AUTOMOTIVE

FRANCISCO J. CAZORLA, JAUME ABELLA

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SAFETY-CRITICAL SYSTEMS

- Failure or malfunction may result in
  - Death or serious injury to people
  - Loss or severe damage to equipment/property
  - Environmental harm
- Exhaustive Verification and Validation (V&V) process to guarantee the safety goals are met
- Each domain has its own guidelines and regulations for SW and HW

DO178C

ISO26262

EN50126/8

AUTOMOTIVE DOMAIN

- High-performance needed but… within specific domain requirements
  - Reliability
    - Harsh operating conditions due to Electro-Magnetic Interference (EMI), humidity, vibration, etc.
  - Safety
    - Development process subject to functional safety standards
      - Design
      - Verification and validation
  - Security
    - Connectivity
    - Updates

AUTOMOTIVE COMPLIANT MCU

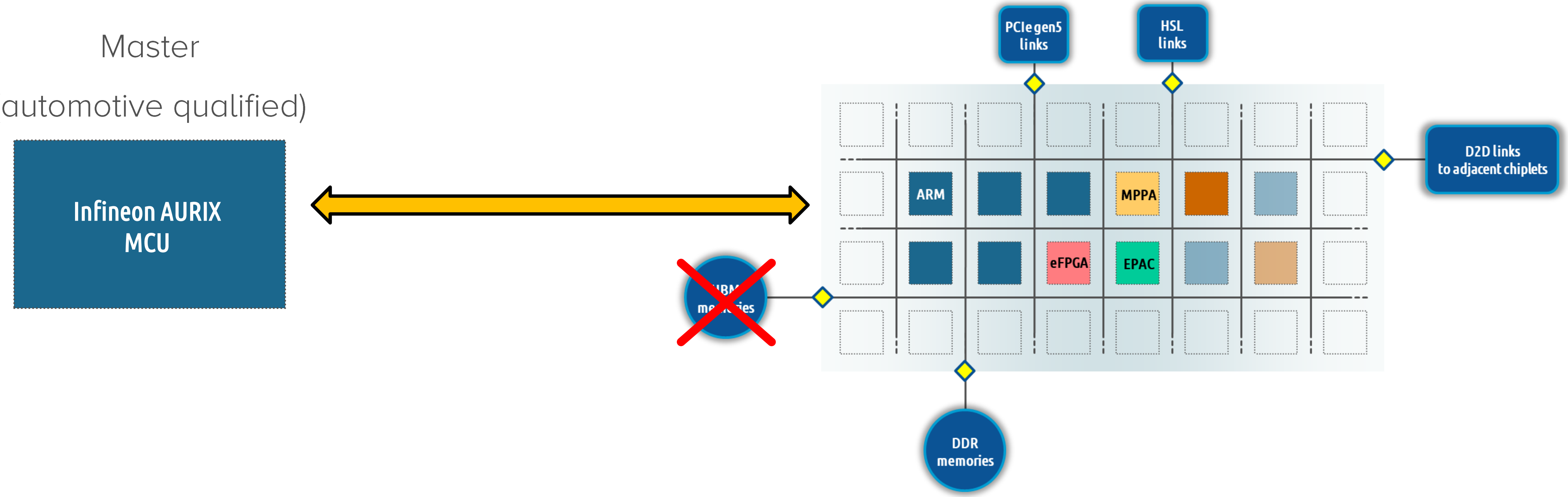
- Specifically designed to meet automotive requirements for any safety integrity level
  - E.g. Infineon AURIX processor family
- But insufficient performance for some ADAS and AD applications
  - ADAS: Advanced Driver Assistance System
  - AD: Autonomous Driving
- GPP can deliver performance needed
  - … but must also meet automotive requirements

THE EPI APPROACH: EMBEDDED HPC ARCHITECTURE

Master

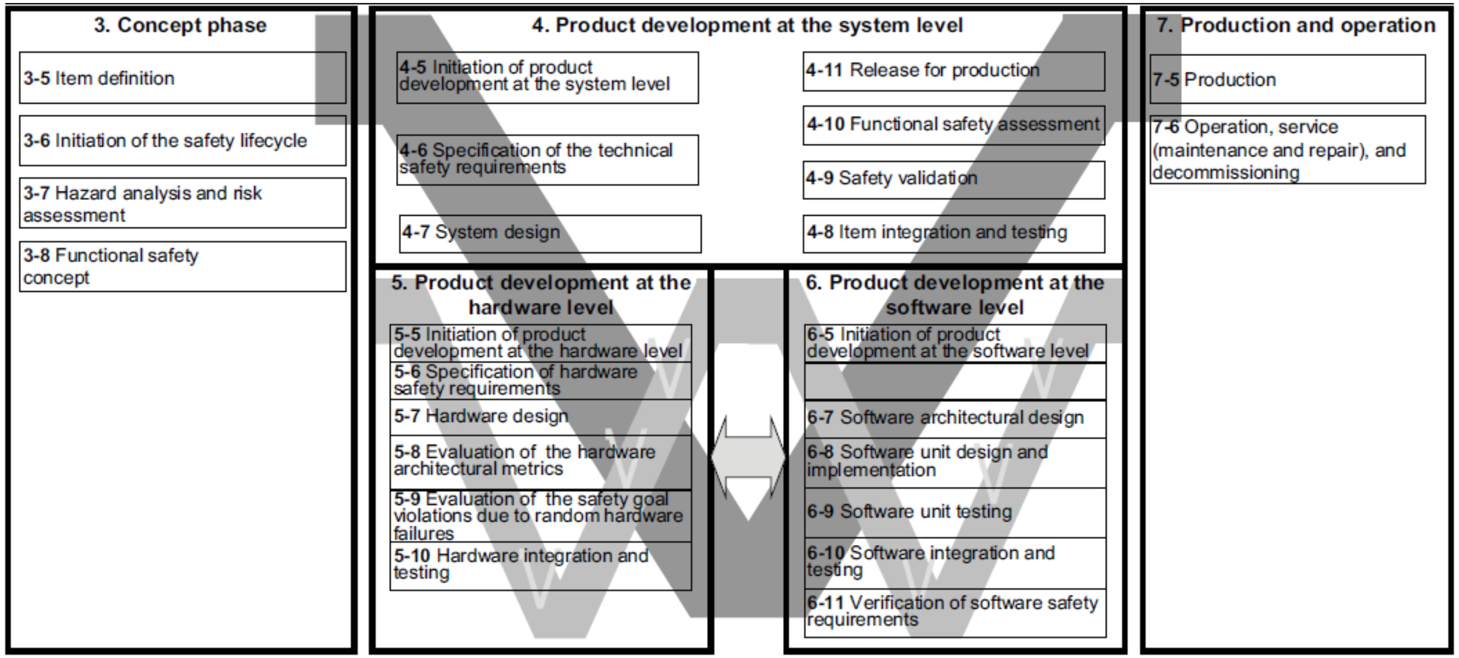
(automotive qualified)

Slave



SAFETY LIFECYCLE (ISO26262)

- Safety lifecycle intended for items designed to offer appropriate safety measures
  - Observability, controllability, diverse redundancy, watchdogs, etc
- GPP is, by nature, against some of these requirements
  - Target: average case, not worst case
  - Few safety measures
- Fitting automotive safety lifecycles is a complex challenge



3. Concept phase

3-5 Item definition

3-6 Initiation of the safety lifecycle

3-7 Hazard analysis and risk assessment

3-8 Functional safety concept

4. Product development at the system level

4-5 Initiation of product development at the system level

4-6 Specification of the technical safety requirements

4-7 System design

4-11 Release for production

4-10 Functional safety assessment

4-9 Safety validation

4-8 Item integration and testing

5. Product development at the hardware level

5-5 Initiation of product development at the hardware level

5-6 Specification of hardware safety requirements

5-7 Hardware design

5-8 Evaluation of the hardware architectural metrics

5-9 Evaluation of the safety goal violations due to random hardware failures

5-10 Hardware integration and testing

6. Product development at the software level

6-5 Initiation of product development at the software level

6-7 Software architectural design

6-8 Software unit design and implementation

6-9 Software unit testing

6-10 Software integration and testing

6-11 Verification of software safety requirements

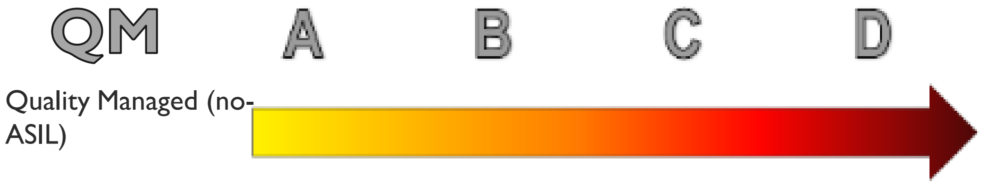
7. Production and operation

7-5 Production

7-6 Operation, service (maintenance and repair), and decommissioning

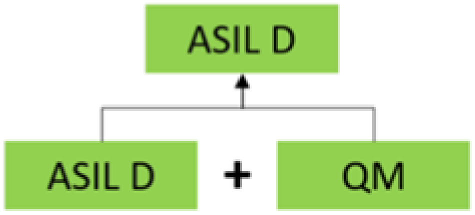
AUTOMOTIVE SAFETY REGULATIONS: ISO26262 AND SOTIF

- Functionalities are classified in different Automotive Safety Integrity Levels (ASIL) based on:
  - Severity
  - Exposure
  - Controllability upon failure
- Higher levels implies stricter design and V&V process
  - Increase costs
  - More difficult to achieve



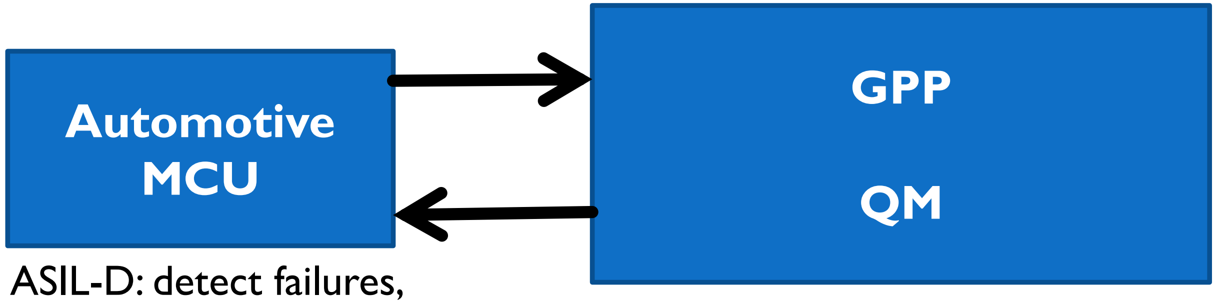
REQUIREMENTS FOR ADAS

- An ADAS unavailable system is a safe system
  - No fault tolerance needed
  - Just detect faults and reach a safe state timely
- ASIL-D MCU monitoring QM GPP
  - No safety requirements for GPP



✓ Fail-safe

✗ Fail-operational

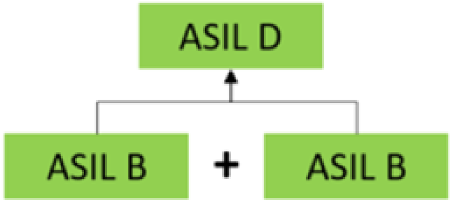


ASIL-D: detect failures, transfer control to the driver (e.g. lane detection)

QM: can be switched off upon a failure

REQUIREMENTS FOR AD

- An AD system must remain always available
  - Fault tolerance needed (no safe state!!)
  - Detect and recover from faults timely
- GPP must also reach ASIL-D (potentially with some help of the MCU)

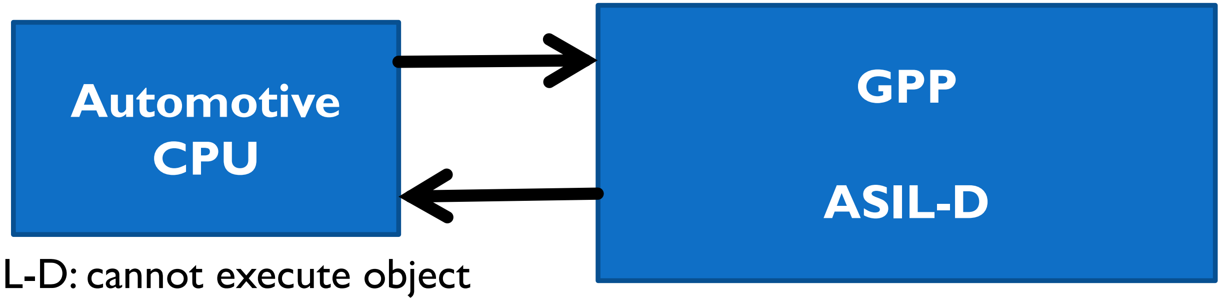


ASIL D

ASIL B + ASIL B

✓ Fail-safe

✓ Fail-operational



Automotive CPU

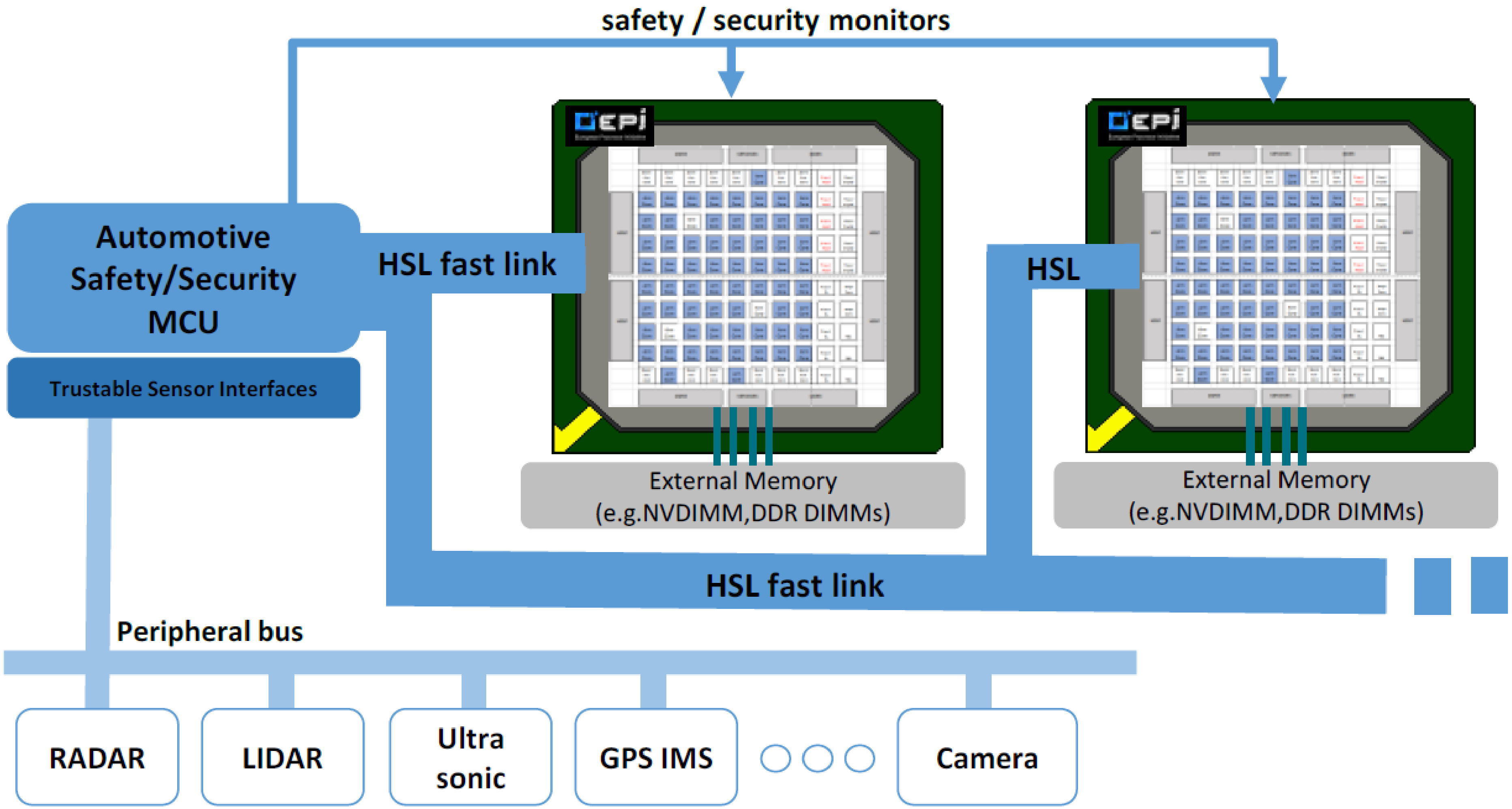
GPP

ASIL-D

ASIL-D: cannot execute object detection (too much performance needed)

ASIL-D: no driver to transfer control, must be fault-tolerant

AUTOMOTIVE EPI ARCHITECTURE DETAILS


safety / security monitors
Automotive Safety/Security MCU
Trustable Sensor Interfaces
HSL fast link
HSL
External Memory (e.g.NVDIMM,DDR DIMMs)
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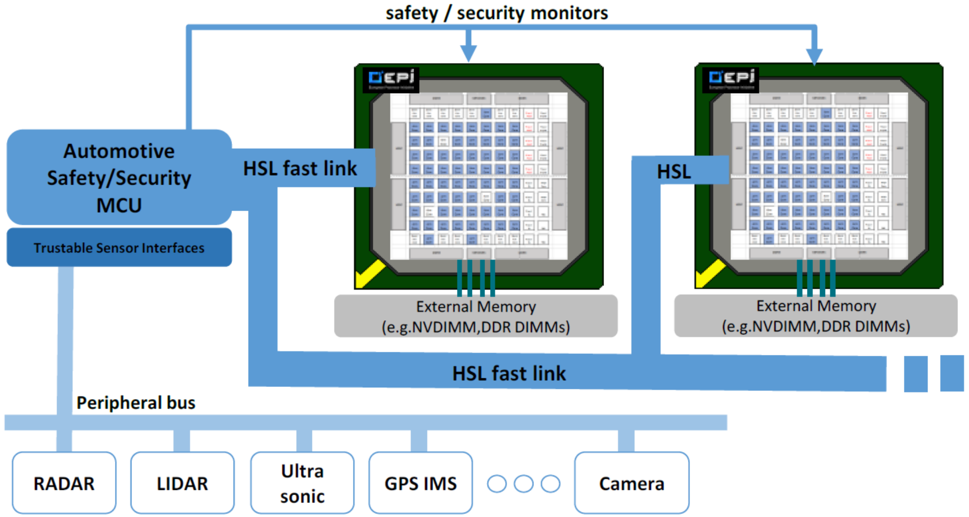
HSL fast link
Peripheral bus
RADAR
LIDAR
Ultra sonic
GPS IMS
○○○
Camera

AUTOMOTIVE EPI ARCHITECTURE DETAILS

- Preferably a single GPP
  - As for automotive MCUs due to efficiency, reliability,…
- I/O managed by the MCU
  - As in today's systems
- Performance-demanding functionalities offloaded onto the GPP
  - Build upon interfaces compliant with auto reliability requirements
- MCU monitors execution in the GPP
  - No safety or security violations
  - E.g. no resource flooding, no resource overutilization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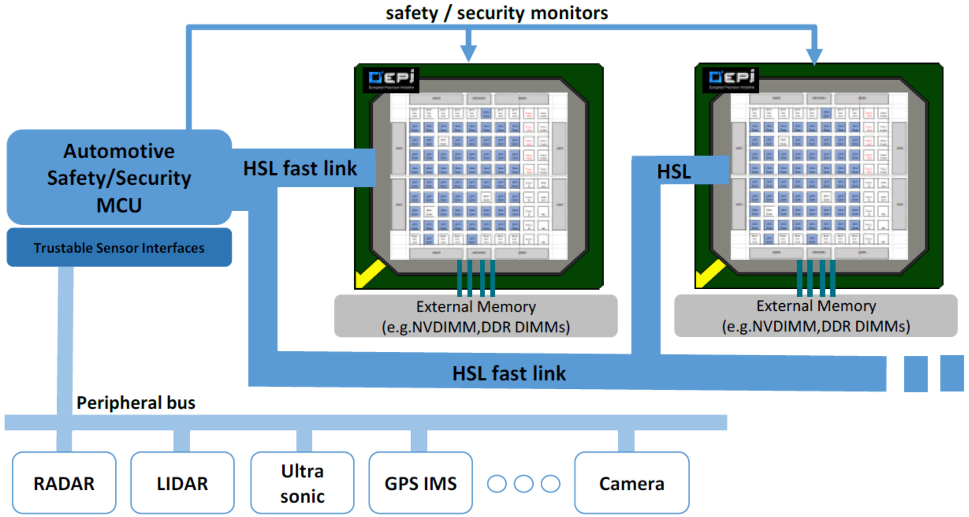
AUTOMOTIVE EPI SOFTWARE STACK

- Build upon AUTOSAR (AUTomotive Open System ARchitecture)
  - Standardized SW architecture
  - Defines interfaces, architecture of apps (SW components, runnables, tasks), diagnosis mechanisms
- MCU with classic AUTOSAR
  - Well stablished practice
  - Legacy SW, any app with sufficient performance in the MCU
- GPP with Adaptive AUTOSAR
  - Scale up to the challenge of complex platforms
  - High-performance CPU
  - Advanced communication with environment
  - Etc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CHALLENGES AHEAD

- Meet automotive requirements preserving performance
  - A single design meeting the requirements of HPC and automotive markets
- Reliability in harsh environments
  - Only reliable components implemented with reliable technology processes
- Sufficient degree of observability and controllability
  - MCU monitors GPP, and must detect faults quickly
  - MCU must have means to take corrective actions on the GPP to preserve fault tolerance
- Deliver performance needed for AD with fault tolerance
  - No safe state
  - HW design must meet not yet fully understood requirements of complex and changing SW systems

QUESTIONS?