# Next-Generation Diagnostics for HPC-based Connected Vehicles

Automotive

Autos, Hybridfahrzeuge und Elektroautos

Landmaschinen

Selbstfahrende und gezogene Maschinen

Nutzfahrzeuge

Transporter, Busse und Lastkraftwagen

# The vehicle is being re-invented

Service / Remote Diagnostics

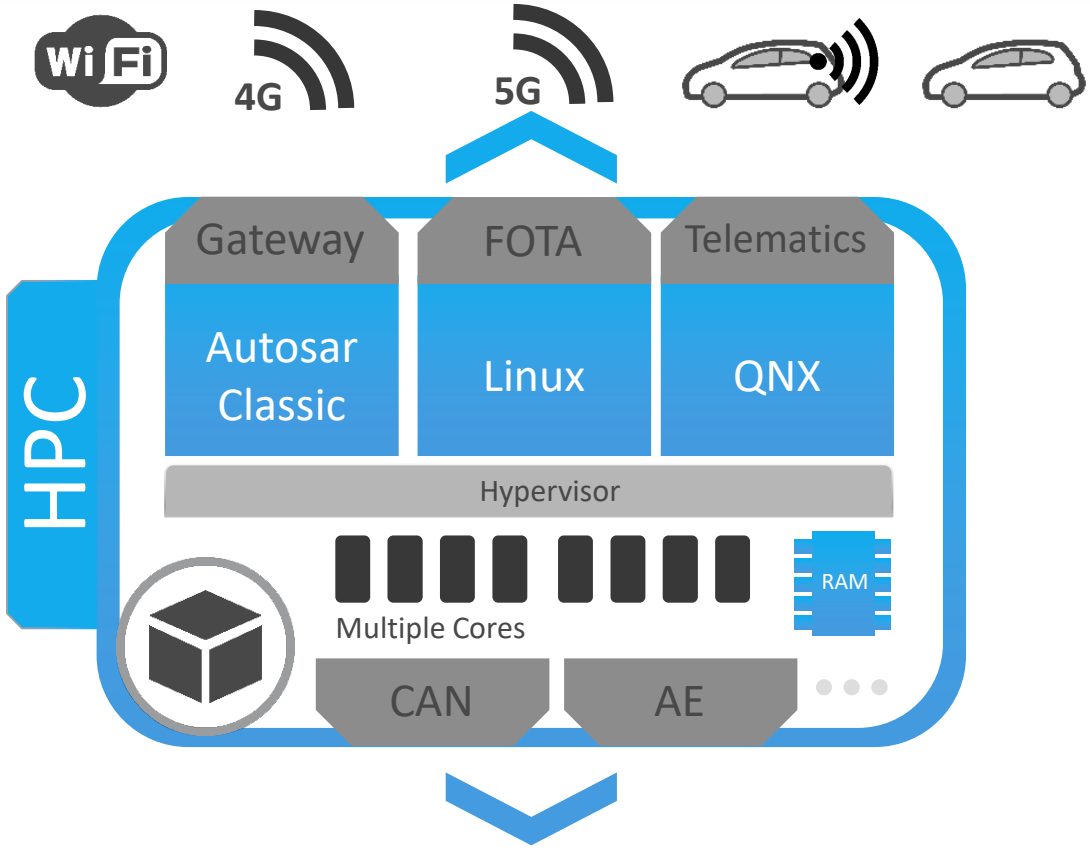
Autonomous Driving

E-Call

User Experience

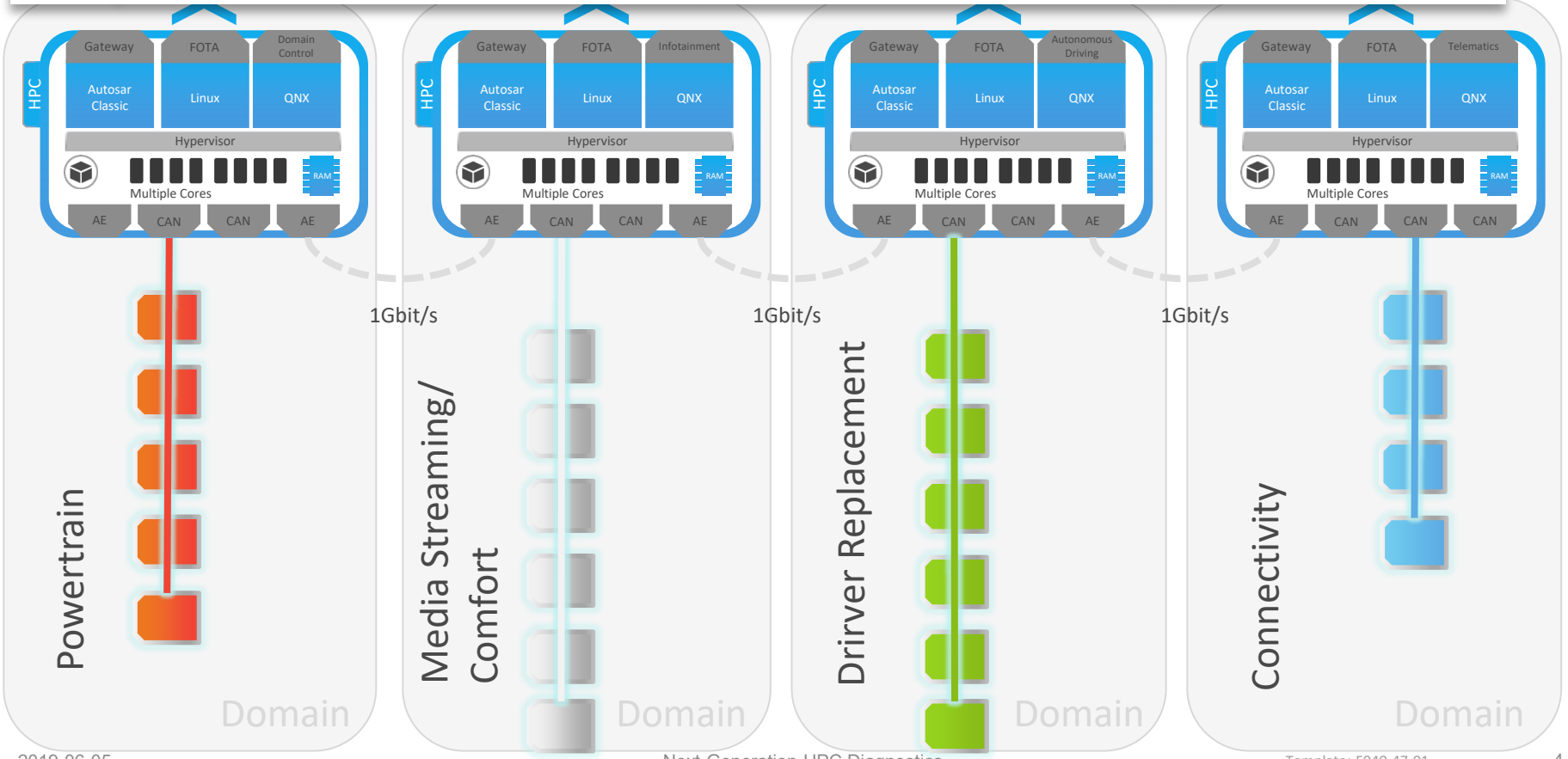
FOTA

# Extension of the vehicle with HPCs*




*High-Performance Computer

# Multiple HPCs as domain controllers, connected via Automotive Ethernet



# ECU vs. HPC

## Electronic Control Units

Traditional open- and closed-loop control functions

Master of sensors and actuators

| | |
|---|---|
| Processor | 1 Core, 32 bit, 300 Mhz |
| Memory | 512 KB RAM<br>128 KB Data Flash<br>4 MB Program Flash |
| Network | Ethernet (10/100 BaseT)<br>FlexRay, 4xCAN |
| OS | OSEK, AUTOSAR classic |

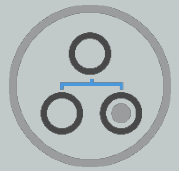
**VS.**

## HPC (High-Performance Computer, MPSoC)

Complex, computing- and data-intensive Tasks (e.g. Autonomous Driving), Sensor data fusion, Image Processing, AI, neuronal networks

| | |
|---|---|
| Prozessor | 4 to 12 Cores, RISC, DSP, Security |
| Speicher | 8-16 GB RAM<br>>100 GB Flash |
| Network | Ethernet (100BASE-T1, 1000BASE-T1),<br>4G / (5G),<br>WiFi, 4xCAN(-FD) |
| OS | Adaptive AUTOSAR, Linux, QNX |

# Network Technologies

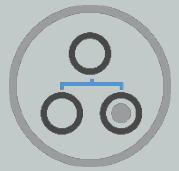


## CAN-Bus (ISO 11898)

Signal Exchange between ECUs, Diagnostic and Reprogramming Communication

| | |
|---|---|
| Cabling | Twisted Pair |
| Bandwidth | 1 Mbit/s |
| Payload | 8 Byte per Frame |
| Layer | Physical & Data Link (1 & 2) |

**VS.**



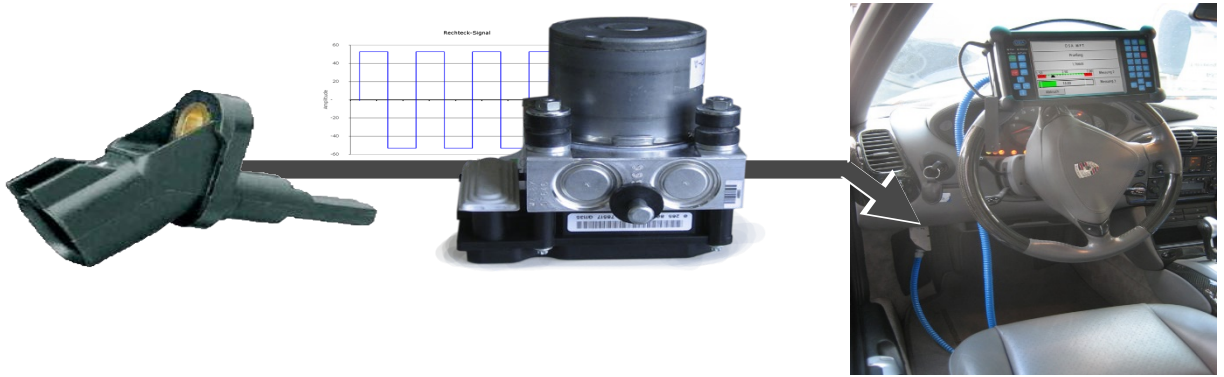
## Automotive Ethernet (IEEE 100(0)BASE-T1)

Data Exchange between HPCs (Image data, Radar data, Computation results), media streaming, UI

| | |
|---|---|
| Cabling | Twisted Pair, Cat6 Kabel |
| Bandwidth | 100 Mbit/s (1000 Mbit/s) |
| Payload | 64 bis 1518 Byte (like 802.3 Ethernet) |
| Layer | 1 & 2 |

# Today‘s Diagnostics (1)

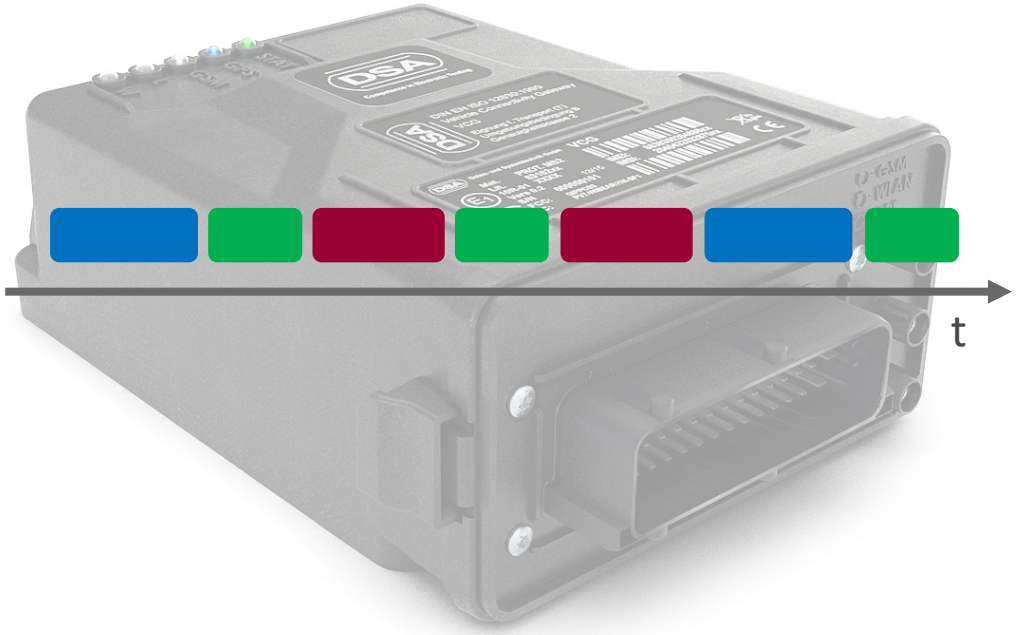
- Allows diagnosis of the **electronics** of a mechatronic system
  - Errors of sensors or their circuits
  - Errors of actuators or their circuits
  - Errors in the bus communication



# Todays‘s Diagnostics (2) – Core Services / UDS

| | |
|---|---|
| ReadDTCInformation | Requesting results of ECU self diagnosis of connected circuits and the bus communication / Requesting historical sensor data as environment data (freeze frames) |
| ReadDataByIdentifier | Requesting current values of sensors / static values of ECUs |
| InputOutputControl ByIdentifier | Excecution of actuator tests and tests of actuator circuits |

# ECU Software

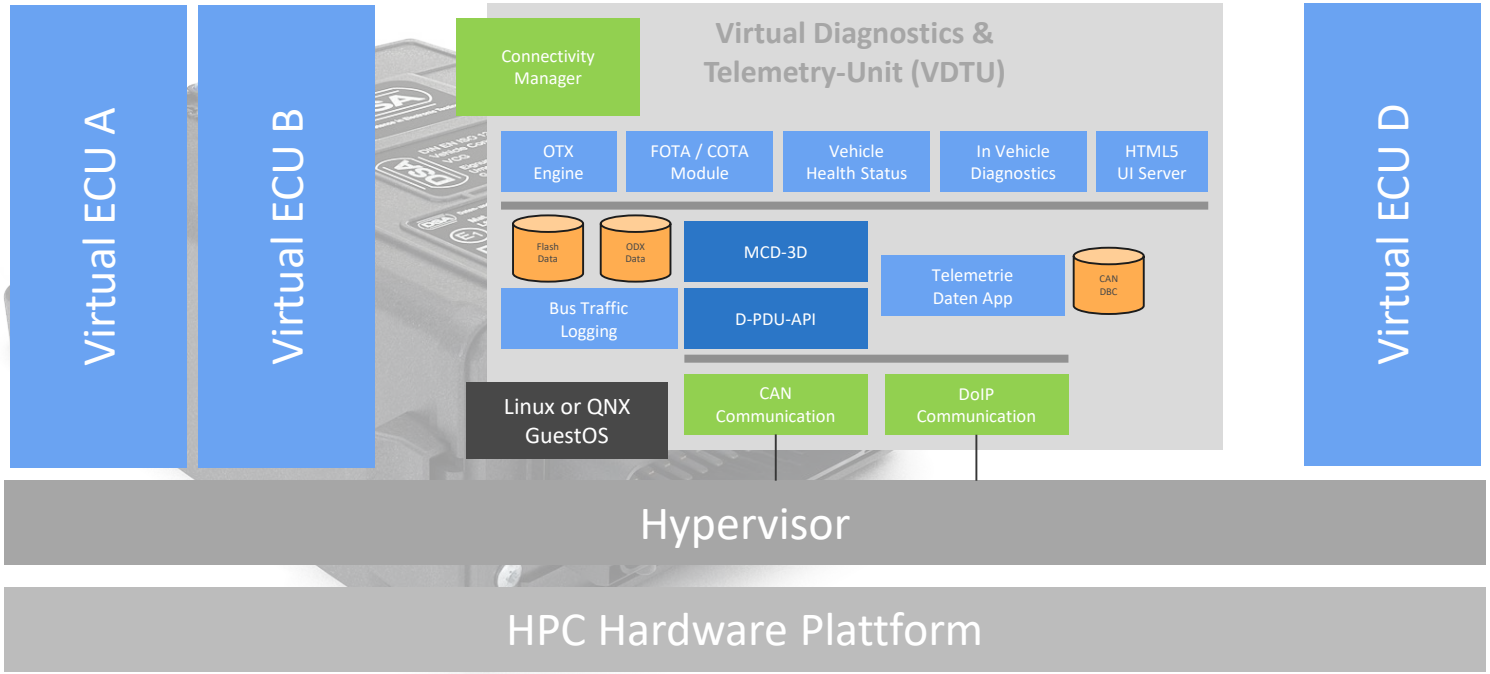



ECU Software is statically scheduled (time sliced Tasks)

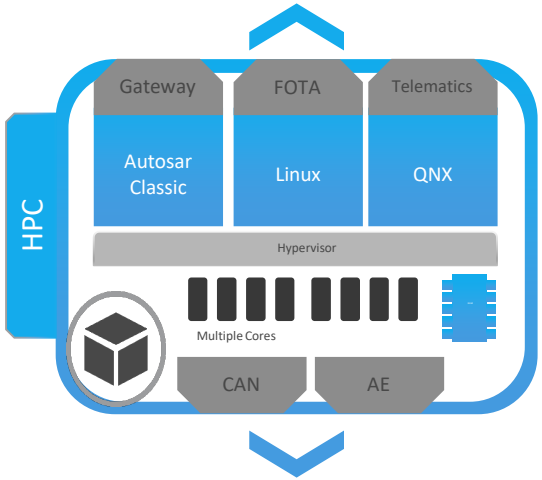
Most Tasks are control functions

Tasks are considered „perfect“ wrt. Diagnostics

# In contrast: HPC Software



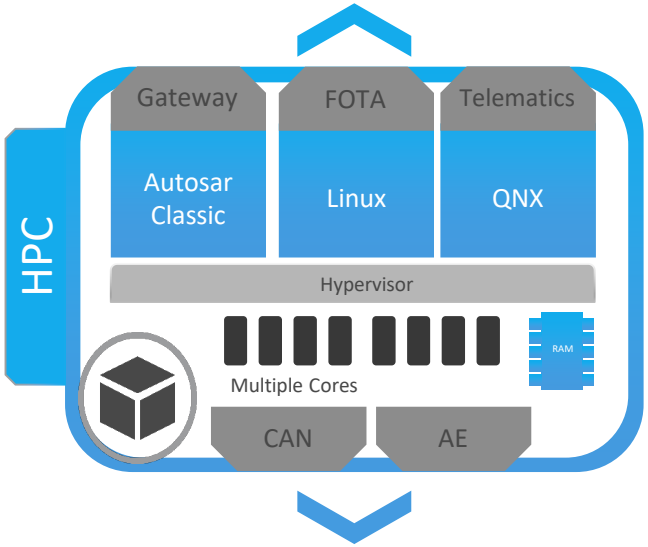
# HPC is a „new world“ from a diagnostics perspective




„resembles“

- Virtual Machines
- Guest Operating Systems
- Parallel Processes
- High Availability Requirements
- Multi-/Many-Core Systems (MPSoC)

# UDS is not sufficient to fully diagnose HPCs




Possibility to make use of modern communication Technology for Use Cases like
Diagnostics, Flash-Update, Variant Coding etc.

Microservices, JSON, Some/IP, REST, Cloud, …

⇒ Analysis / Diagnosis of multi-threaded Systems
⇒ Similar to Analysis / Diagnosis in large IT centers

VS.

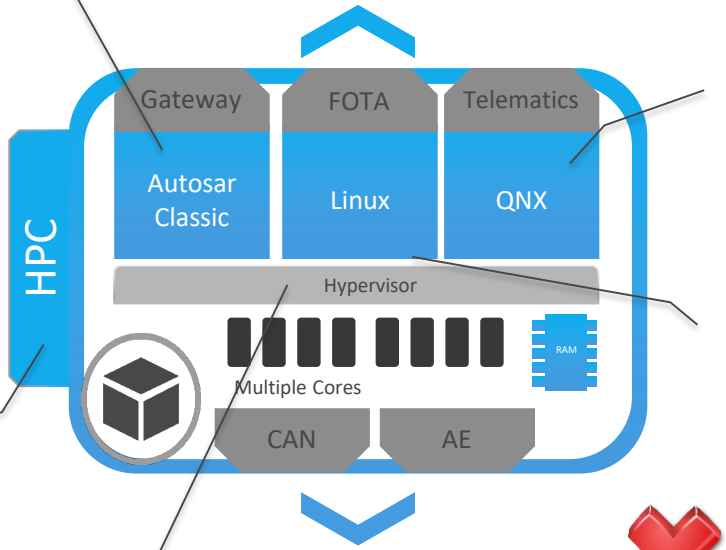
```
0x00000710 03 22 f1 88 aa aa aa aa
```

Today‘s Diagnostics analyse the electronic system under the assumption that the software of an ECU has no bugs.

# Diagnostics of HPCs

UDS sufficient to diagnose the „classic“ guest ECU(s)

UDS not sufficient to diagnose complex, simultaneous software processes (AI-Engine, Connected Functions, ADAS, Sensor Fusion)




UDS sufficient to diagnose all electronics (e.g. sensors) connected to the HPC

UDS not sufficient to flash reprogram HPC or guest ECUs

UDS not sufficient to diagnose the complete HPC


Firmware Over-The-Air
Life Cycle Management
Remote Diagnostics
Customer Binding
D - SA 1980
BUT

# Today‘s legislation relies on OBD

- EUR 5/6 / CARB
  - Emissions Regulation
  - Market Regulation for independent after market
- Legislation for periodical technical inspection in Europe
  - Check of safety-relevant electronics within the vehicle

- BUT: Today‘s vehicles are connected.

⇒ New concepts and business models are being defined

⇒ A new standard has to create options beyond OBD

# Important concepts for a New Diagnostic Standard

- Standardization Efforts today focus on a specific usage scenario
- However, at minimum, 3 usage scenarios have to be supported by a future standard:

On-Board

Proximity

Remote

# On-board Diagnostics

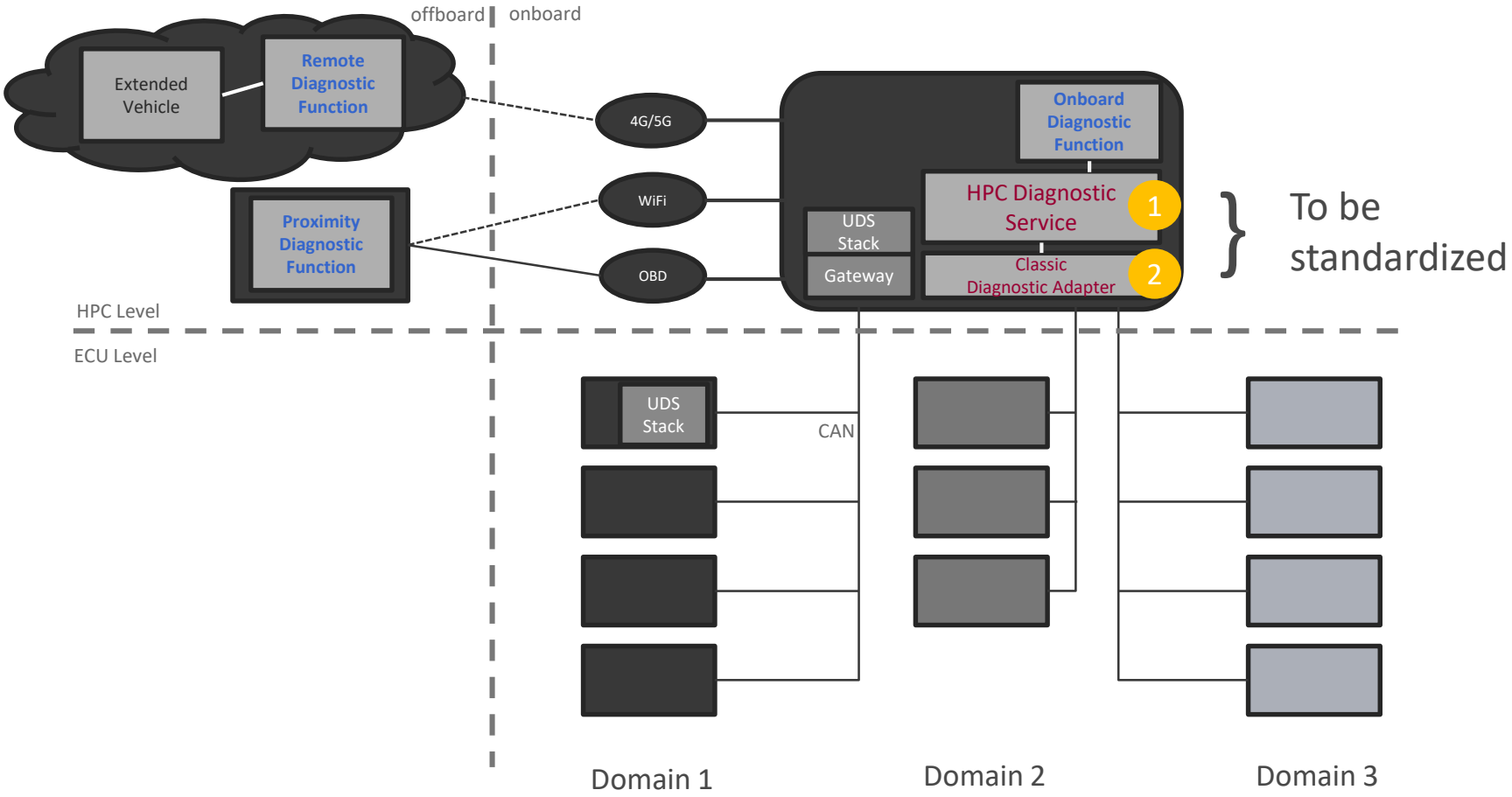
- Implementation of on-board monitors
  - Monitoring of critical components
  - Preventive/Predictive maintenance monitors
- Implementation of fleet-monitoring scenarios
  - Assembling vehicle status information periodically
  - Assess health-status of free-floating vehicle fleets

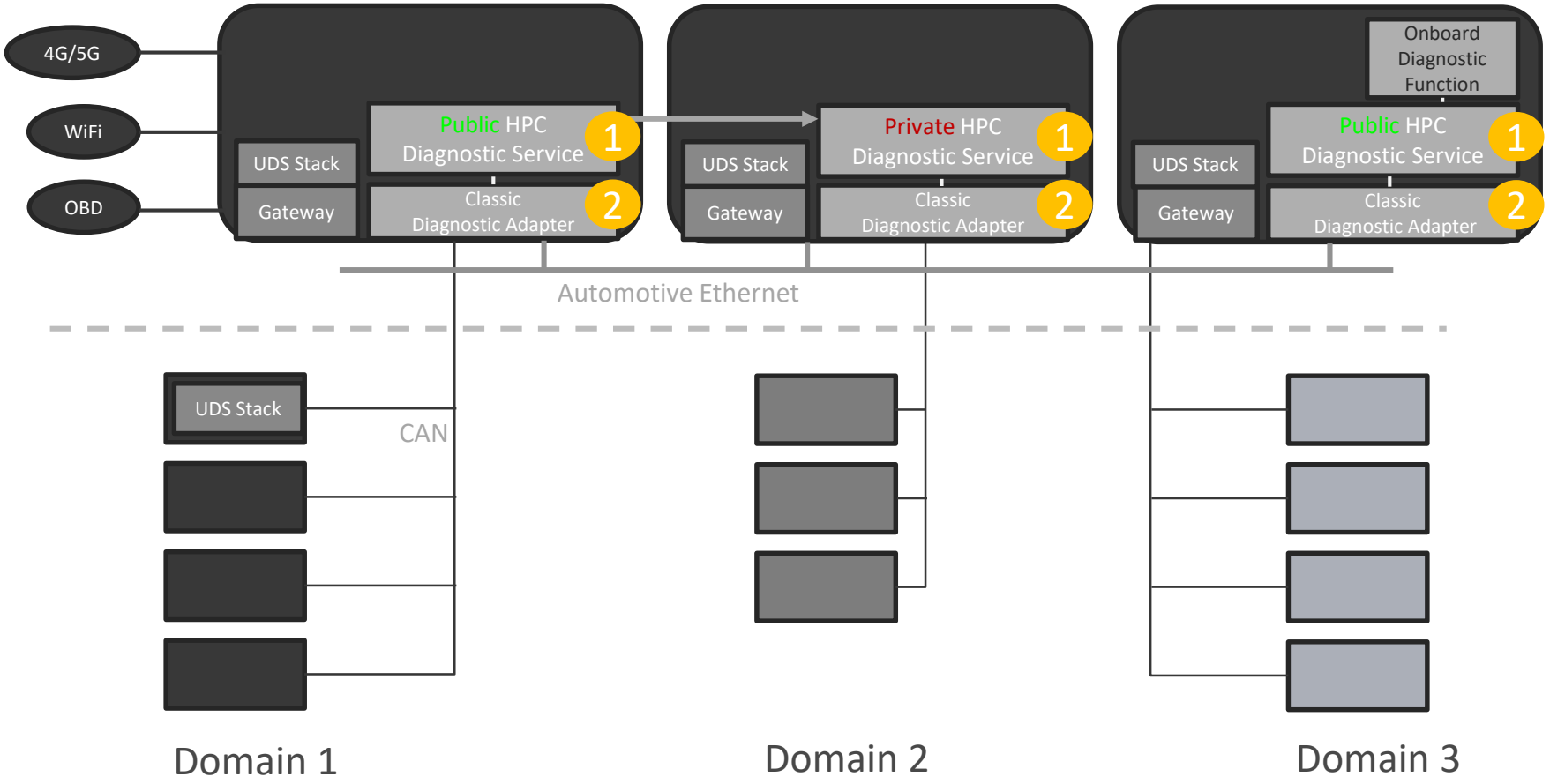
# Proximity Diagnostics

- Workshop / Service Bay vehicle check
- Road-side assistance with service-technician at vehicle location
- Emissions check
- Vehicle manufacturing
- Vehicle engineering

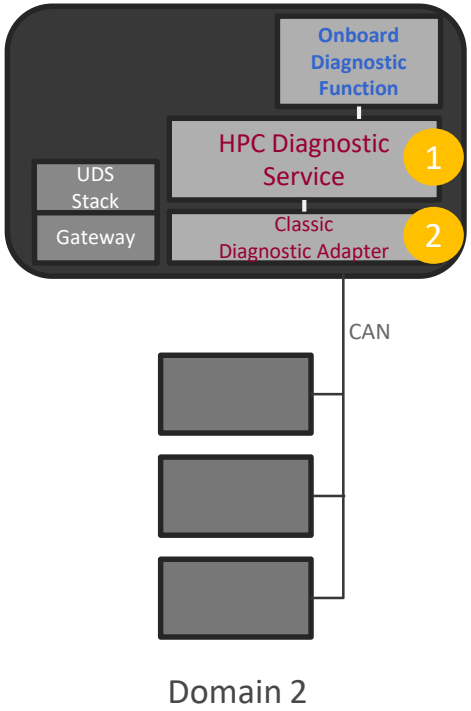
# Remote diagnostics (Over-the-air)

- Remote Service by central help desk
- Service technician preparing for vehicle expected in the workshop
- Remote Assistance by service technician on customer request
- Remote road-side assistance
- Remote activation / de-activation of vehicle functions
- Fleet managment


offboard
onboard
Extended Vehicle
Remote Diagnostic Function
Proximity Diagnostic Function
4G/5G
WiFi
OBD
Onboard Diagnostic Function
HPC Diagnostic Service
1
UDS Stack
Gateway
Classic Diagnostic Adapter
2
To be standardized
HPC Level
ECU Level
UDS Stack
CAN
Domain 1
Domain 2
Domain 3


4G/5G
WiFi
OBD
UDS Stack
Gateway
Public HPC
Diagnostic Service
1
Classic
Diagnostic Adapter
2
UDS Stack
Gateway
Private HPC
Diagnostic Service
1
Classic
Diagnostic Adapter
2
Onboard
Diagnostic
Function
UDS Stack
Gateway
Public HPC
Diagnostic Service
1
Classic
Diagnostic Adapter
2
Automotive Ethernet
UDS Stack
CAN
Domain 1
Domain 2
Domain 3

# Core Aspect (1): Communication Paradigms

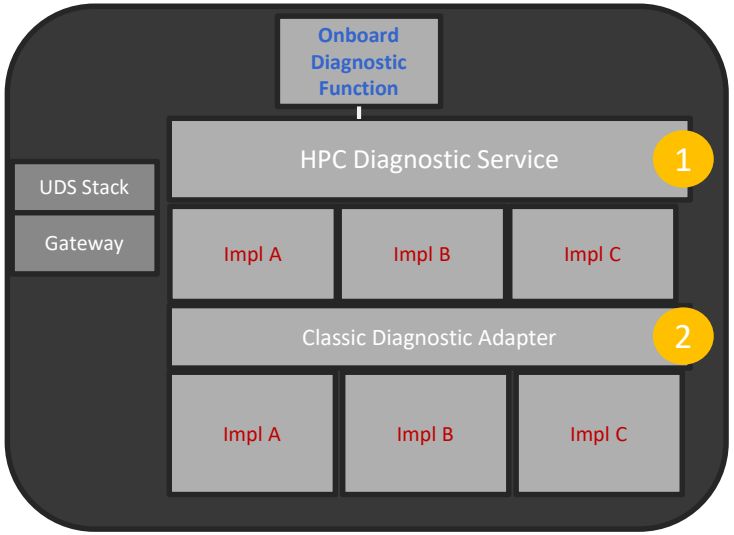



Stateless service-oriented interface

Stateful communication

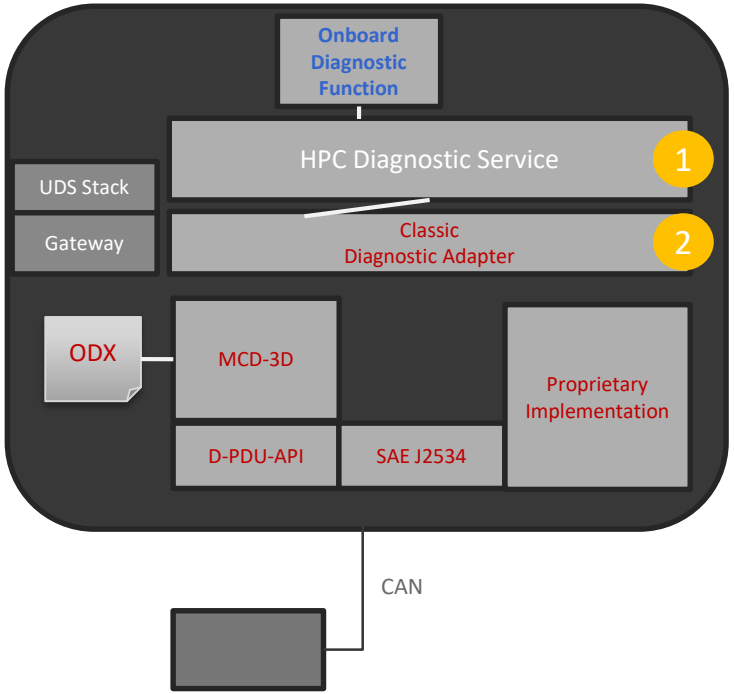
=> Classic Diagnostic Adapter needs to maintain state!

# Core Aspect (2): Standardize Interfaces!




- Same interface, many possible implementations

# Core Aspect (3): Compatibility with other (ASAM) standards




- It should be possible to implement the Classic Diagnostic Adapter on top of a MCD-3D based diagnostic stack
- However, it should not be a mandatory requirement to do so

# Core Aspect (4): No invention of base technology

- Focus every interface on a requirement and/or use case it helps to fulfil
- Define (service) interfaces and their data structures
- Do not invent (base) technology
  - Evaluate and select best-in-class existing technology on basis of best-fit assessment

# Core Aspect (5): Diagnose Software

- New standard requires capabilities to diagnose behavior of software
  - Threading / Deadlocks / Race Conditions
  - Watchdog / Watchdog Status / Watchdog Activity
  - Performance / Load / Memory Footprint / Network Load / Latency
  - Log Files / Post Mortem Analysis

- Remark: Software diagnosis is not meant for the service technician / worker, but for expert analysis

# Suggestion: SOHD has three parts

Part 1: Use Case and Requirement Description

Part 2: Classic Diagnostic Adapter Interface

Part 3: HPC Diagnostic Service Interface

Parallel ISO standardization will be launched as soon as consistent concept for New Work Item Proposal exists

# SOHD

## **S**ervice-**O**riented **H**PC **D**iagnostics


DSA
DSA
Daten- und Systemtechnik GmbH
Pascalstraße 28
D-52076 Aachen
www.dsa.de
Telefon: +49 (0) 2408-9492-0
Telefax: +49 (0) 2408-9492-92
E-Mail: sales@dsa.de