SCALABLE, SAFE UND MULTI-OEM CAPABLE ARCHITECTURE FOR AUTONOMOUS DRIVING.

9th Vector Congress | Simon Fürst
Stuttgart | 21-Nov-2018

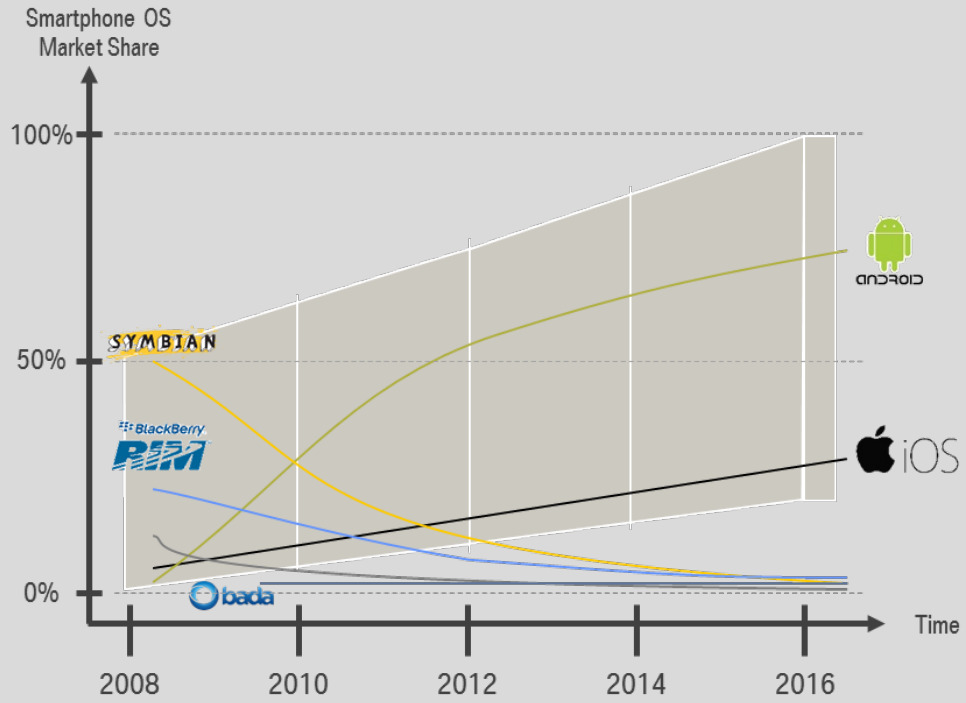
BMW GROUP

THE NEXT 100 YEARS

Rolls-Royce Motor Cars Limited

WE BELIEVE ONLY A FEW PLATFORMS WILL SURVIVE THE RACE FOR AUTONOMOUS DRIVING. THIS IS JUST ONE REASON WHY WE AIM FOR A MULTI-OEM PLATFORM.

Within just a few years only two operating systems for smartphones got established in the market: Android & iOS. All others died out!



Just as in the smartphone operating system market, only a few Autonomous Driving Platforms will succeed.

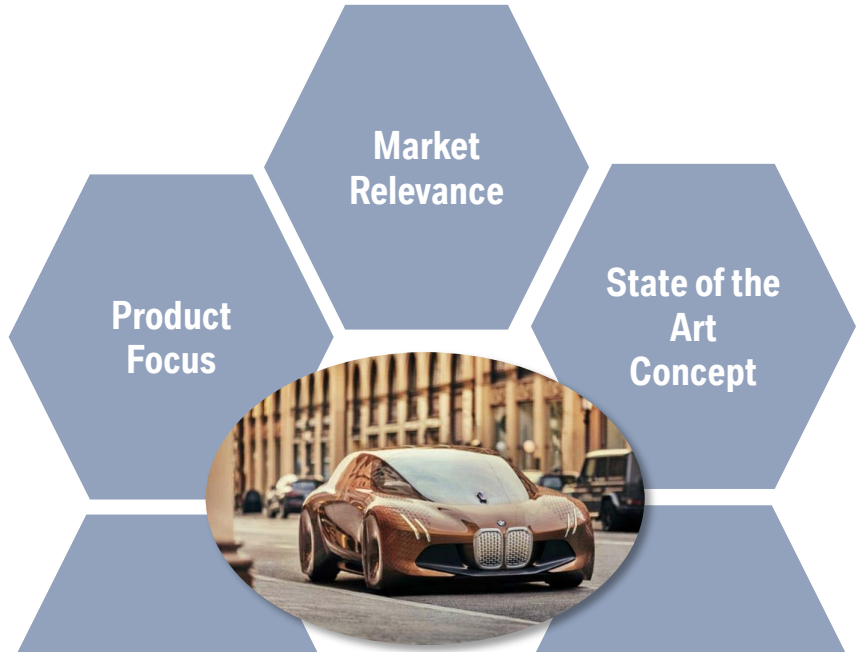
PAST **FUTURE**

BMW TACKLES AUTONOMOUS DRIVING CHALLENGES WITH STRONG PARTNERS.

Leading Automotive OEMs

- More than 100 years of automotive design and production.
- Premium ADAS customer experience.
- Advanced vehicle electronics integration.

- More than 4.7 million vehicles per year.
- Advanced vehicle electronics integration and redundancy architecture capabilities.
- Strong US and European footprint.



Leading Technology Partners

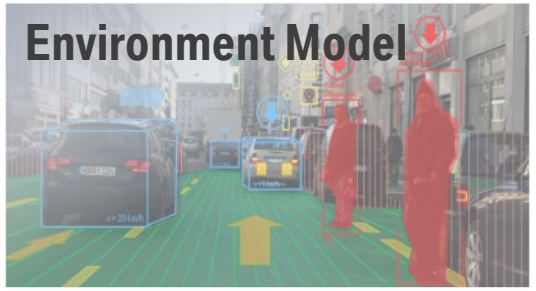
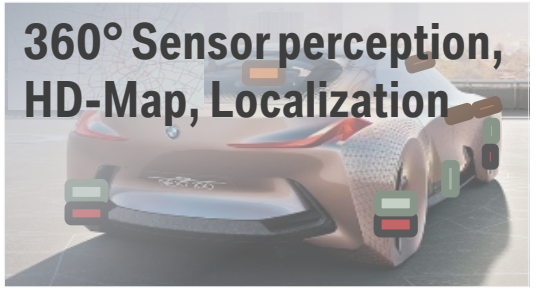
- #1 semiconductor manufacturer.
- Broad support for OS and safety.

- Leading automotive computer vision technology provider.
- Extensive AI expertise.

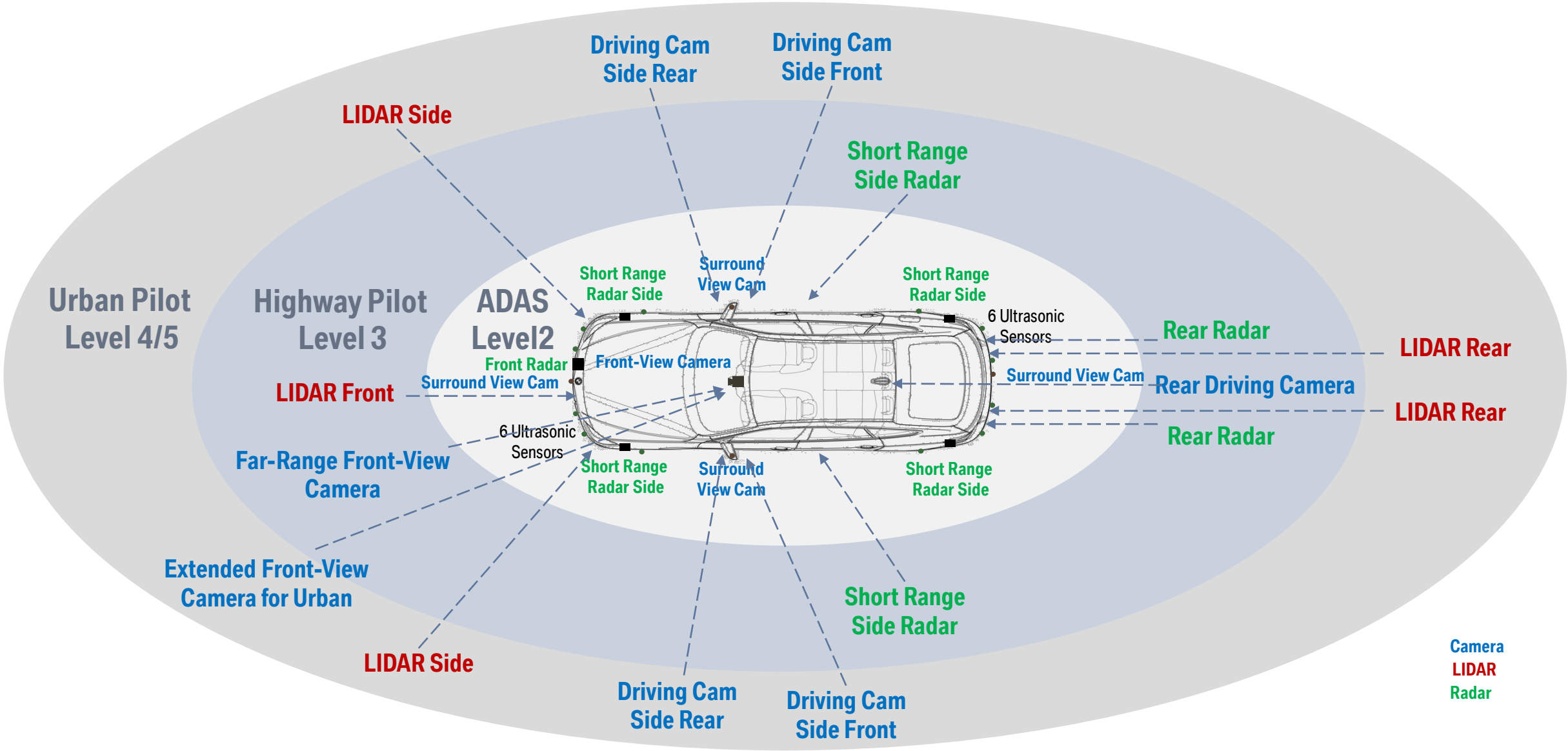
Leading Integration Partners

- Specialized know-how within Automotive industry.
- Reliable system integration partners.
- International footprint with high standard.
- State of the Art technology providers (e.g. LiDAR)

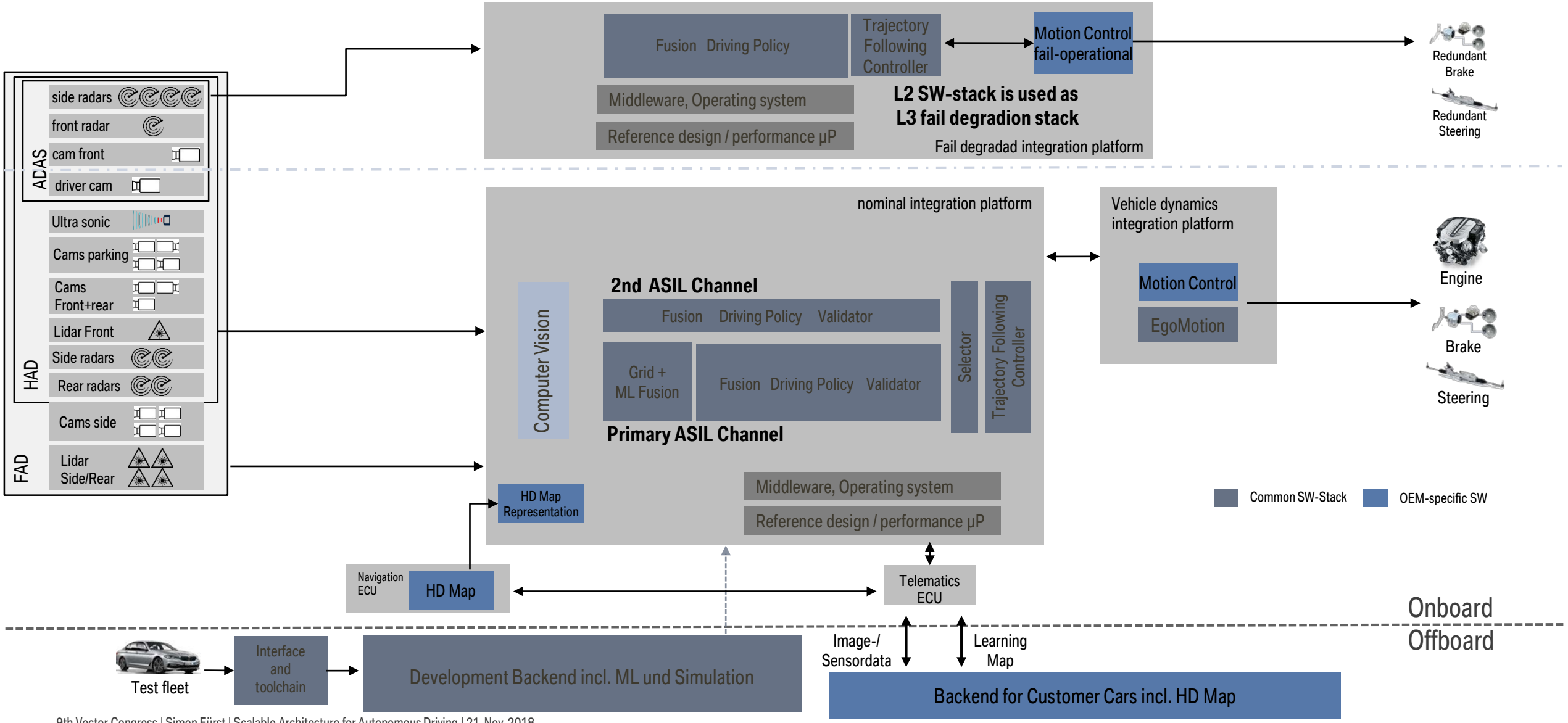
A SCALABLE, SAFE UND MULTI-OEM CAPABLE ARCHITECTURE NEEDS TO INTEGRATE THE FOLLOWING MAIN CHALLENGES OF AUTONOMOUS DRIVING.

DATA	Data Collection 	Data Center & Big Data Processing 	AI training and Algorithm Evaluation 
SOFTWARE	Environment Model 	Prediction 	Driving Policy 
HARDWARE & INTERFACES	360° Sensor perception, HD-Map, Localization 	High Performance and safe automotive silicon. 	Motion Control, Odometry 

COMMON SCALABLE SENSOR CONCEPT MAXIMIZES VALIDATION SYNERGIES.



A MULTI OEM API CONNECTS THE COMMON SW-STACK WITH THE OEM SPECIFIC SOFTWARE AND HARDWARE.



BMWS SAFETY VISION FOR AUTONOMOUS DRIVING.

Targeting for **maximum safety and significant improvements compared to today‘s average human drivers**.

- Avoid accidents under any circumstances, no matter who is responsible for causing the accident.
- If accident is unavoidable, minimize human severity.

To achieve this vision we are developing a scalable safety concept for Highway-Pilot (L3) and Urban Pilot (L4/5) applications, together with strong and safety-oriented OEMs, Tier1s and Technology Partners.

THE TEN SAFETY COMMANDMENTS FOR AUTONOMOUS DRIVING.

- Since the system is responsible to fulfil the driving task, functional safety requires redundancy
- If system limits are reached the system need to minimize those risks or performs a safe TOR with sufficient time
- Behavior of the system in traffic needs to be predictable. All valid traffic rules need to be taken into account
- Driver‘s responsibilities: Driver monitoring and clear mode awareness necessary
- If the driver does not respond to a system initiated TOR a minimum risk maneuver has to be performed
- Driver initiated activation and deactivation needs explicit driver intend
- Effects of automation on the driver need to be taken into account
- Security: Protection against manipulation of the system is mandatory
- Data recording while the system is active is necessary to recognize and document unusual events
- Multi stage validation including simulation (e.g. Pegasus: 240 Mio km) is necessary to ensure that the safety goals are met

TOR: Take over request

FUNCTIONAL SAFETY FOCUS FOR HIGHWAY PILOT AND URBAN PILOT.

ASIL QM
ASIL B
ASIL C
ASIL D

Teleoperation of vehicle

Safe and high precision positioning

HD-Map

Safe Localization

Safe HMI for a clear mode awareness

Safety Features like Automatic Emergency Braking

Fusion of LIDARs, RADARs and cameras with a range up to 300m

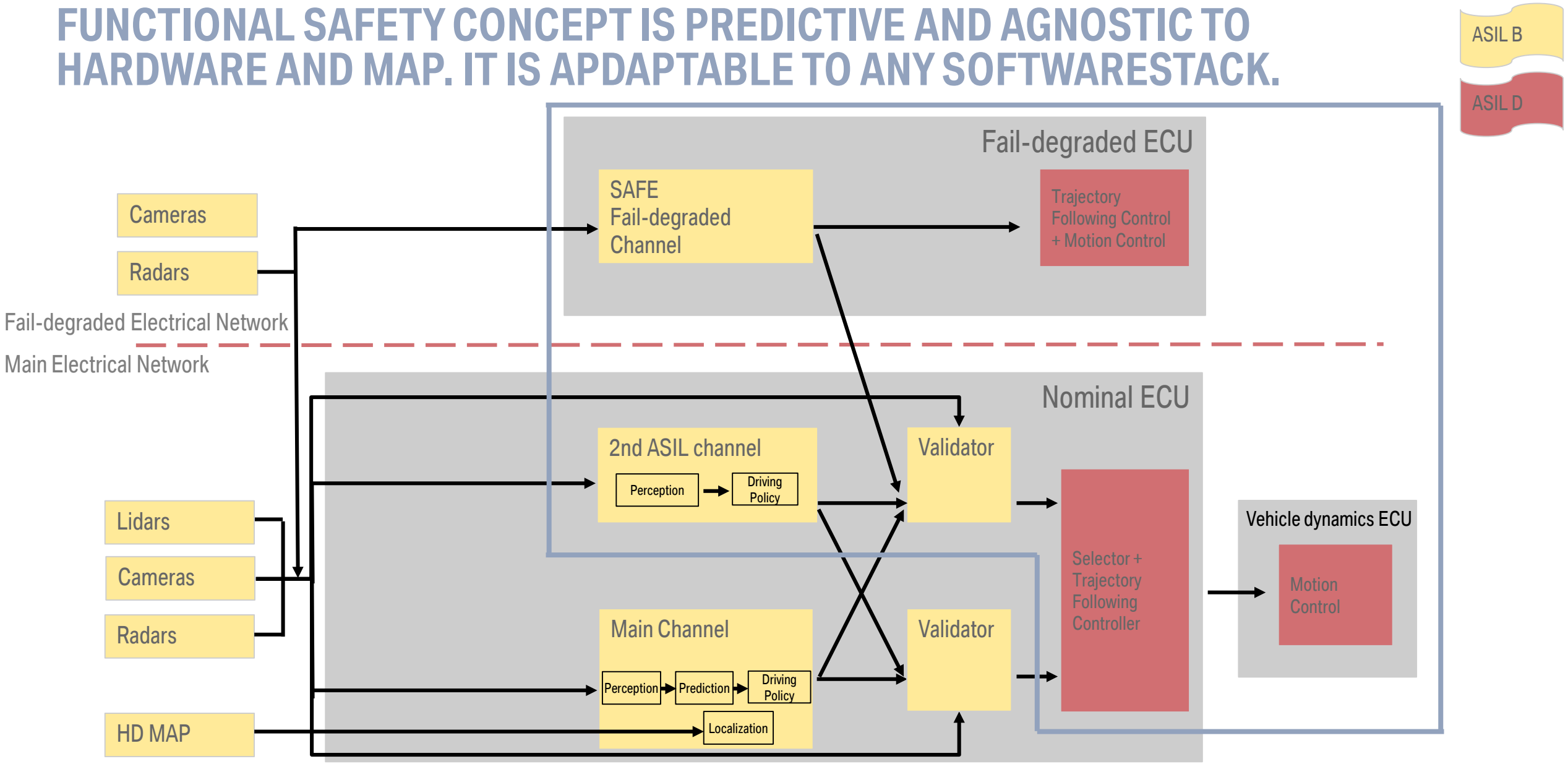
Highway-Pilot and Urban Pilot details see next page

Minimum risk maneuver

Emergency stop assistant

Road condition preview
Including hazard warning

FUNCTIONAL SAFETY CONCEPT IS PREDICTIVE AND AGNOSTIC TO HARDWARE AND MAP. IT IS APDAPTABLE TO ANY SOFTWARESTACK.



THE CHALLENGE
XPAD ECU FAMILY - FACTS AND FIGURES

4 Different SOC architectures

- Infineon AURIX, Intel Denverton, Intel Xeon, MobilEye EQ5 (MIPS)

3 Internal software suppliers

- EV, EF, JC

5 External Software Suppliers:

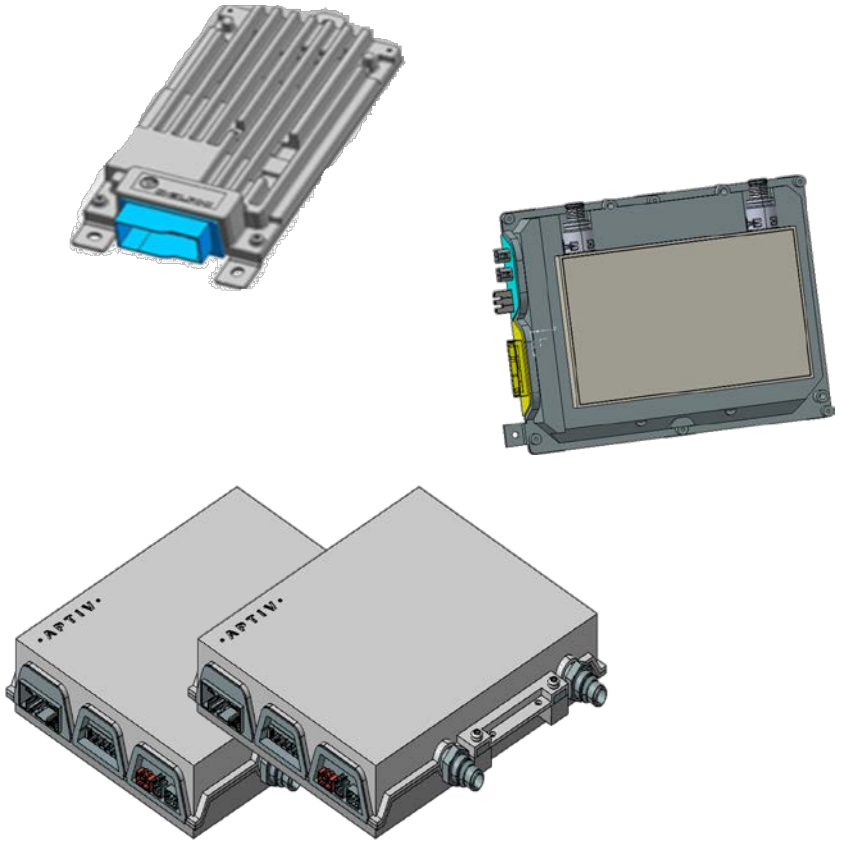
- Intel / MobilEye
- Aptiv
- N.N. (Adaptive AUTOSAR)
- N.N. (Safe Linux)
- N.N. (Supplier for GNSS positioning engine)

25 software images (25 diagnostic addresses)

- 2 mPAD
- 7 hPAD
- 16 uPAD

21 Adaptive AUTOSAR images!

AUTOSAR



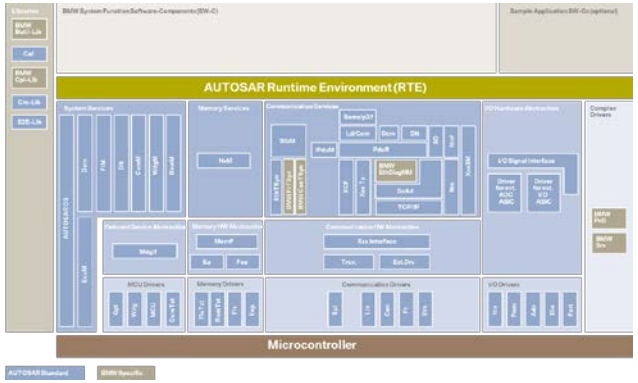
AUTOSAR AT BMW
SP2021 CONCEPT CHANGES IN BMW SYSTEM SOFTWARE

- BMW system software components will be redesigned in order to support different API requirements
- They split into a generic part and a platform specific adapter

Example: BMW StdDiag

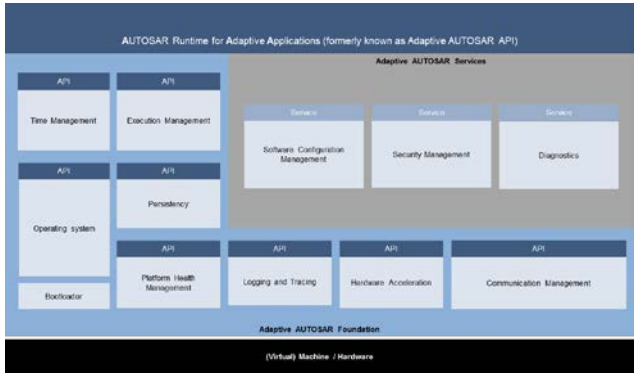
GENERIC PART
STDDIAG

CLASSIC AUTOSAR ADAPTER
STDDIAG



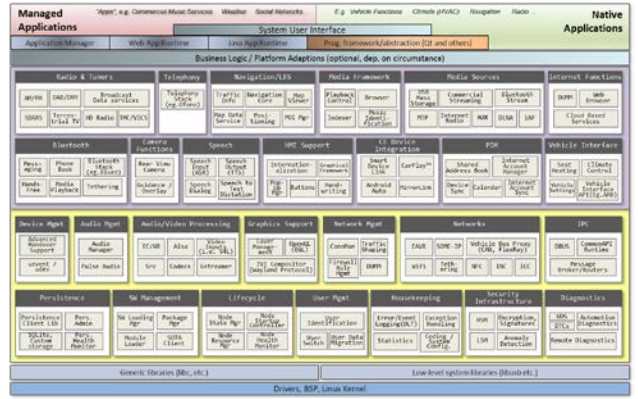
Application Mode BAC 4 SP2021

ADAPTIVE AUTOSAR ADAPTER
STDDIAG



ABAC SP2021

GENIVI ADAPTER
STDDIAG



GenIVI in MGU in 2022

MAIN BENEFITS OF SAFETY CONCEPT FOR AUTONOMOUS DRIVING.

Benefits of collaboration on safety concept

Automotive grade safety concept and transparent implementation approach for partners and regulators.

Maximizing **availability** of **AD feature** in diverse traffic environments of different regions of the world.

Functional safety for AD features

Increased flexibility to integrate and combine **any** ASIL B platform software

Underlying concept

White box development and shared code basis.

Permanent analysis and validation of the planned driving actions.

Combining LIDAR, RADAR and camera to achieve maximum advantages by the following multi sensor fusion.

Minimization of common cause failures through hardware and software diversity.

Hardware, Software and Map agnostic approach.

THANK YOU FOR YOUR ATTENTION.
LOOKING FORWARD ON YOUR FEEDBACK AND QUESTIONS.