PRODUCT BRIEF

Intel® GO™ Automated Driving Solutions

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Automated driving, accelerated.

Intel® GO™ automated driving solutions are incredibly scalable and designed to accelerate time to market. They include high-performance in-vehicle computing, software development tools, 5G-ready connectivity, a robust data center platform, and the latest advances in artificial intelligence (AI).

Solutions for Automated Driving, from Car to Cloud

Automated driving will change lives and societies for the better, resulting in fewer accidents, greater mobility, and more efficient traffic flow. With Intel GO automated driving solutions, Intel brings its deep expertise in compute, connectivity, and the cloud to the automotive industry.

Automated driving on a global scale takes more than high-performance sensing and compute in the vehicle. It requires an extensive infrastructure of data services and connectivity. Each automated vehicle will generate a massive amount of data—about 4,000 GB every day.[1] This data will be shared with all automated vehicles to continuously improve their ability to accurately sense and safely respond to surroundings.

To communicate with the data center, infrastructure on the road, and other cars, automated vehicles will need high-bandwidth, reliable two-way communication, along with extensive data center services to receive, label, process, store, and transmit huge quantities of data every second.

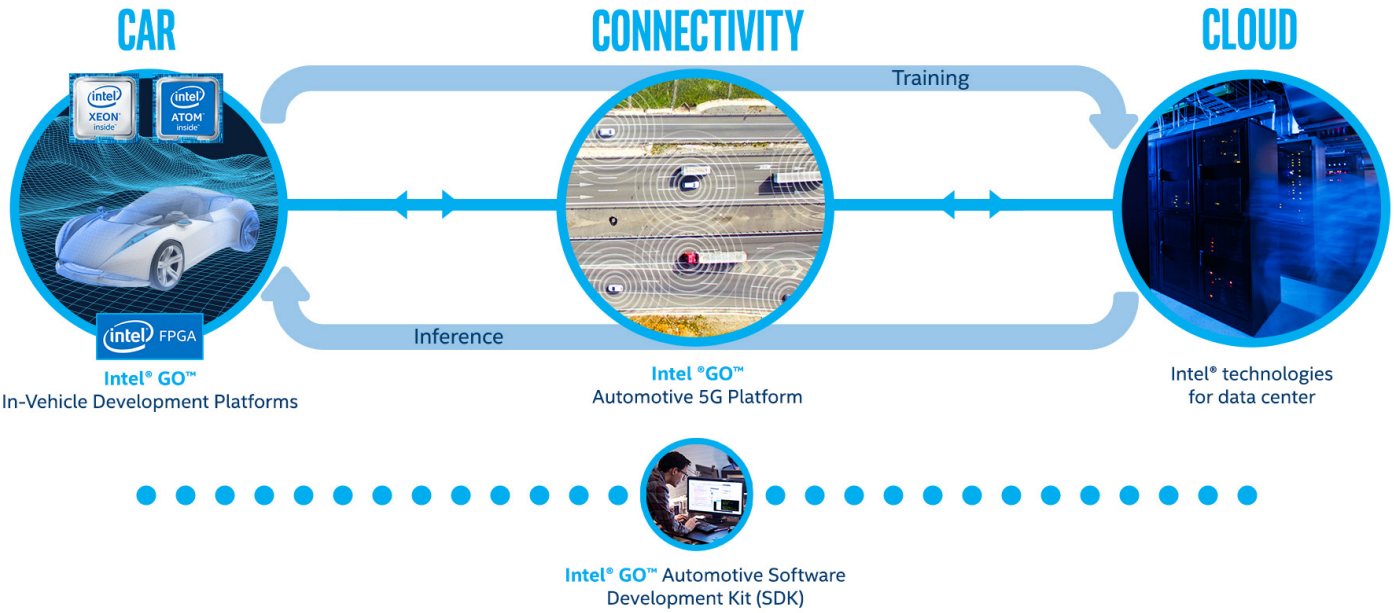
Intel® GO™ Development Platforms for Automated Driving

As driving becomes more automated, the vehicle must be able to visualize the road ahead, evaluate countless possible scenarios, and choose the best sequence of actions. It must process millions of data points every second and quickly respond to a constantly changing environment. This requires a tremendous amount of both parallel and sequential computing.

In many ways, the requirements for in-vehicle computing mirror those for the data center. Servers must be capable of incredible compute performance and power efficiency, while managing and processing a massive amount of data. In addition, servers must be highly available and reliable.

Intel® GO™ development platforms for automated driving, based on next-generation Intel® Atom™ and Intel® Xeon® processors for automotive, are built on the same technologies that put Intel at the forefront of extremely high-performance, reliable, available, and power-efficient data center solutions.

Efficient, scalable performance
Intel offers a spectrum of powerful and efficient compute solutions that range from Intel Atom processors at less than 10 watts up to high-core-count Intel Xeon processors, delivering compute performance to fuel actionable insights from the most demanding decision-making and data processing workloads.



Functional safety
Many of the same fault detection, correction, and recovery capabilities that enable extreme reliability and availability for servers can be used to deliver functional safety to computing systems for automated driving. In addition, Intel will work with Wind River systems and other software suppliers to deliver functional safety to operating systems, software, and tools for automated driving.

Security
As vehicles become smarter, more automated, and better connected, hardware and software security becomes increasingly critical. Intel delivers multilayered security solutions for automated driving, from strong protection in and around the electronic control unit (ECU) to authentication for over-the-air software updates.

Intel Atom and Intel Xeon processors for automotive include an integrated hardware-enhanced security module combined with trusted cloud services. This provides layered protection from chip to cloud with features rooted in the hardware, like secure boot and trusted execution. In addition, Intel® processors include support for hardware-enabled virtualization, allowing applications to run in isolation in more secure virtual containers.

Flexible Hardware Acceleration for Highly Parallel Workloads

In order to "see" its environment, a self-driving vehicle must collect and process data from various sensors, including lidar, ultrasound, radar, and optical sensors. This massive amount of data must be correlated and fused to create a complete and accurate view of the vehicle's surroundings.

Various techniques have been developed to enable the vehicle to create a model of its environment using multiple sensor inputs. The underlying algorithms behind these techniques are rapidly evolving and require a balance of high-performance computing, flexibility, and programmability. Intel will offer agile solutions that combine the compute performance of Intel Atom and Intel Xeon processors with the flexibility of field-programmable gate arrays (FPGAs) and the efficiency of both programmable and fixed-function accelerators—all in a single platform.

Arria® 10 FPGAs
This powerful, cost-effective, scalable design platform allows automakers and suppliers to get designs up and running without full hardware development of their own. In addition, FPGAs can be deployed in production systems to provide the combined benefits of hardware acceleration and field programmability. Arria 10 FPGAs feature hard floating-point digital signal processing (DSP) blocks with speeds up to 1,500 giga floating-point operations per second (GFLOPS).

Hardware acceleration
Intel is continuously making investments and developing hardware acceleration technologies for computer vision and deep learning/machine learning. These will deliver the parallel compute performance needed to enable fully autonomous driving with the lowest possible power consumption. As these powerful accelerators become available, they will be incorporated into Intel GO in-vehicle development platforms as acceleration modules, enabling developers to quickly take advantage of the most sophisticated acceleration technologies as they evolve.

Incredibly Scalable Development Platforms

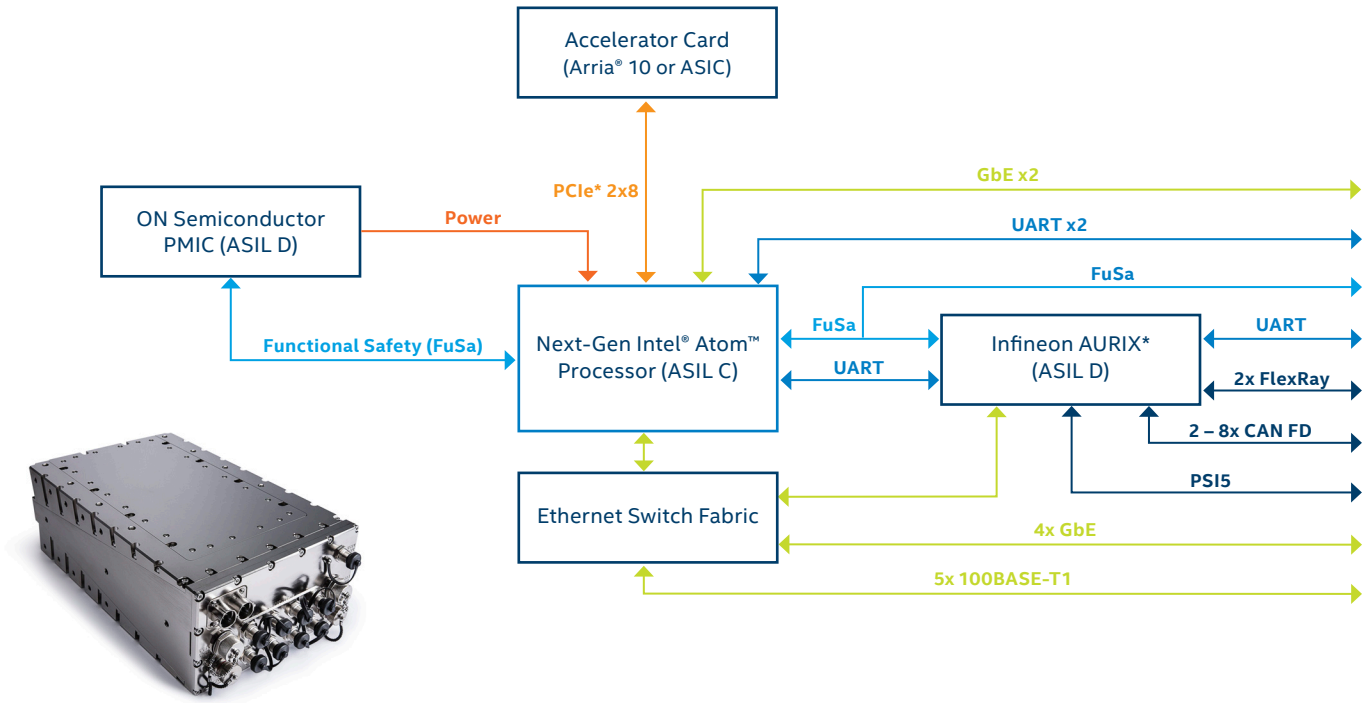
Intel GO development platforms for automated driving, including both Intel Atom and Intel Xeon processor versions, make it easier for developers to build, evaluate, benchmark, and optimize automated driving solutions, from Advanced Driver Assistance Systems (ADAS) to fully autonomous vehicles. These platforms jump-start development, enable flexibility in design, and speed time to market. Both platforms include Arria 10 FPGAs to speed production and come with a set of sample applications, run times and libraries, and middleware. In addition, they provide building blocks to enable developers to deliver functional safety and security to platforms.

Intel GO Development Platform for Automated Driving (Intel Atom processor version)
This production-ready platform for ADAS can be tested to peak compute capabilities under extreme temperature conditions.

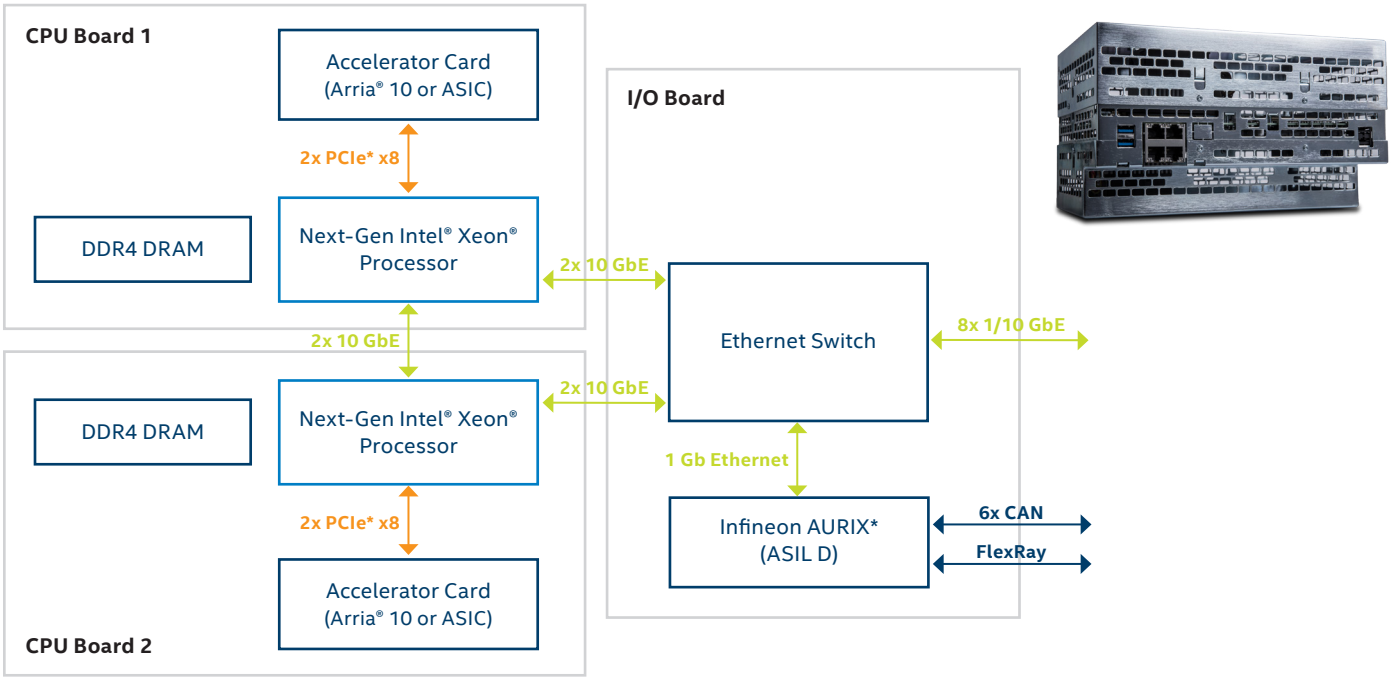
- **The next-generation Intel Atom processor for automotive** delivers high performance per watt, packing substantial compute into low-power designs while enabling an incredible range of ADAS features, from basic collision avoidance to high-speed automated cruise control. It utilizes a power-efficient microarchitecture on Intel 14 nm technology. The processor will be both AEC-Q100 Grade 2 capable and ISO 26262 ASIL C certified for SEooC (Safety Elements out of Context) for single-processor systems and ASIL D for dual-processor systems.
- **Arria 10 FPGAs** deliver a scalable design platform that is both powerful and cost effective.
- **Infineon AURIX* microcontrollers (MCUs)** meet both the performance and safety standards demanded by the automotive industry. Developments using AURIX require less effort to achieve the ISO 26262 ASIL D standard due to its holistic safety concept, and high performance allows for more functionality and a resource buffer for future requirements.
- **Elektrobit EB robinos*** enables carmakers and Tier 1 automotive suppliers to quickly and efficiently develop and bring to market highly automated driving systems by simplifying the complexity of modern ECUs. EB robinos works with AUTomotive Open System ARchitecture (AUTOSAR) basic software and includes AUTOSAR software components.
- **An optimized power management integrated circuit (PMIC) from ON Semiconductor** can be scaled to align with the power requirements of the full range of next-generation Intel Atom processors for automotive. The NCV81340 PMIC and NCV81341 Power Stage ICs are designed to be AEC-Q100 Grade 2 and ISO 26262 ASIL D compliant.

INTEL® GO™ DEVELOPMENT PLATFORM FOR AUTOMATED DRIVING

Intel® Atom™ processor version



Intel® Xeon® processor version



Intel GO Development Platform for Automated Driving (Intel Xeon processor version)
This platform allows developers to prototype and optimize solutions for fully autonomous driving using next-generation Intel Xeon processors, FPGAs, and hardware acceleration for computer vision and deep learning.

- **Two independent central processing unit (CPU) boards**, each containing a high-core-count Intel Xeon processor with multiple channels of DDR memory per board, deliver extremely high compute performance and plentiful memory bandwidth.
- An **accelerator mezzanine card connector on each CPU board** enables boards to be equipped with an Arria 10 FPGA expansion card and incorporate the latest hardware acceleration technology as it becomes available.
- An **integrated 16-port 10 gigabit Ethernet (10 GbE) switch** provides high-bandwidth Ethernet connectivity between the two CPU boards and allows a large amount of sensor data to be received and mirrored across both CPUs, as well as to an external data logger.
- **Infineon AURIX microcontrollers (MCUs)** provide ingredients for the development of functional safety concepts and automotive connectivity via CAN and FlexRay* interfaces.
- A separate **camera interface box**, featuring 12 GMSL camera ports to capture serial video streams and convert them from GMSL to Ethernet, will become available later in 2017.

Intel® GO™ Automotive Software Development Kit (SDK)

The software stack within automated driving systems must be able to efficiently handle demanding real-time processing requirements while minimizing power consumption. The Intel® GO™ automotive SDK helps developers and system designers maximize hardware capabilities while speeding the pace of development with a variety of tools:

- Computer vision, deep learning, and OpenCL™ tool kits to rapidly develop the necessary middleware and algorithms optimized for perception, fusion, and decision-making.
- Sensor data labeling tool for the creation of “ground truth” for deep learning training and environment modeling.
- Automated driving-targeted performance libraries, leading compilers, performance and power analyzers, and debuggers to enable full stack optimization and rapid development in a functional safety compliance workflow.
- Sample reference applications, such as lane change detection and object avoidance, to shorten the learning curve for developers.

These tools are highly interoperable, allowing data to flow smoothly from one tool to another and providing a consistent development experience across Intel Atom processors, Intel Xeon processors, and FPGA hardware. Developers can use this kit on Intel®-based workstations or in Intel®-based data centers and can easily deploy their code onto Intel GO development platforms for automated driving with full functional compatibility.

Intel® GO™ Automotive 5G Platform

To confidently support vehicle-to-everything (V2X) communications, over-the-air updates, and new in-vehicle experiences, providers will need increasingly higher data transfer speeds, as well as faster response times—not just in seconds, but in milliseconds. The Intel® GO™ automotive 5G platform, available February 2017, offers the industry's first 5G-ready platform for the automotive segment. This platform allows automakers to develop and test a wide range of use cases and applications for 5G.

Based on Arria 10 FPGAs and advanced RFICs, this platform gives developers the flexibility to test different prestandard 5G specifications operating in various channelizations. It supports multilayer MIMO transmission in both sub-6 GHz and 28 GHz mmWave frequency bands, and is interoperable with 5G-enabled radio access infrastructure provided by global network partners. It also provides LTE coverage fallback via the Intel® XMM™ 7360 LTE modem. The platform can support peak speeds of up to 7 Gbps.

The Intel GO automotive 5G platform will target several use cases that are of utmost relevance to the automotive industry:

- High-definition map downloads in real time
- HD content for in-vehicle infotainment (IVI)
- Over-the-air firmware and software updates
- Sensor data uploads from the vehicle for machine learning
- Use cases leading to safety, smart intersections, and cooperative driving

Intel will continue its long-standing collaboration with leading telecom operators, network infrastructure providers, and the automotive industry at large to pave a path to 5G. In addition, Intel plans to launch, in the near term, optimized 5G-enabled modules for commercial automotive development.

Intel® Technologies for the Data Center

High-performance computing in the car is essential to making immediate driving decisions. However, the data center is responsible for all artificial intelligence (AI) simulation and ongoing training. The data generated by automated vehicles will serve as a new kind of currency, opening the door for the automotive ecosystem to act on emerging business opportunities. The greatest opportunity lies in AI, as machine learning and deep learning will enable automated driving models. In addition, data about traffic, roads, and users can be used to create new applications and better experiences.

Intel provides extensive data center capabilities and expertise to support these demanding workloads. Intel® technologies for the data center support Intel GO automated driving solutions with full scalability to continuously store and manage unprecedented volumes of data and enable cloud services.

- Sophisticated hardware, based on Intel Xeon and Intel® Xeon Phi™ processors, delivers the high-performance computing needed to support AI and other intensive workloads.
- Platform services, including database services, distributed compute engines, and frameworks for machine learning and deep learning, offer specialized support for automated driving.
- Functional applications and capabilities for automated driving are optimized to run most efficiently on data center infrastructure.

Through automation, software-defined infrastructure, and continuous refinement of the hardware and software stack, Intel is committed to maximizing performance per dollar, per watt in the data center. Furthermore, Intel aims to deliver significant reduction in the time to train a deep learning model over the next few years.

Future Intel Automotive Solutions

As part of Intel's vision to accelerate the adoption of automated driving, Intel is planning to introduce an extensive roadmap of new solutions, including the following:

- Intel processors optimized for automotive and automated driving
- Automotive-grade Arria 10 FPGAs to fulfill the need for high-performance and deterministic signal processing in a lower power envelope
- Acceleration capabilities for computer vision and deep learning
- New tools for the data center, software, and connectivity, and hardware-enhanced security

In addition, Intel will continue to provide new automotive reference platforms to enable carmakers and automotive suppliers to accelerate innovation and speed time to market.

	INTEL® GO™ DEVELOPMENT PLATFORM FOR AUTOMATED DRIVING (INTEL® ATOM™ PROCESSOR VERSION)	INTEL® GO™ DEVELOPMENT PLATFORM FOR AUTOMATED DRIVING (INTEL® XEON® PROCESSOR VERSION)
Processor	Next-generation Intel Atom processor for automotive	Next-generation Intel Xeon processor for automotive
Support for multiple SoCs/CPUs	Boards can be daisy-chained via GbE	2 CPU boards per system
DRAM	2 channels DDR3L/DDR4 DRAM	Multiple channels DDR4 DRAM per board
Acceleration module	Arria® 10 FPGA acceleration module Additional hardware acceleration modules to be developed	Arria® 10 FPGA acceleration module Additional hardware acceleration modules to be developed
Microcontroller	Infineon AURIX* MCU, ASIL D	Infineon AURIX* MCU, ASIL D
System I/O	6 x 1 gigabit Ethernet 5 x 100BASE-T1 2-8 x CAN FD FlexRay* USB 2.0/USB 3.0 UART	8 x 1/10 gigabit Ethernet 6 x CAN FD FlexRay* USB 2.0/USB 3.0 UART
Integrated storage	eMMC flash drive	Solid-state drive
Software	Sample applications, runtimes and libraries, programming tools, operating system, and more	
Software development kit (SDK)	Intel® GO™ Automotive Software Development Kit (SDK) • Deep learning SDK • Computer vision SDK • OpenCL™ SDK • Sensor data labeling tool • Performance libraries • Optimizing compilers • Performance and power analyzers • System and application-level debuggers	

Learn More

For more information about Intel® GO™ automated driving solutions, contact your Intel account manager or visit intel.com/automotive/GO.

1. "Data Is the New Oil in the Future of Automated Driving." Intel, Nov. 2016, newsroom.intel.com/editorials/krzanich-the-future-of-automated-driving/.

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