A byte future

Software-based solutions are reshaping automotive electronics and architecture.
Integrated third-party services

Over-the-air updates

Partially cloud-based operation

Connectivity
Electrification

New electronics

Advanced algorithms to reduce energy consumption
Autonomous driving

- Need for unlimited reliability
- Higher demand for computing power and communication
- Built-in sensors and actuators
Diverse mobility

Shared mobility services and robotaxis

Customized driver experience
OEMs enter partnership to standardize vehicle architecture.

New regulations require OEMs to provide third-party interface.

5G Mobile networks are widely available around the world.

Requirements call for redundant implementation of safety-critical functions in vehicles.

Alibaba announces own open-source vehicle stack.

Regulatory changes facilitate use of OTA updates.

2030
Architecture

Expanded middleware layer to abstract applications from hardware
Limited number of architecture stacks with integrated hardware and software
ECU consolidation

Data capabilities

Data connectivity for entertainment and HAD channeled via the OEM; more open interfaces in infotainment
Increasing use of cloud to combine in-vehicle data with environmental data
Updatable components that communicate bidirectionally

Sensors

More intelligent sensors
Significant spike in the number of in-vehicle sensors in the medium term

Power and data networks

Rise of the automotive Ethernet
Fully redundant power and data networks
Evolving E/E architecture

1st generation

2nd generation

3rd generation

4th generation

5th generation

Distributed E/E architecture

Domain centralized E/E architecture

Vehicle centralized E/E architecture

Today

Outlook

Body/comfort  Chassis  Power-train

Central GW

Domain controller

Infotainment

Sensor  Gateway

Actuator
Event-driven

Time-driven

Time- and event-driven

Cloud-based (off-board stack)

Event-driven
L3 automation

- Radar
- GNNS
- Cameras
- LiDAR
- Ultrasound

L4 automation

- Radar
- GNNS
- Cameras
- LiDAR
- Ultrasound
- Infrared camera
Sensing
Preprocessing
Object recognition and feature extraction
Sensor fusion
Drive policy
Control
Preprocessing
Sensing
Sensing

Preprocessing

Object recognition and feature extraction

Sensor fusion

Drive policy

Control

Central ECU/
domain control

Centralized processing
Sensing, Preprocessing, Object recognition and feature extraction, Sensor fusion, Drive policy, Central ECU/domain control, Control, Sensors, Distributed processing, Preprocessing, Sensing
Sensing

Preprocessing

Object recognition and feature extraction

Sensor fusion

Control

Drive policy

Central ECU/ domain control

Sensors

Extent of shift to sensor-based processing depends on:

- Price of data transmission
- Price of computing power
- Advances in sensor technology
- Degree of vehicle automation
Existing power and data networks

Challenges

- Stringent safety requirements for HAD (e.g., redundancy)
- Diagnostics and self-protection mechanisms
- Need for more electrical power
New flexible, smart approaches to power and data networks

Ring topology
Modular power distribution units
Switched Ethernet
Ethernet AVB and TSN
- OEMs
- Tier-1/car electronics system suppliers
- Semiconductor suppliers
- Computing and connectivity players
- Software giants and tech players
Capture market opportunities resulting from the increasing need for smart sensors, complexity increase of ECU consolidation and the demand for Software solutions

— co-developing solutions closely with automotive OEMs, tier-1 and tier-2 suppliers

building up

— dedicated software capabilities to complement hardware products
But remember

Speed is crucial
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**Speed is crucial**

| 1. Partnerships along the value chain are useful to get access and to gain a deeper understanding of the automotive industry |
| 2. Solutions should be standardized across platforms onboard and offboard. |
| 3. The transition to Centralized Control Units CCUs offers potential for differentiation at higher stack levels |
Rethinking car software and electronics architecture

By Daniel Kraft, Johannes Dedeurwaerdere, Georg Duck, and Christian Waechterhofer

As the car continues its transition from a hardware-driven machine to a software-driven electronics device, the auto industry’s competitive rules are being rewritten.

The engine was the technology and engineering core of the 20th-century automobile. Today, software, large computing power, and advanced sensors increasingly step into that role; they enable most modern innovations, from efficiency to connectivity to autonomous driving to electrification and more.