)**



**Highly automated driving
on the motorway (2011)**



**HAD on the vehicle's limit
(2014)**



**360° collision avoidance
(2015)**



**Fully automated remote
valet parking (2015)**



NEW 7 SERIES ALREADY PROVIDES FUNCTIONS VERY CLOSE TO HIGHLY AUTOMATED DRIVING.

Active Side Collision Protection and Cross Traffic Alert.



Pedestrian Protection & Night Vision.

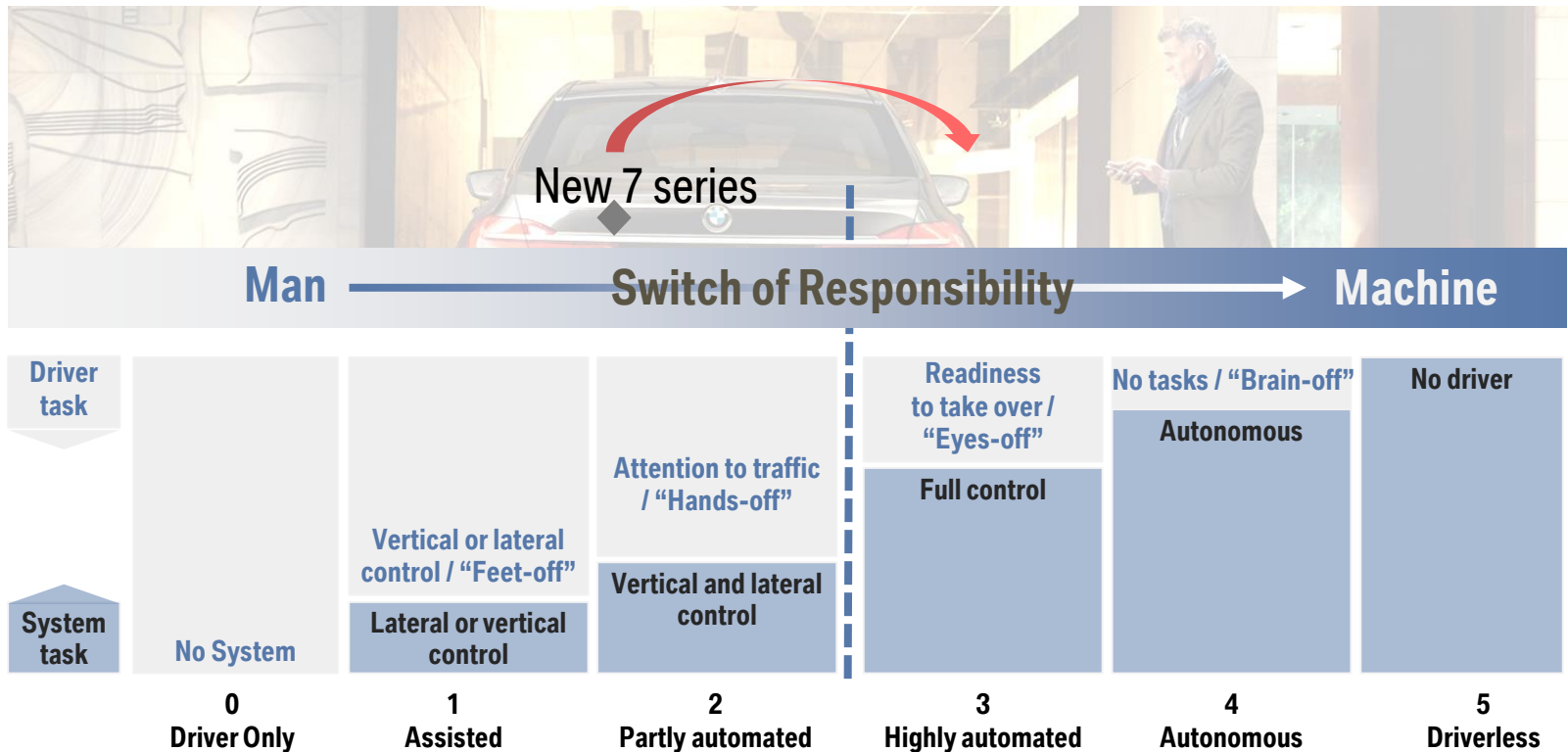


Traffic Jam Assistant up to 60km/h



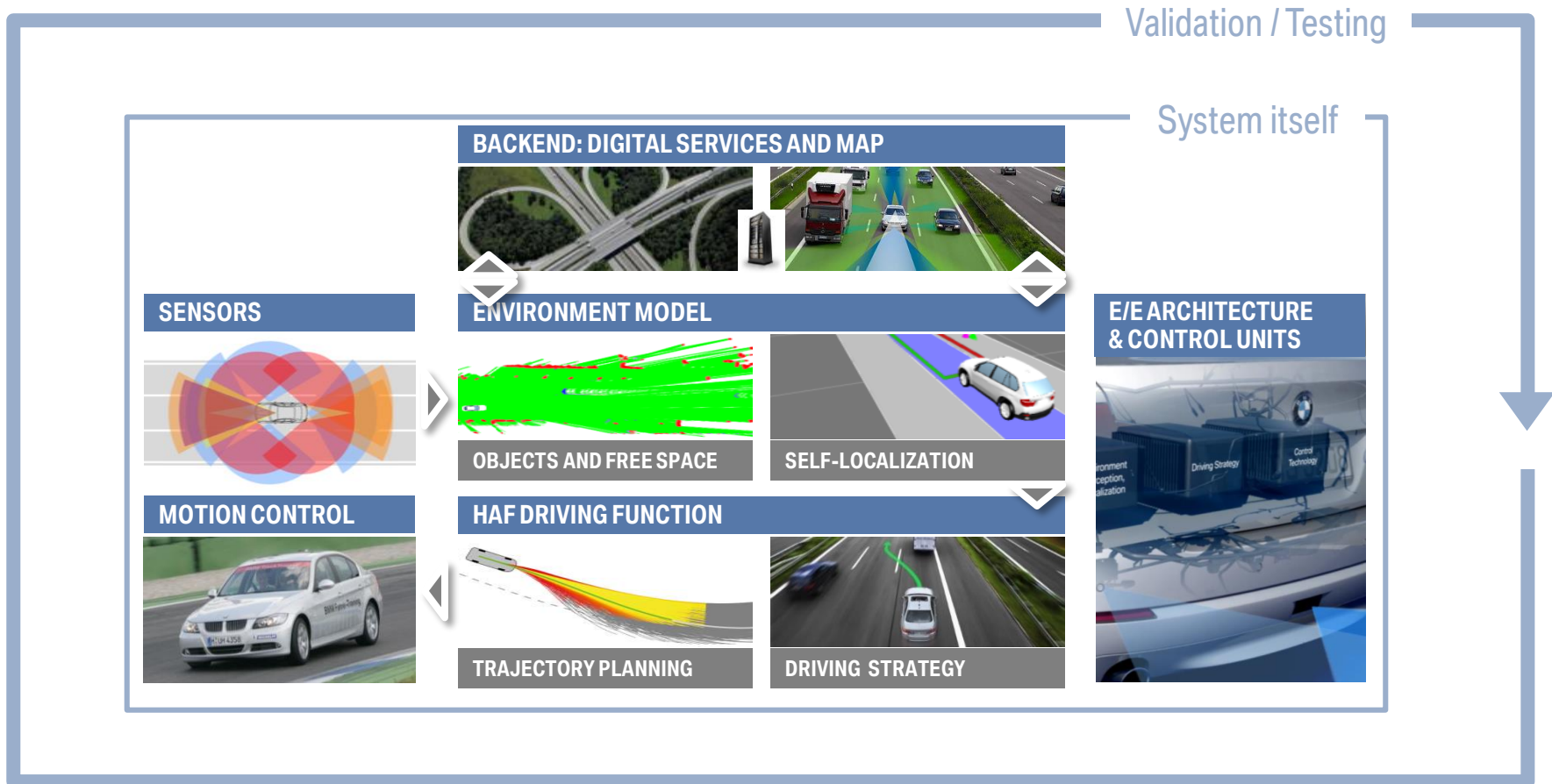
Remote Controlled Parking

HOWEVER TRUE AUTOMATED DRIVING STILL MEANS A BIG STEP BECAUSE OF RESPONSIBILITY SWITCH.

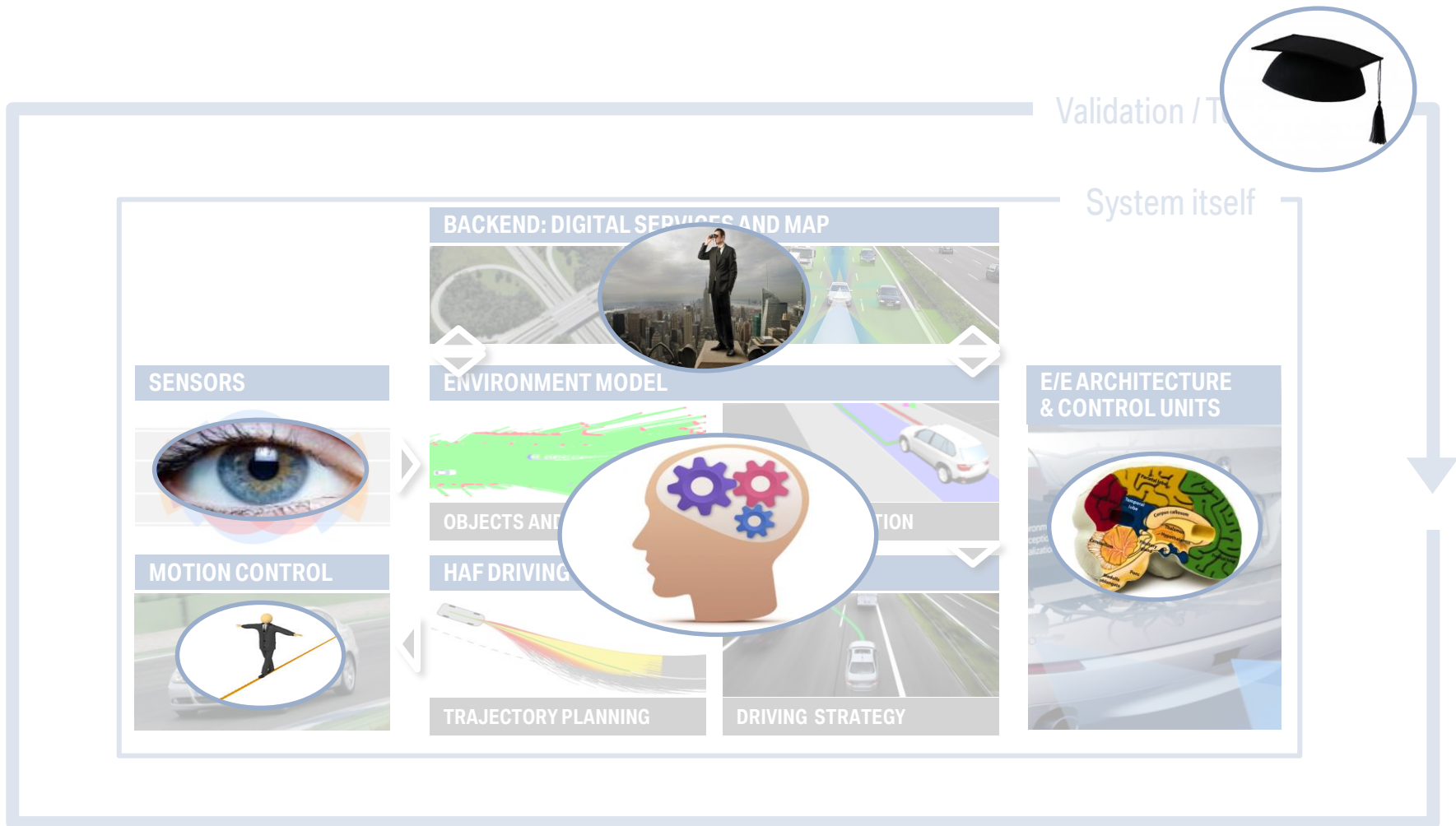


Source: SAE, VDA, LT-Analyse

MANY TECHNOLOGIES TO BE MASTERED ON THE WAY TO HIGHLY AUTOMATED DRIVING.



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BACKEND: HD MAP WITH DYNAMIC INFORMATION WILL PROVIDE LIVE ROAD PREVIEW AS ESSENTIAL DIGITAL SERVICES.



EN-ROUTE APPROVAL



VARIABLE TRAFFIC SIGNS



TRAFFIC CONDITIONS



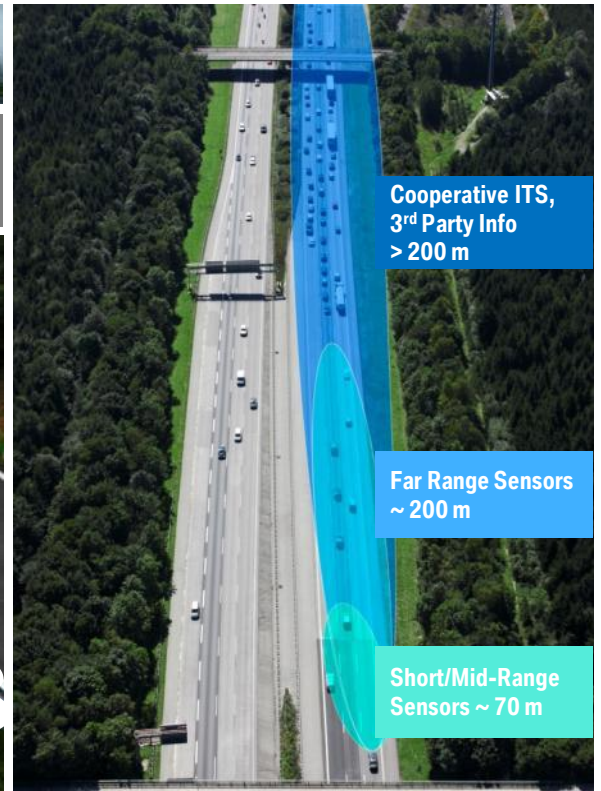
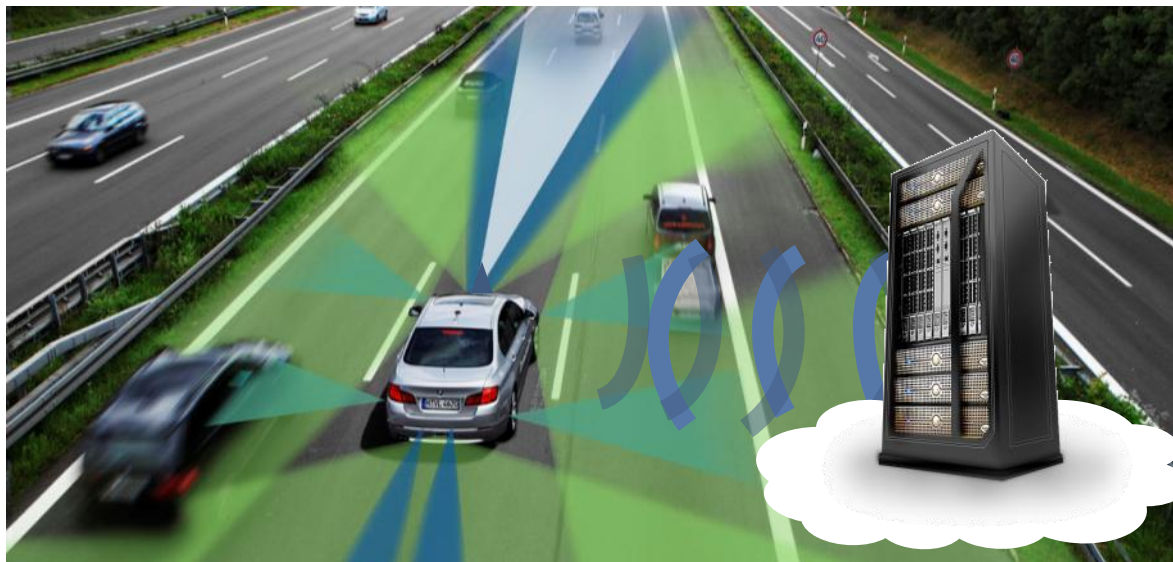
ROAD WORKS



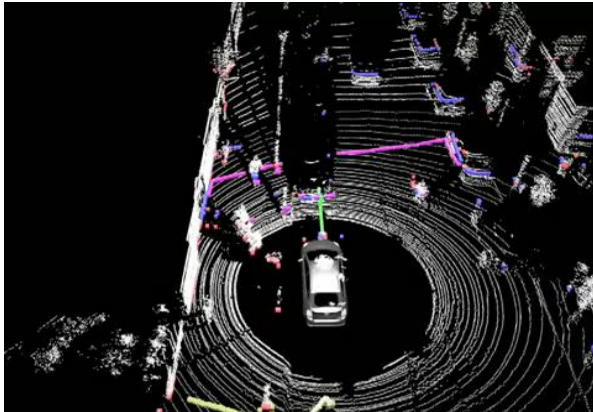
HIGH-PRECISION DIGITAL MAPS



WEATHER CONDITIONS



SENSORS: PRICE LEVEL AND PACKAGE OF CURRENT HIGH PERFORMANCE LIDAR SENSORS IS A CHALLENGE.



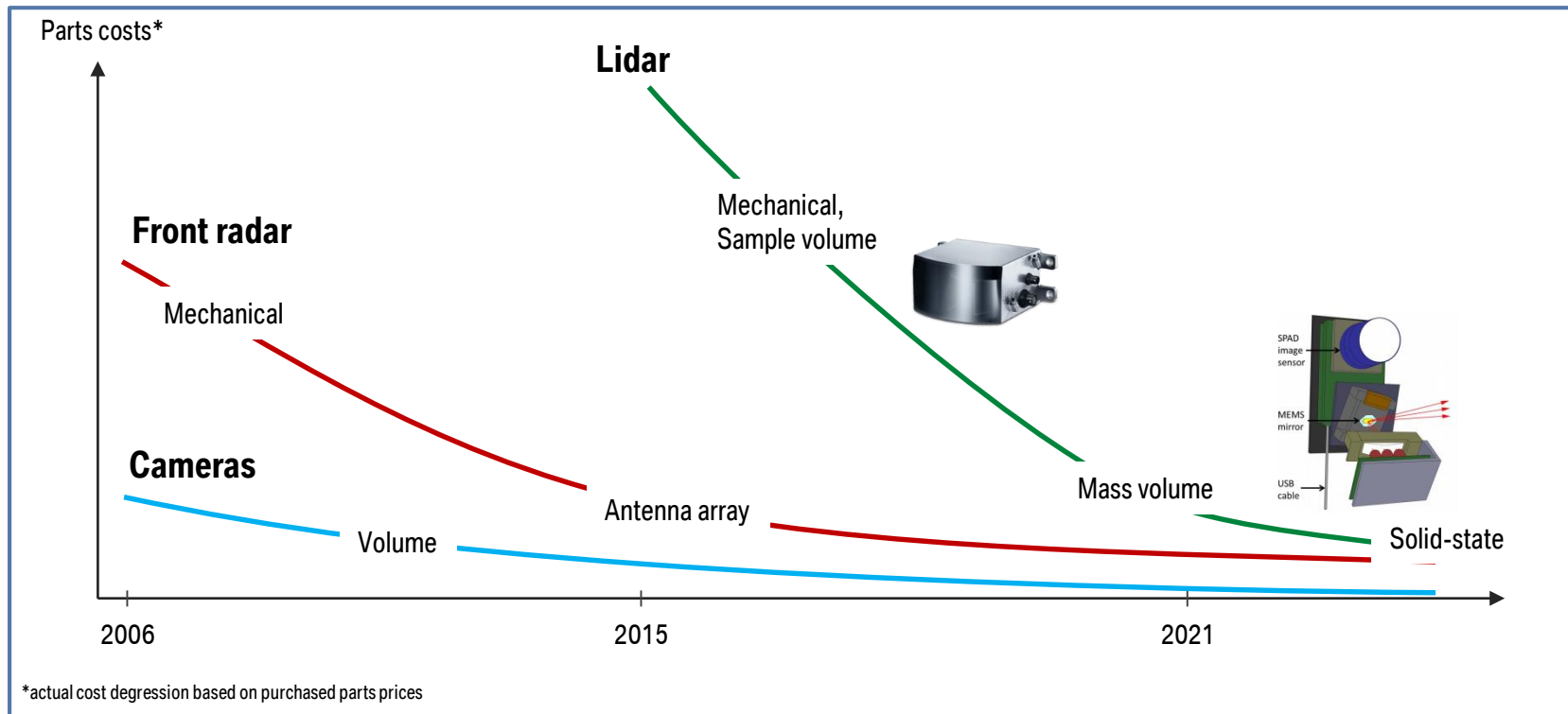
Example:

Velodyne 64-beam laser – rotates 360-degrees and takes up to 1.3 million readings per second, making it a truly versatile sensor on the car. Mounting it on top of the car ensures its view isn't obstructed.



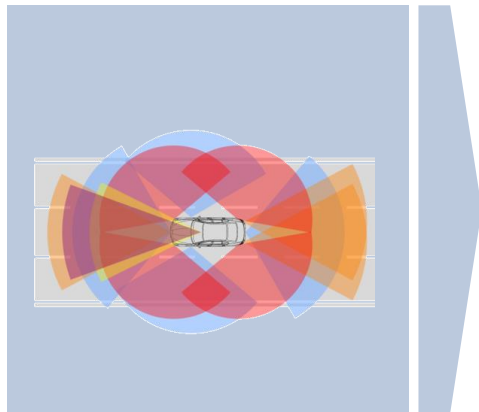
~€60.000.-

BUT COST EFFICIENT ALTERNATIVES ALREADY ON THE HORIZON AND EXPECTED TO BECOME MASS MARKET COMPATIBLE AS IN THE PAST.

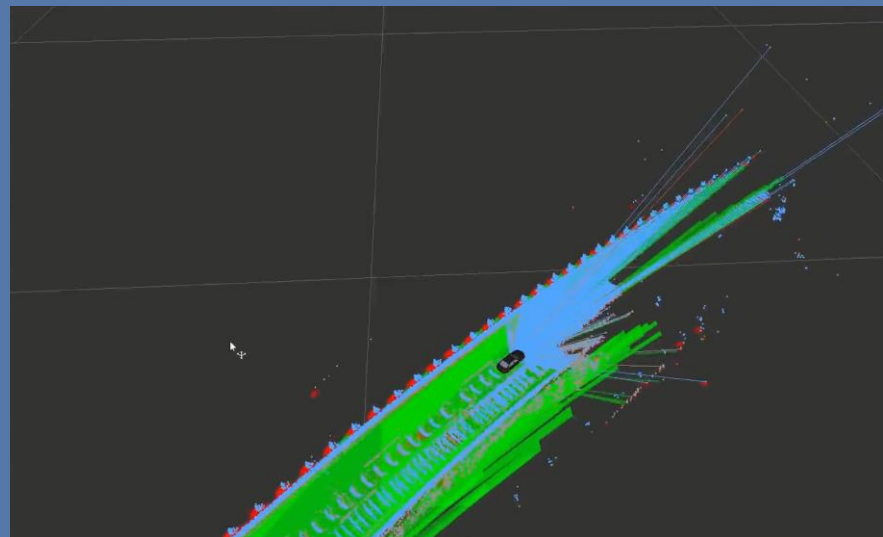


Source: Quanergy, Valeo, Team Research, "Low-cost compact MEMS scanning LADAR system for robotic applications", Moss et al., 2012

ONBOARD SENSOR FUSION GENERATES A REAL-TIME ENVIRONMENTAL MODEL OF VEHICLE SURROUNDINGS.



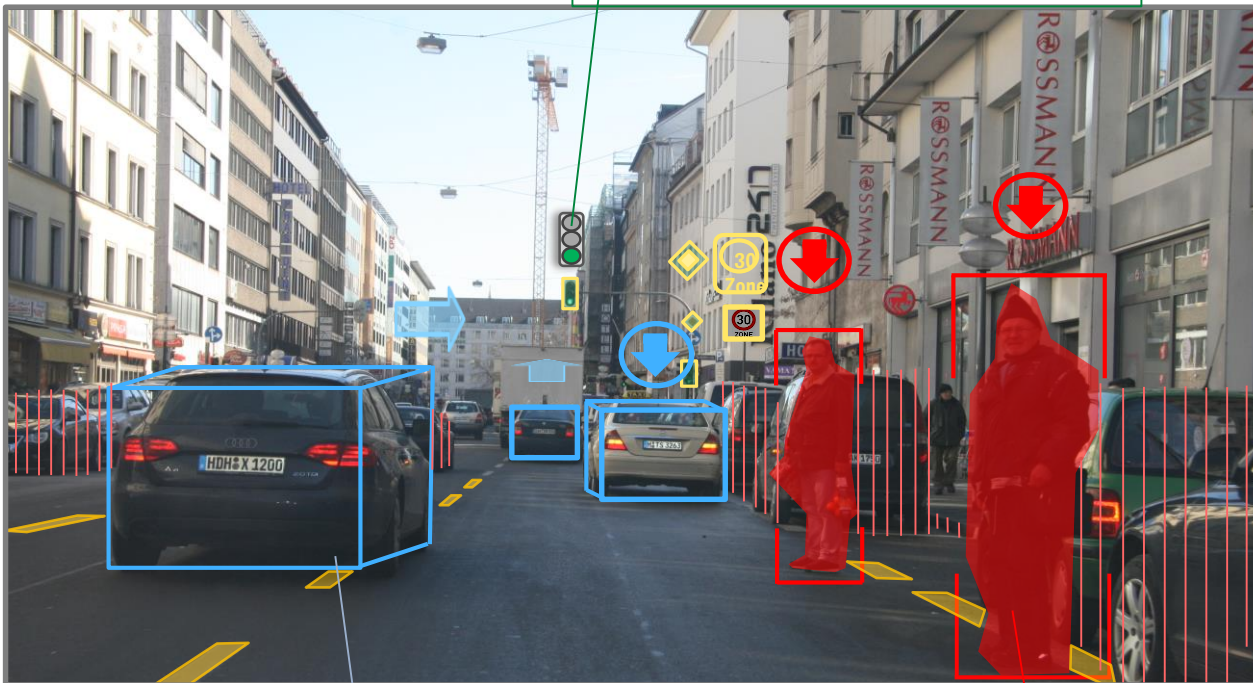
ENVIRONMENTAL MODELLING BASED ON GRIDS



PERCEPTION: FOR BOTH SENSING OF THE ENVIRONMENT AND CONTEXTUAL UNDERSTANDING MACHINE LEARNING SEEN AS AN ESSENTIAL BUILDING BLOCK.

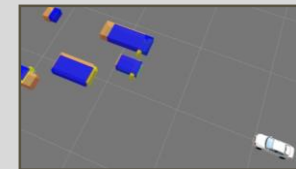


Green light will last for the next 10sek

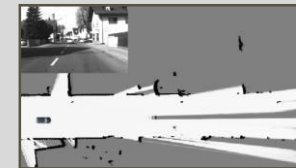


Is indicating lane change and will likely do that in 2 sek

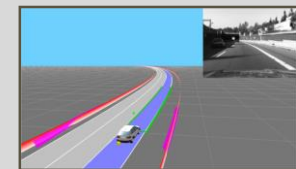
Looks at me – will likely not cross



Object-based models



Occupancy maps/free space



Road models

REMAINING CHALLENGES COMPRISE INDUSTRIALISATION AS WELL AS TECHNOLOGICAL, SOCIAL AND LEGAL ASPECTS.

Challenges

Description

Industrialization

- Field operational tests with a heterogeneous fleet to gather all kinds of situational data for a later **functional validation**.
- Standardization of methods for validation of usage/functional safety.
- Systematic quantification of benefits of HAD through standardized methods.



Technological advancements

- Data security, particularly with respect to backend connectivity.
- Development of highly accurate, digital maps in the backend.
- Improved **environmental model** and cost-down of sensors.



Societal aspects

- Proactive communication of opportunities provided by HAD to facilitate societal acceptance
- Assurance of data privacy and security to retain current customer trust levels

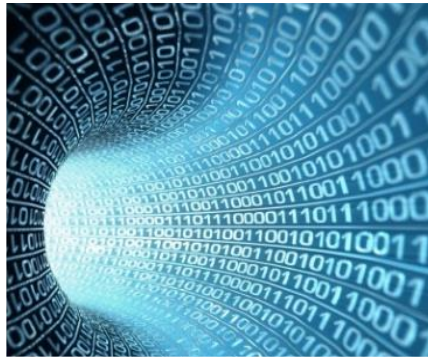


Legal aspects

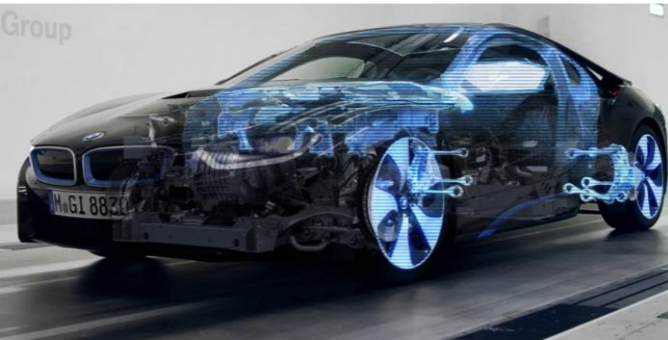
- Concerted approach to solving **legal issues** with respect to accreditation (HAD systems may not satisfy country-specific accreditation laws), regulatory law, as well as product liability.

ZULASSUNGRECHT	VERHALTENSRECHT	PRODUKTHaftUNG
<p>Europäische Union: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p> <p>USA: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p> <p>China: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p>	<p>Europäische Union: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p> <p>USA: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p> <p>China: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p>	<p>Europäische Union: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p> <p>USA: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p> <p>China: - Zulassungspflicht für alle Kraftfahrzeuge - Zulassung durch die Mitgliedstaaten - Zulassung durch die Mitgliedstaaten</p>

Diskussionen über Änderungen des Zulassungsrechts und des Verhaltensrechts laufen auf nationaler und internationaler Ebene. (z. B. Bundesverkehrsministerium, UN/ECE)



THANK YOU FOR YOUR ATTENTION!



**BMW
GROUP**

Research and Technology

