Putting the brain in driverless vehicles with MDC

By Wang Yige

Since the beginning of the modern era, technological advances and products that change our lives have occurred every 10 to 15 years, from the Ford Model T car over a century ago to smartphones, which debuted in 2007. In the next ten or so years, driverless cars are likely to be another game changer based on three major factors:

The right conditions: The combination of new energy and AI form powerful conditions for transforming the automotive industry.

Consumer demand: People are always searching for ways to make life better, and the market space tends to be vast for efficiency and convenience boosters.

Safety and accessibility: There are approximately 1.3 million deaths per year due to road traffic accidents, with 94 percent caused by human error. Driverless vehicles are not only safer, but they'll also greatly benefit people with disabilities who cannot drive and find it hard to get about.

Six levels of autonomous vehicles

SAE International defines six levels of self-driving cars: L0 (no automation), L1 (driver assistance), L2 (partial automation), L3 (conditional automation), L4 (high automation), and L5 (full automation). Currently the general belief in the automotive industry is that the large-scale adoption of autonomous driving at L2, L3, L4, and L5 will be achieved in 2018, 2020, 2025, and 2030, respectively. These milestones will be pushed by a mix of industrial, commercial, and social factors.

A car brain for overcoming challenges

Driverless vehicles perceive the environment using on-board sensors such as cameras, Lidar, millimeter-wave radars, and ultrasonic sensors. They make decisions based on data to avoid collisions and plan routes by predicting the trajectories of the driverless vehicle, other vehicles, and pedestrians at future points in time.

After a path is planned, the vehicle must then be controlled so that it follows the desired trajectory. This involves processes such as sensor environment awareness, high-precision maps and GPS, V2X communication, the integration of multiple data sources, decision-making and planning algorithm calculations, electronic control, and the execution of calculation results.

These processes call for a powerful brain that can carry out real-time analysis, process large amounts of data, and perform complex logic operations, which in turn place extremely high requirements on computing power. The computing power required for each level of self-driving vehicle is generally held to be as follows: less than 10 TOPS for L2, 30 to 60 TOPS for L3, more than 100 TOPS for L4, and predictions of around 1,000 TOPS for L5. Existing platforms are only capable of meeting some requirements of L3 and L4 automation.

Commercial autopilots can be traced back to

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the US Defense Advanced Research Projects Agency's (DARPA) Autonomous Land Vehicle (ALV) program in 1984. Since then, autonomous driving has gained widespread interest from academia and industry, with research institutes, car companies, Internet giants, and startups all getting involved. However, the development of autonomous driving has actually been quite slow, and the technology is still something only few enjoy. There are several reasons for this:

Poor experience: Autonomous driving is currently limited by computing power. Only conditional autonomous, which requires strict conditions, such as few cars, prescribed lanes, and slow speeds, is achievable at present. Today's computing platforms are unable to process enough sensor data in real time or perform integration, planning, and decision-making to a high enough level.

High cost: A car model claiming to provide L3 autonomous driving costs approximately US$50,000 to US$80,000, with the autonomous driving feature alone costing about US$8,000. And the ability to offer higher levels of automated driving will cost even more.

Safety concerns: Cars are durable, high-cost consumer goods with long lifespans. The equipment in a car must withstand harsh conditions, such as vibrations, temperature extremes, high humidity, and dust. Hardware reliability can directly impact the safety of driverless vehicles, a fact that concerns many consumers.

To overcome these challenges and produce higher-level driverless vehicles for regular consumers, we need increased computing performance, affordable solutions, and the assurance of safety and reliability.

MDC: An intelligent engine for cars

In the future, cars will become Mobile Data Centers (MDC) on wheels. Huawei introduced the MDC solution in response to the requirements that driverless cars place on computing platforms. In its MDC solution, Huawei has installed its Host CPU, AI, ISP, and SSD control chips, all of which it has developed in-house.

Through bottom-layer software and hardware integration and optimization, the solution delivers industry-leading time synchronization, accurate sensor data processing, multi-node real-time communication, minimized noise, low-power management, and fast and secure boot functionality.

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High performance: MDC is equipped with Huawei's latest Ascend AI chipset, which is capable of up to 352 TOPS of computing power, satisfying L4 requirements. MDC can access and process data flows in real time from more sensors than has been previously possible, including cameras, millimeter wave radars, Lidar, and GPS. This will provide safer and more reliable computing support for autonomous driving systems to handle complex road conditions.

High safety & reliability: MDC's E2E redundancy design prevents single-point-of-failures. It copes with harsh external environments, including ambient temperatures from -40°C to 85°C, and complies with industry-grade reliability and functional safety standards such as ISO 26262 ASIL D.

High energy-efficiency: MDC features industry leading 1 TOPS/W E2E energy efficiency, surpassing the industry average of 0.6 TOPS/W. Not only does energy efficiency extend a car's cruising range, it also enables lower temperatures for computing. This improves the reliability of electronic components and eliminates the need to configure vulnerable components such as heat dissipation fans, which minimizes the hardware footprint, structural impact on vehicles, and potential failures.

Low latency: The bottom-layer hardware platform has a real-time operating system, with efficient bottom-layer hardware and software integration optimization. It offers sub-10 us kernel scheduling latency and sub 1-ms ROS internal node communication latency, which gives an overall E2E latency of 200 ms, improving safety over the industry average of 400 to 500 ms.

The Huawei MDC is also an open platform that offers components-as-a-service, interface standardization,

and development tools. Through the platform, it’s possible to quickly develop, debug, and run autonomous driving algorithms and functions. For different levels of automated driving algorithms, the platform supports smooth evolution from L3 to L5 autonomous driving algorithms for different hardware configurations with a unified software architecture.

Huawei teamed up with Audi to carry out joint innovation on L4 autonomous driving with the MDC solution, and the results were encouraging. Tests with an Audi Q7 equipped with Huawei MDC in China were successful on dimly lit urban and rural roads at night under complex traffic conditions, including unclear lane lines, and pedestrians, bicycles, and scooters crossing the road. It also successfully carried out high-speed cruising, following other vehicles, recognizing traffic lights and pedestrians, and self-parking in an underground garage.

Autonomous driving algorithms developed through the joint innovation have achieved excellent results in KITTI 2D, 3D, and BEV tests.

Huawei believes that driverless vehicles will bring huge benefits to society. It has applied its industry-leading chips, platform-level engineering capabilities, and complete development diagnostic tool-chain to create the MDC solution, offering a true car brain. Together with car manufacturers, Huawei will apply its AI capabilities to steer the advancement of autonomous driving technology into the fast lane.