IN SPRINTS TOWARDS AUTONOMOUS DRIVING.

BMW GROUP TECHNOLOGY WORKSHOPS.

December 2017

BMW GROUP THE NEXT 100 YEARS

Rolls-Royce Motor Cars Limited

AUTOMATED DRIVING OPENS NEW OPPORTUNITIES FOR CUSTOMERS AND COMMUNITY.

THE DEVELOPMENT OF TODAY'S ASSISTED FUNCTIONS TO TOMORROWS AUTONOMOUS DRIVING EQUALS A TECHNOLOGICAL QUANTUM LEAP.

Driver	Feet off	Hands off	Eyes off	Attention off	Passenger
No assistance	Assistance	Semi-automated	Highly automated	Fully automated	Autonomous
(L 0)	(L 1)	(L 2)	(L 3)	(L 4)	(L 5)
Individual	Transfer of responsibility		Transfer of responsibility		Machine

BMW HAS CREATED A STRONG SETTING FOR THE DEVELOPMENT OF AUTONOMOUS DRIVING TO SHAPE THE FUTURE OF MOBILITY.

Product

HAD/ FAD fleet

User Interface

Competence

MOBILEYE Our Vision. Your Safety.™

intel

Core cooperation

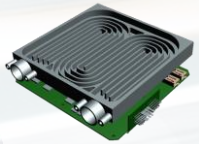
& Development partners

DELPHI Continental FCA MAGNA

Autonomous driving

Technology

PAD



Backend / Data storage

Artificial Intelligence

Sensors

Enabler

Agile development

agile

Autonomous Driving Campus

CROSS-INDUSTRIAL PARTNERSHIPS NEEDED FOR A SUCCESSFUL DEVELOPMENT OF THE AUTONOMOUS DRIVING.

COOPERATION.

SENSORS: CAMERA, RADAR, LIDAR.
OBJECT FUSION.
ROAD MODEL.
DRIVING STRATEGY/PLANNING.

AUTONOMOUS DRIVING.

BMW, MOBILEYE (Our Vision. Your Safety.™), intel, Continental, DELPHI, FCA (FIAT CHRYSLER AUTOMOBILES), MAGNA, OEMs

HD-MAP.

CENTIMETER PRECISION.
REAL-TIME CAPABLE.
HIGHLY AVAILABLE AND RELIABLE.

OEM-COOPERATION.

BMW, Audi, MOBILEYE (Our Vision. Your Safety.™), here, intel, Mercedes-Benz

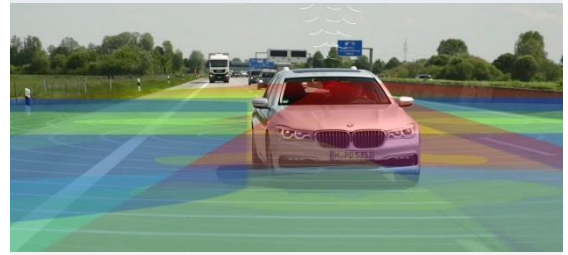
INFRASTRUCTURE 5G.

ULTRA LOW LATENCY.
ULTRA HIGH RELIABILITY.
ULTRA HIGH DATA RATES.

5G AUTOMOTIVE ASSOCIATION.

BMW, Audi, Mercedes-Benz, intel, ERICSSON, HUAWEI, NOKIA, Qualcomm

SENSOR STANDARD.

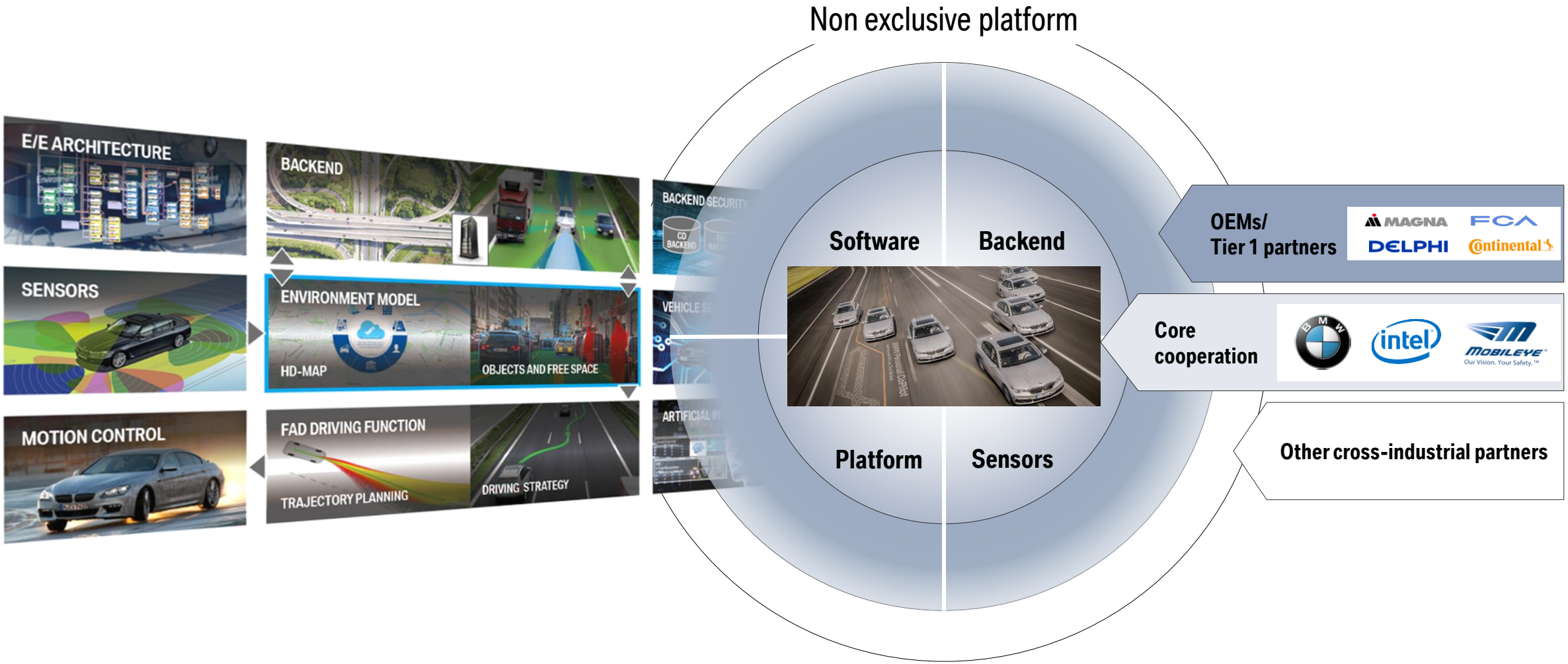


SENSORS: CAMERA, RADAR, LIDAR.
COMPLEXITY REDUCTION.
FLEXIBILITY.
FUTURE-PROOF INTERFACE.

INTERNATIONAL BOARDS & ASSOCIATIONS.

Continental, DELPHI, BOSCH, Valeo, HELLA, MOBILEYE (Our Vision. Your Safety.™), Autoliv, ISO, BMW, Audi, Mercedes-Benz, VDA

FOR A FAST SUCCESS, BMW WILL DEVELOP A NON EXCLUSIVE PLATFORM FOR THE MARKET TOGETHER WITH ITS PARTNERS.



THE WINNING FORMULA IS TO ADOPT A LEAN AND AGILE MIND-SET, BOTH ACROSS THE ORGANIZATION AND WITHIN COLLABORATIONS.

Short distances,
fast communication.

Interdisciplinary teamwork
for common targets.

Central base for workshops,
simulation and validation.

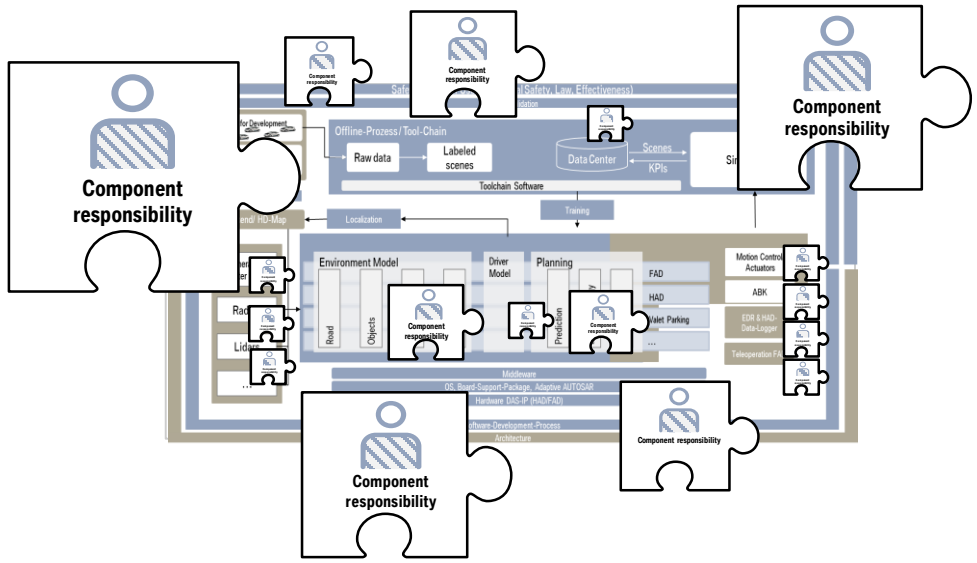
Highly efficient agile
product development.

New organization
models.

Scalable and open
for partners.

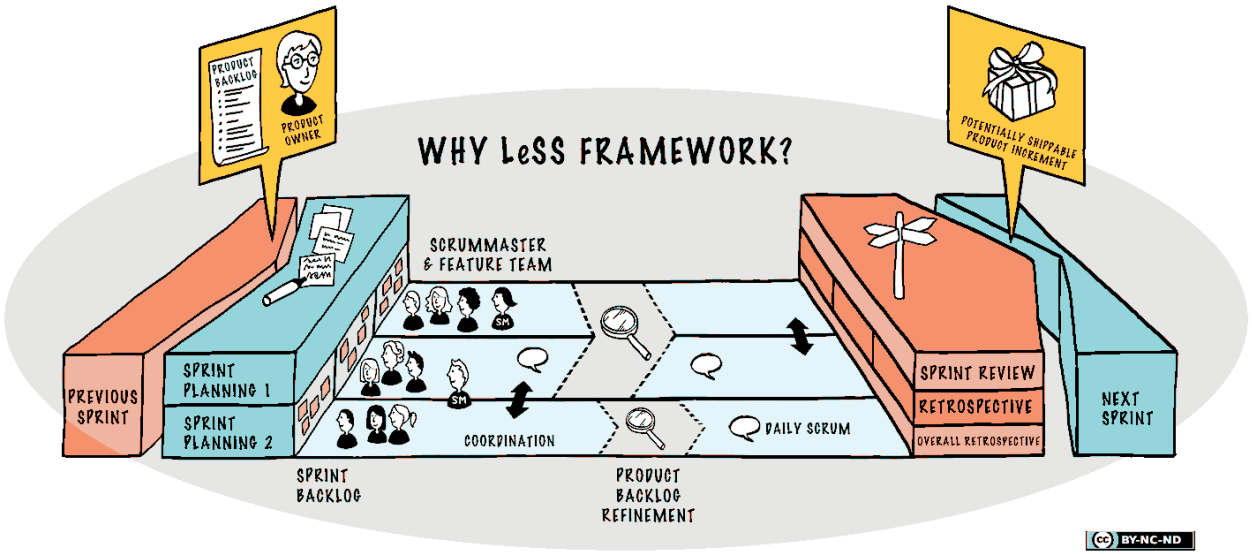
THE CHANGE WE ARE DRIVING FORWARD IS NOT ONLY ABOUT TECHNOLOGY, IT'S ALSO ABOUT WORKING MODELS.

Today.



Focus on components and cascaded responsibility.

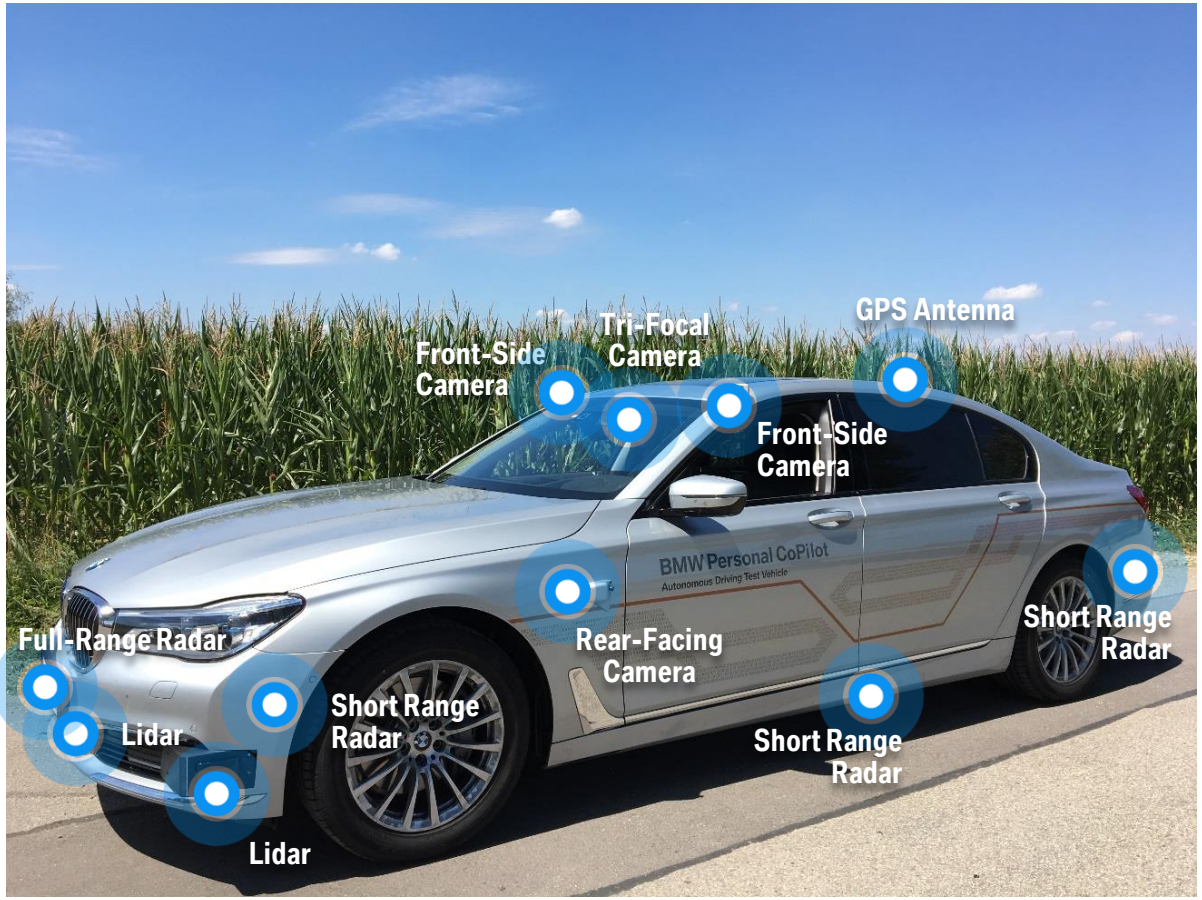
Tomorrow.



Focus on features with end-to-end responsibility.

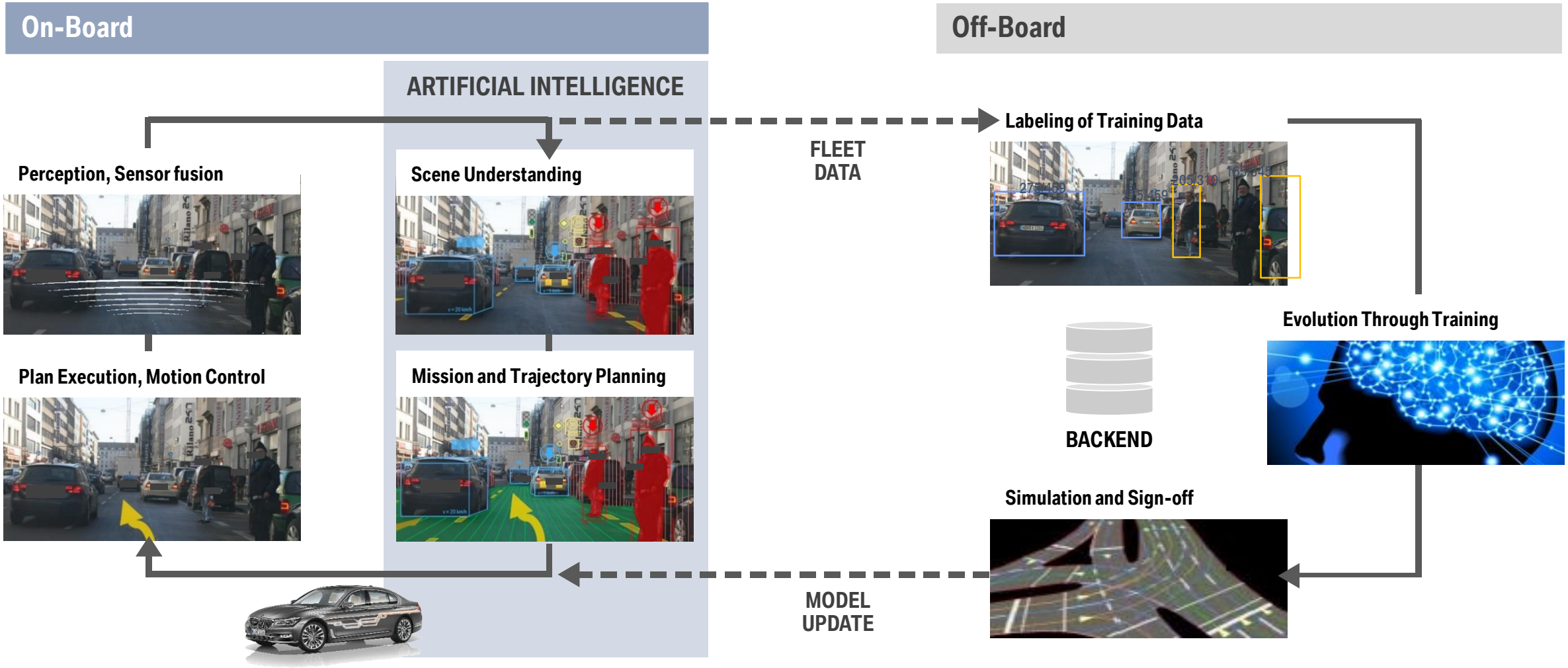
CORE OF THE AUTONOMOUS DRIVING TECHNOLOGY IS THE END-TO-END ARCHITECTURE.

BMW TAKES THE SENSOR SETUP TO A NEW LEVEL TO RELIABLY DETECT ALL RELEVANT OBJECTS IN URBAN ENVIRONMENTS – TARGET SENSOR SETUP WILL CONTAIN 44 SENSORS.



Not shown: 360° Surround-View Cameras, 360° Ultrasound Coverage, 1x Rear Camera, 2x Rear Lidar, 2x Full-Range Radar.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING ARE INDISPENSABLE TO SUCCESSFULLY UNDERSTAND AND TRAIN THE RIGHT DRIVING BEHAVIOR.

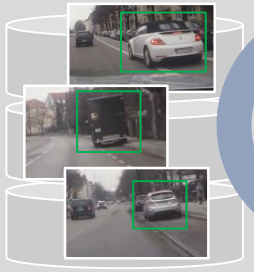


MACHINE LEARNING BY EXAMPLE – PARKED VEHICLE CLASSIFICATION.

Training – Backend

Sensors

Labeled training-data



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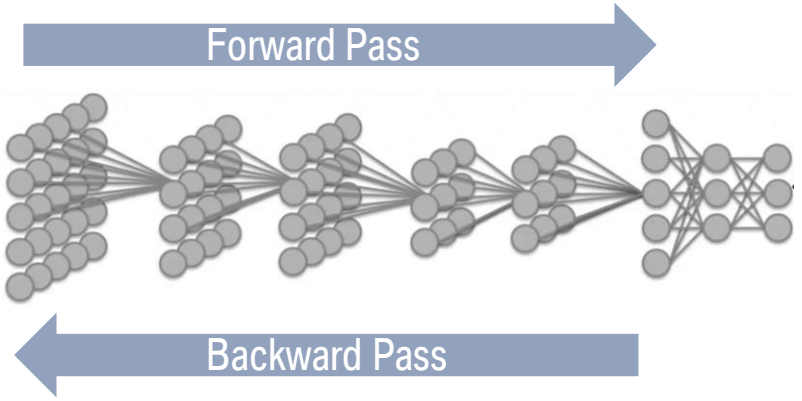


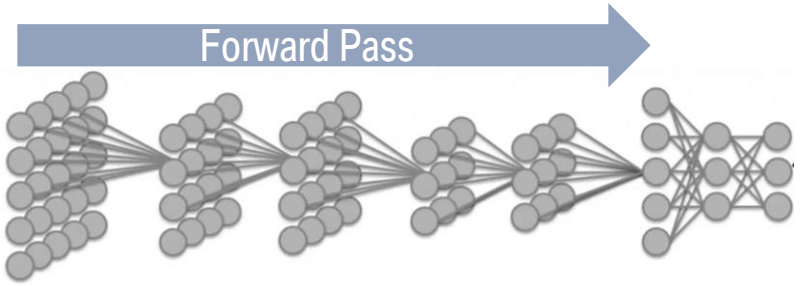
Not Parked

Parked

Learned model

Execution – On board

Sensors



Parked

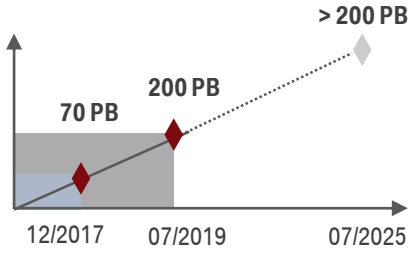
DATA DRIVEN DEVELOPMENT REQUIRES STATE OF THE ART DATA CENTERS.

Data center

End of 2017 70 PB data capacity at BMW, target capacity of 200 PB in 2019 compares with 770 km CDs.

Storage capacity

Ramp-up of capacity up to 200 PB until 2019, with flexibility of further capacity increase.

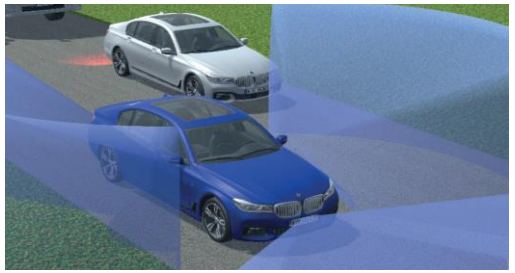


INTEL Campeon

Currently ~ 85 PB storage capacity – 10x larger network gateways into INTEL than ever before.

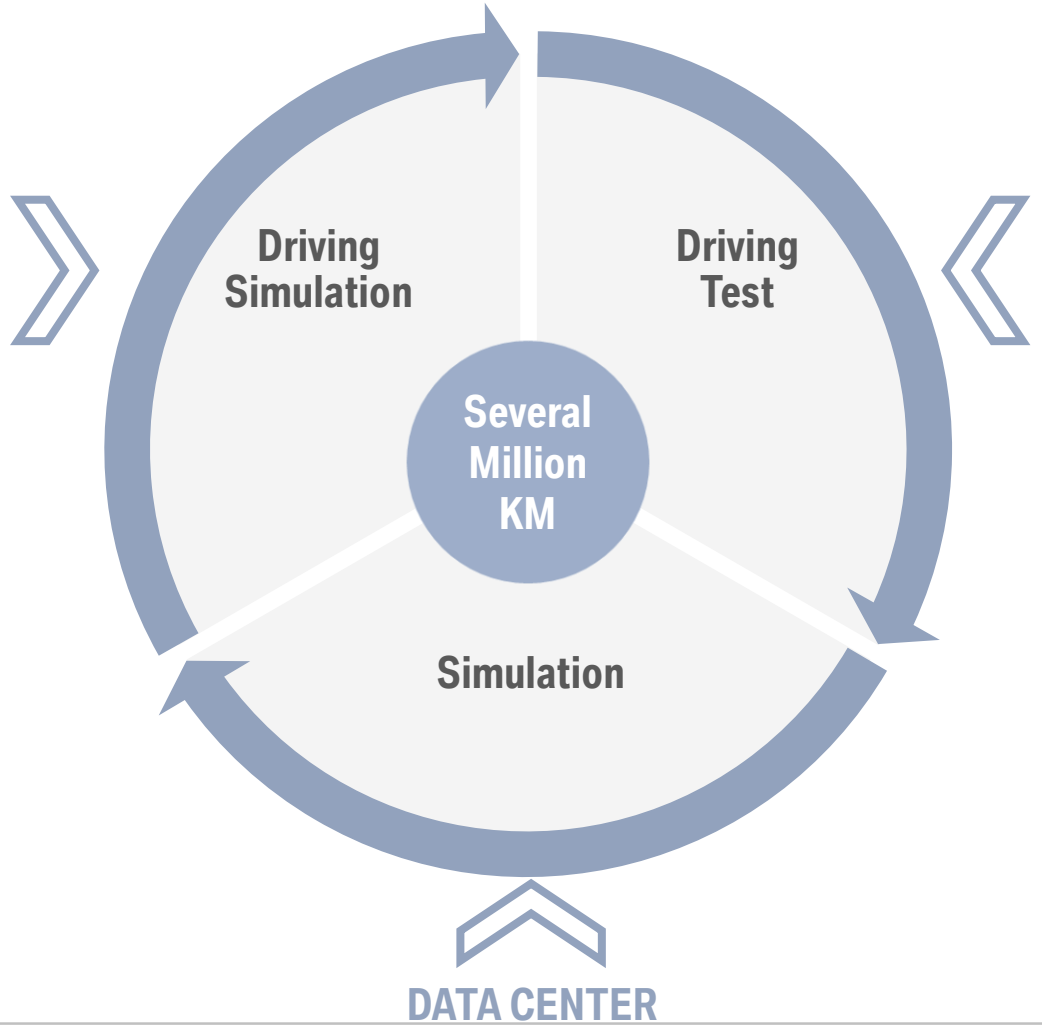
SAFETY FIRST: SEVERAL MILLION KILOMETERS WITHOUT ACCIDENTS TO BE COMPLETED – SIMULATION AND HUGE DATA STORAGE IS REQUIRED.

Driving simulation.



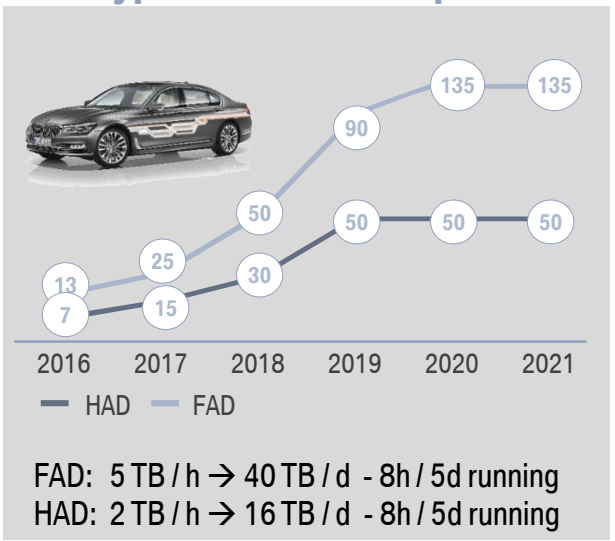
Hardware Testing.

Test on Proofing Ground.



Global Development Fleet.

Prototype vehicle build up.



SAFETY FIRST: SEVERAL MILLION KILOMETERS WITHOUT ACCIDENTS TO BE COMPLETED – SIMULATION AND HUGE DATA STORAGE IS REQUIRED.

SiL – Software in the Loop.

Performance of new Features

Test safety-relevant Scenarios

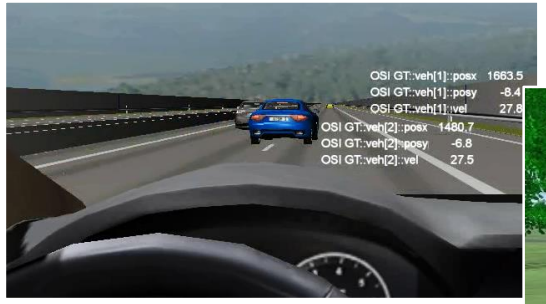
Fast Feedback for Developer

HiL – Hardware in the Loop.

Real Hardware in simulated Environment

Virtual Integration in the Lab-Car

Evidence of Safety-Aspects



WE PERFORM UP TO 2 MILLION SCENARIOS PER DAY!

FOR DATA COLLECTION AND TEST DRIVES A MODERN TEST FLEET OF 40 VEHICLES IN 2017 ON BASIS OF 7 SERIES WAS BUILD, WORLD WIDE TEST DRIVES STARTED.

Data Driven Development.

Prototypes as critical to success developing tools.

Mission: testing, developing and collecting data.

MODERN VEHICLE INTEGRATION LAB FOR VEHICLE TEST FLEET AT THE AUTONOMOUS DRIVING CAMPUS.

Perfect realization in Vehicle Integration Lab at AD Campus: Ingestion and flashing of the prototypes

BMW WILL PAVE THE WAY TOWARDS AUTONOMOUS DRIVING WITH A GO LIVE OF THE HAD AND FAD FUNCTIONS STARTING WITH THE iNEXT IN 2021.

AD Campus Munich

40 HAD/ FAD test vehicles

HAD drives in US/ EU
FAD drives MUC downtown

Tier 1
OEMs
Integration of further partners

Ca. 140 HAD/ FAD test vehicles ww

HAD drives in US/ EU/ Asia
FAD drives US/ EU/ Asia

HAD/ FAD starting with iNext

2017 2018 2019 2020 2021

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