Solution Brief

Intel® Architecture for Software-Defined Vehicles

intel automotive

The Road to Software-Defined Vehicle Transformation Is Here

The transformation to software-defined vehicles (SDVs) is redefining how vehicles go to market. Intel provides the fast and open path automakers need.

New vehicles each require more than 100 ECUs and over a mile of cable.

The automotive industry is in the midst of a major shift. Automakers, automotive solution developers, private owners, and fleet supervisors all want vehicles that can do more with systems that are easier to manage. Everyone also wants vehicles that are faster to develop, easier to scale, and that have the capability to evolve over time to improve performance and deliver new experiences.

Traditional automotive architecture relies on discrete devices with proprietary software. This limits innovation and customer appeal. The software defined vehicle (SDV) addresses this challenge by running automotive workloads as software on a powerful central compute platform. Intel has a new solution for SDV development that not only makes vehicles easier to develop, but easier to manage as well: the Intel® Automotive system-on-chip (SoC) platform.

Challenge: The limits of distributed microcontroller architecture

The level of technology available on today's automobiles has grown steadily. However, the vehicles we drive today aren't much different than those made a half century ago in terms of how they integrate technology and features.

The automotive industry relies on networks of electronic control units (ECUs) within a vehicle to deliver features. Adding a feature such as power windows or air conditioning means adding another box with a microcontroller and the associated cabling. This has led to new vehicles each being laden with more than 100 ECUs and over a mile of copper cabling to connect them all. The wiring harness alone can exceed 150 pounds.

Automotive ECUs are often built on outdated 90nm technology and are connected via buses built on a similarly outdated architecture. These closed solutions offer slow speeds of 8 to 10 Mbps, and even the most capable vehicle buses max out at 100 Mbps, which is far exceeded by a typical laptop.

Relying on ECUs has also created major production headaches for automakers. Most of these devices are produced in a single market and shifts in production have led to vehicles sitting unfinished in the factory due to backorders. ECUs are also purpose-built for a single task and can't be reused or repurposed. Their closed architecture and lack of standardization also makes it more challenging to integrate cloud connectivity into vehicles.

The distributed microcontroller-based architecture is no longer sustainable technologically or economically. There is simply no more room inside the vehicle to continue adding or improving features. But more importantly, the complexity and lack of standardization of these systems limits scalability and prevents vehicles from evolving.

Key benefits for the Intel® architecture for SDV solutions

- Simplifies board design and software development with a power-efficient, compact form factor
- Offers an open ecosystem for solutions and partners
- Supports a diverse array of high-intensity automotive workloads with extensive compute headroom
- Offers built-in AI acceleration for advanced automotive use cases
- Easily modifiable to generate distinctive, ownable automotive features

Solution: An SDV platform that's powerful, open, flexible, and scalable

Addressing the challenges created by legacy architecture requires a minor revolution in automotive design and manufacturing. Rather than employing individual devices to operate features, modern SDV architecture runs features as software applications on a single compute platform. Instead of an ECU managing the navigation and another for voice commands, vehicle systems run alongside other automotive workloads in virtualized environments on the CPU.

Intel provides a fast path for SDV transformation with the Intel Automotive SoC platform. By converging SDV workloads onto a single, performant, automotive-grade compute package, the Intel Automotive SoC platform greatly simplifies the complexity of the vehicle. This simplification enables fast deployment of new functions such as improved safety features, performance optimizations, content delivery systems, and personalized in-vehicle infotainment (IVI). Automakers also no longer need to update a network of discrete ECUs or proprietary compute devices to modify or integrate a feature.

SDV architecture helps vehicles appeal to younger car buyers. Here's what they're looking for:

- **Smart, connected tech:** The car should be able to integrate seamlessly with their smartphones and digital lives.
- **Personalization:** They want a car that can learn from their preferences and habits, with artificial intelligence (AI) capabilities that offer personalized suggestions and services. The car should also be able to capture their unique personality.
- **Eco-friendly performance:** The car should be optimized for high fuel efficiency and low emissions.
- **Comfort and convenience:** Digital experiences such as voice control, engaging in-vehicle infotainment, gaming, and streaming video content for passengers make the difference.

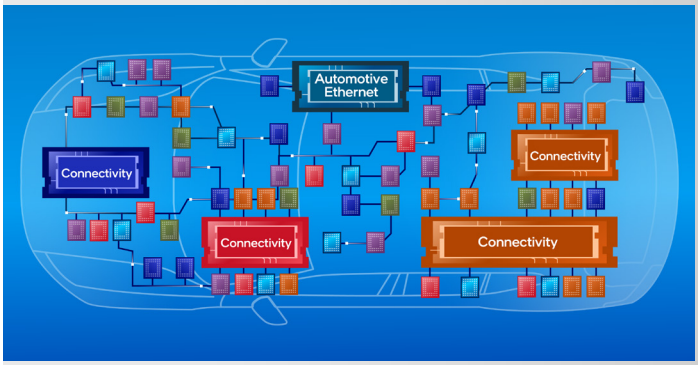
SDVs will create a more than USD 650B value potential for the auto industry by 2030[1]

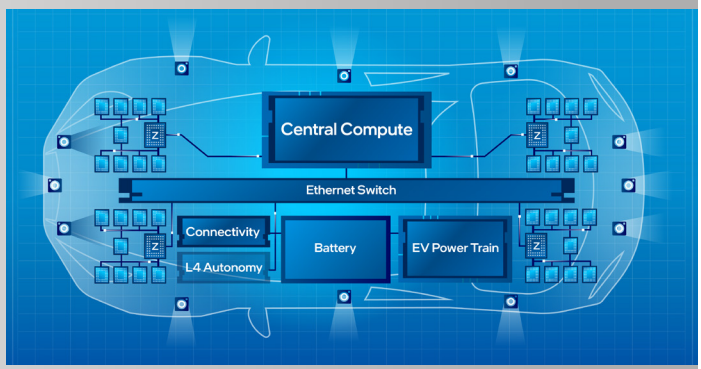
SDVs support the features drivers and fleet managers want

Virtualizing features and experiences gives consumers and fleet operators greater flexibility to customize their vehicles. Vehicle owners can select the exact programs, features, and personalization options they want. With high-speed over-the-air (OTA) connectivity enabled by Intel solutions for SDVs, owners can even update options and access customized content while the vehicle is in motion. The same capabilities enable fleet managers to update system performance, push content to drivers, or gather driving analytics in real time. Offering this level of control will unleash a new wave of demand across the automotive industry.

Enabling the latest automotive features such as voice recognition, intelligent parking assist, and advanced driver-assistance systems (ADAS) requires bringing AI acceleration to space- and power-constrained locations inside a vehicle. The Intel Automotive SoC platform runs multiple OSs, with different workload intensity and criticality, and features built-in AI acceleration, which makes it easier to develop and integrate advanced use cases.

The transformation of automotive design





Legacy microcontroller architecture

Fixed-function, distributed, closed

- More than 100 ECUs
- More than a mile of copper cabling
- Archaic, legacy buses

Modern SDV architecture

Open, consolidated, connected

- Fewer than 50 ECUs
- High-speed Ethernet with optical cabling
- Lead N/N-1 nodes

Solution architecture

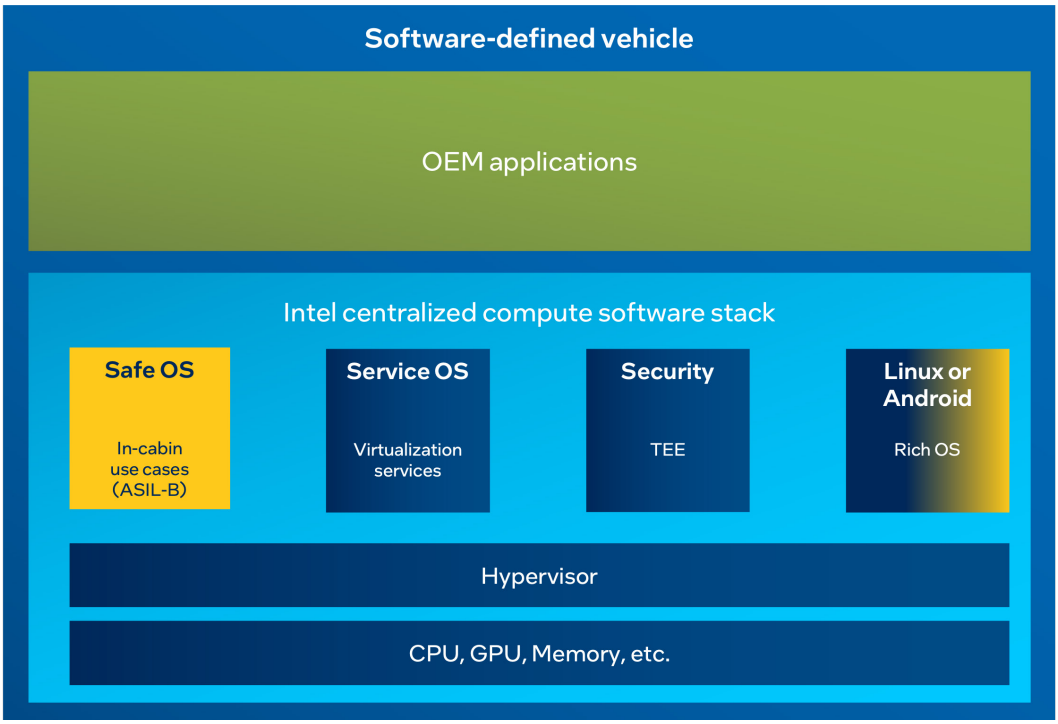


Figure 1: The Intel-enabled SDV consolidated software architecture

The Intel Automotive platform follows Intel® software and hardware leadership in modern, software-defined data center and enterprise-class solutions. This automotive platform extends enterprise-class solutions with automotive requirements, bringing key innovations from the enterprise cloud to the vehicle, specifically with high-quality support for virtualization, containers, and orchestration technologies. The technologies that run optimally in the enterprise cloud on Intel® architecture also run optimally in-vehicle on Intel architecture.

Automotive-qualified compute package

The Intel Automotive SoC platform has been modified to meet all applicable safety and reliability requirements for the automotive industry and offers:

- AEC-Q100 Grade 3 electronics
- Extended temperature range of -40°C to 85°C
- Board/package compatible—thermal, electrical, mechanical
- Functional safety (FuSa) enhancements
- Automotive Safety Integrity Level (ASIL) B

The Intel Automotive SoC platform can be modified and customized with additional automaker chiplets, the integration of high-performance peripherals such as Intel® RealSense™ technology for powerful video analytics, and Intel® Arc™ graphics cards to deliver detail-rich experiences and immersive entertainment. Automakers and solution developers will be able to leverage virtualization, containerization, and other computing techniques that are difficult or impossible with legacy automotive architecture.

Did you know?

When using the Intel® Automotive SDV SoC Family with single root I/O virtualization (SR-IOV) capabilities, each workload or virtual machine is separated directly at the GPU silicon level, which frees up the software layers for enablement of additional performance and functionality with zero latency. As of the publication of this brief, Intel Automotive is the first solution providing GPU SR-IOV technology tailored specifically for automotive applications. This delivers powerful performance for GPU workloads running in virtualized automotive environments.

Intel Offerings

BSPs/Hypervisor
- QNX (ASIL B) hypervisor
- ACRN (ASIL B) open-source hypervisor

Android
- Per Google roadmap
- Google compliance
- GAS verification

Security
- OP-TEE
- Key management
- Cryptography services
- Secure storage

Safety
- SoC safety monitoring
- Vehicle/Cockpit (ASIL-B)

Ecosystem Partners

Third-party applications
- Driver and cabin monitoring
- ADAS

OS/Hypervisors
- RTOS Safe OS
- Linux Rich OS

AUTOSAR
- Adaptive AUTOSAR

Connected services
- Cloud partners

Use cases

The Intel Automotive SoC platform brings the compute power and capabilities to converge a range of automotive use cases.

A sample of use cases supported by the Intel® Automotive system-on-chip (SoC) platform

Natural language processing
Drivers enjoy hands-free controls and personalization via conversational AI with a voice assistant.

Distinctive and engaging displays
Design experiences that improve safety with high-resolution, multidisplay digital cockpits enabling touchscreen commands and gesture recognition.

Advanced safety features
Support advanced customer safety use cases, such as 360-degree surround view, rear cameras with virtual parking assists, and intelligent telltale displays.

Fleet management
Leverage advanced telemetry to monitor vehicle use and condition. The platform also improves efficiency and helps reduce costs by enabling fleet managers to seamlessly deploy OTA updates across large groups of vehicles.

Cutting-edge entertainment
Keep passengers happy with video streaming and even AAA gaming on 4K rear-seat displays.

Over-the-air (OTA) updates
Update and manage features and driving experience applications, as well as infotainment options and content, with OTA connectivity.

Take your SDV journey farther by collaborating with Intel

The road to SDV transformation can be a challenging one. Collaboration across the SDV stack is the key to delivering the open software and hardware standardizations the industry needs. Intel is committed to open source, open APIs, and open standards that give automakers freedom of choice to work with their preferred solution providers. As the leader of the software-defined transformation in the data center, Intel is uniquely positioned to help automakers get the most out of SDV transformation.

Get connected to the Intel® Automotive ecosystem at intel.com/automotive.

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1. "Software-Defined Vehicles Will Create a More Than $650 Billion Value Potential for the Auto Industry by 2030," BCG, September 2023, bcg.com/press/7september2023-software-defined-vehicles-create-650-billion-value-potential.

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