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

Leading Technology Partners

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

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

Leading Integration Partners

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

Resources

- Product Focus
- Market Relevance
- State of the Art Concept
- Team
- Technology
- Resources
A scalable, safe and 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.

- **FAD**
  - Ultra sonic
  - Cams parking
  - Cams
  - Front+rear
  - Lidar Front
  - Side radars
  - Rear radars
  - Cams side
  - Lidar Side/Rear

- **HAD**
  - Side radars
  - Front radar
  - Cam front
  - Driver cam
  - Rear radars

- **ADAS**
  - Side radars
  - Front radar

- **Navigation**
  - Cam front

- **ECU**
  - HD Map

- **Telematics**
  - ECU

- **Computer Vision**
  - Cams side
  - Cams

- **Motion Control**
  - EgoMotion

- **Selector**
  - Trajectory Following Controller

- **Fusion**
  - Driving Policy
  - Grid + ML Fusion

- **Trajectory Following Controller**
  - L2 SW-stack is used as L3 fail degradation stack

- **Controller**
  - L2 SW-stack is used as L3 fail degradation stack

- **Backend for Customer Cars incl. HD Map**

- **Development Backend incl. ML und Simulation**

- **Onboard**
  - Test fleet
  - Interface and toolchain

- **Offboard**
  - Backend for Customer Cars incl. HD Map

- **Vehicle dynamics integration platform**

- **Fail operadional**

- **Common SW-Stack**

- **OEM-specific SW**
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
FUNCTIONAL SAFETY FOCUS FOR HIGHWAY PILOT AND URBAN PILOT.

- 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
- Minimum risk maneuver
- Highway-Pilot and Urban Pilot details see next page

- Emergency stop assistant

- Road condition preview
  - Including hazard warning

ASIL D
ASIL B
ASIL C
ASIL QM
FUNCTIONAL SAFETY CONCEPT IS PREDICTIVE AND AGNOSTIC TO HARDWARE AND MAP. IT IS ADAPTABLE 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!
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.
## 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.