

# Automotive Systems

Hitachi Automotive Systems, Ltd. integrated its management with Keihin Corporation, Showa Corporation, and Nissin Kogyo Co., Ltd. to form Hitachi Astemo, Ltd. in January 2021.

## 1 Functional Enhancements and Commercial Launch of Compact Stereo Camera



1 Compact stereo camera Gen3-ADAS

Along with the spread of active safety systems, the New Car Assessment Programme (NCAP) has been extended beyond just Europe to also Australia and Asia. Japan is making automatic braking systems compulsory on new vehicles from 2021. Compact stereo cameras could provide a variety of functions for driving safety and convenience with this one unit, so a wide range of vehicles from commercial trucks to small cars adopt this as a core control device to realize advanced safety vehicles (ASVs).

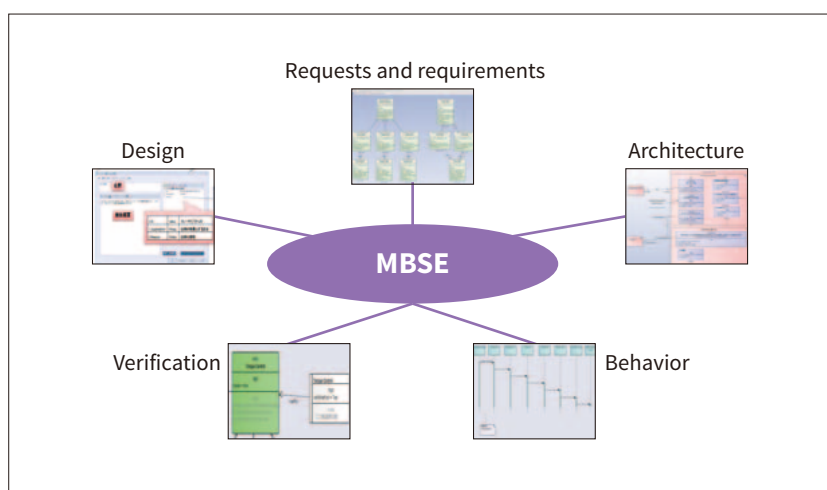
Hitachi Astemo has developed proprietary technology incorporating machine learning artificial intelligence (AI) for object detection like distant vehicles and night-time pedestrians to enhance the performance of Gen3 compact stereo cameras. This has contributed to lower accidents in the Japanese market, scoring highly on the night-time pedestrian test in the Japan NCAP (JNCAP) 2018. Furthermore, an upgraded version incorporating lane keeping, traffic sign recognition, collision prevention with oncoming vehicles at intersections, and automatic speed control functions has been adopted for use in pickup trucks and in overseas markets. A vehicle fitted with this

system was awarded the maximum five-star rating by the Australian NCAP 2020.  
(Hitachi Astemo, Ltd.)

## 2 Development of System Model and Software Architecture for Standardized Inverter Software

With the aim of making the development of inverter software more efficient, Hitachi Astemo has adopted the practice of software product line development to facilitate standardization and re-use across different products. To enable re-usable software components to be produced, the company identifies the commonalities and differences (variations) between products at the system design stage and allows for these differences in the software architecture. Steps are also taken to improve the independence of software components at the software design stage.

To make such designs possible, model-based systems engineering (MBSE) development techniques based on modeling languages such as Systems Modeling Language (SysML) and Unified Modeling Language (UML) are used throughout both the system and software designs.  
(Hitachi Astemo, Ltd.)



2 Software development using MBSE



**3** Autonomous driving control unit (left) and OTA control unit (right)

Ongoing improvements to autonomous driving and driving support create a need for timely software updating to keep pace with these functional enhancements. In response, Hitachi Astemo has developed a new autonomous driving control unit that works with over-the-air (OTA) software update systems for the wireless updating of software and an OTA control unit that controls OTA software updates on vehicles.

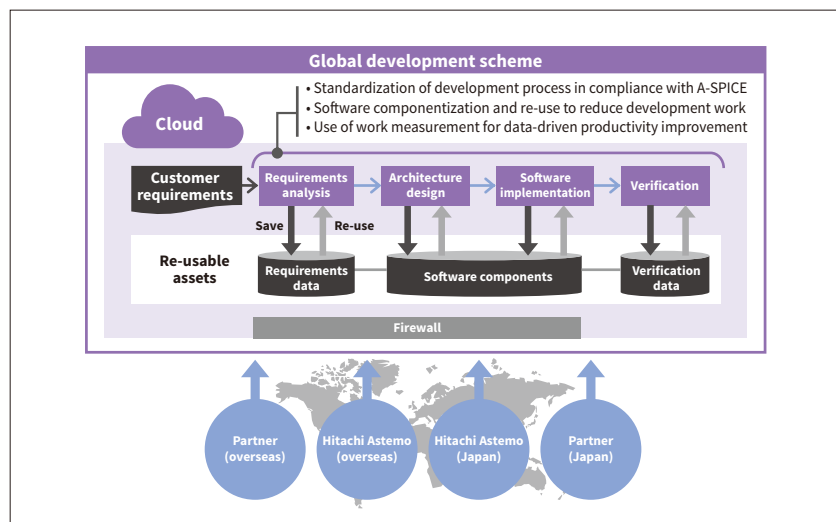
The autonomous driving control unit is equipped with system on a chip (SoC) and micro controller unit (MCU), for external objects detection and vehicle control respectively. These deliver high-speed processing together with a high level of reliability and safety as well as high-speed communication provided by Controller Area Network (CAN) and Ethernet.

The OTA control unit downloads update software while driving in order to shorten the time when the vehicle is unavailable due to software installation. It also enables reliable software updates by the encryption and digital signature verification of the update software to reduce security risks such as leakage of the update software or unauthorized software rewriting. (Hitachi Astemo, Ltd.)

The automotive control software used in vehicles' electronic control units (ECUs) continues to grow in size and complexity as more advanced functionality is added, including vehicle electrification, greater use of electronics, and external connectivity. Given the inevitability of further increases in the scale of software development, automotive suppliers are under pressure to combine short delivery times with high quality and this is driving a shift away from closed development toward open and global practices that allow for the entry of new players.

In response, Hitachi Astemo has established a globally integrated cloud-based development environment that enables efficient large-scale development, expanding collaboration with partners in Japan and elsewhere (including suppliers and overseas operations). It is pressing ahead with the global standardization of its development process, which is defined in accordance with the industry-standard Automotive Software Process Improvement and Capability Determination (A-SPICE) process model. The development process includes practices that allow for software componentization and re-use to reduce the duplication of effort across different projects.

The development environment includes systems for work measurement to enable a data-driven approach to working through the plan, do, check, act (PDCA) cycle. The company also intends to continue with ongoing improvements to enhance its development capabilities. (Hitachi Astemo, Ltd.)



**4** Establishment of global development scheme for automotive control software

## 5 High-current Ignition Coil for Contributing to CO<sub>2</sub> Reduction



5 High-current ignition coil

Fuel economy regulations have been tightening around the world. As one solution, exhaust gas recirculation (EGR) in gasoline engines is on the rise. While EGR can improve thermal efficiency by reducing pumping loss and cooling loss, deterioration of ignitability is a technical challenge. Overcoming this requires intense air-motion inside the engine cylinder and higher output of ignition energy will be necessary. From the viewpoint of the ignition coil, increasing the energy output of the ignition coil also increases its size. That is a new issue.

In response, new ignition coil features improved magnetic efficiency achieved by means that include a new core design and the bypassing of the magnetic circuit.

As a result, it achieved world-class performance with more than double the energy density and 1.5 times the maximum energy than the previous model. In actual engine testing, the new ignition coil allowed the EGR rate to be increased by 5% without deterioration of ignition performance, improving thermal efficiency by 3% more than the previous model.

(Hitachi Astemo, Ltd., Hitachi Automotive Systems Hanshin, Ltd.)

## 6 Integrated Control for Vehicles Using Electric Actuators Offering Safety and Peace of Mind

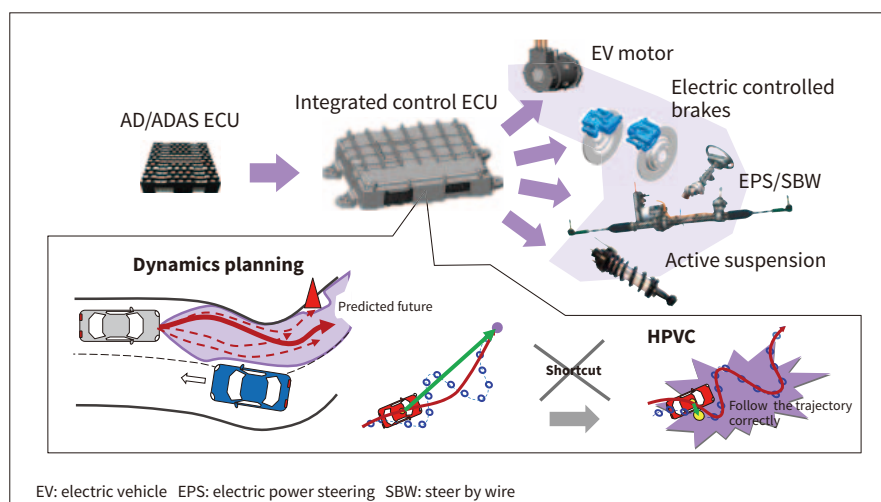
While autonomous driving/advanced driver assistance systems (AD/ADAS) designed with the goal of zero accidents play an important part in delivering road safety, it is also important that they be subject to ongoing development aimed at providing comfortable transportation. This requires vehicle control techniques that ECUs can use for automatically driving vehicles in the manner of a skilled driver.

Skillful driving requires that the following three requirements be satisfied.

- (1) The ECU must maintain sufficient distance from objects to cope with unexpected situations and risks.
- (2) Passengers must not be jostled back and forth or lurch left and right, even when driving on winding roads.
- (3) Vehicle speed must be maintained to get passengers to their destination quickly.

To achieve these requirements, Hitachi Astemo is developing Dynamics planning algorithms for calculating comfortable vehicle trajectories (including routes and vehicle speeds), high-precision vehicle control (HPVC) to accurately follow the resulting trajectories, and a variety of actuators to realize this vehicle control. By using these technologies in tandem to provide integrated control in a single ECU, the company intends to contribute to achieving the goal of zero accidents through the supply of automotive systems that deliver safe and comfortable driving.

(Hitachi Astemo, Ltd.)



6 Algorithm for trajectory calculation and HPVC for trajectory control