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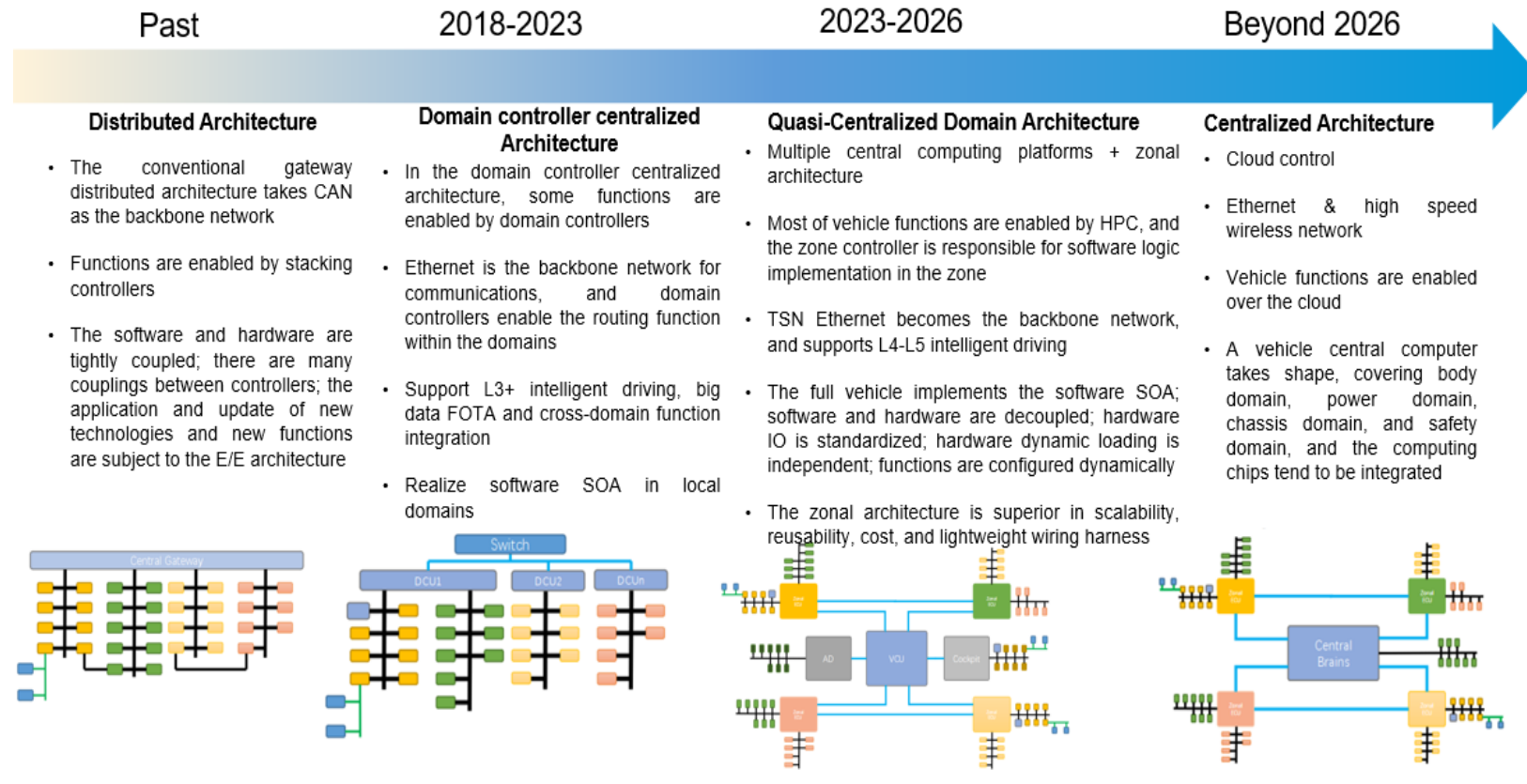
**Intelligent Vehicle E/E  
Architecture Research Report,  
2023**

Sept. 2023

# E/E Architecture Research: How will the zonal EEA evolve and materialize from the perspective of supply chain deployment?

Through the lens of development trends, automotive EEA (Electronic/electrical Architecture) will eventually evolve to central computing architectures with functional logics centralized in one central controller. OEMs become ever more radical in EEA planning. For OEMs, the year of 2023- 2023 will be a key time node to mass-produce the next-generation “quasi-central computing + zone” architecture.

## Evolution Trends of Automotive E/E Architecture in the Next 5- 10 Years

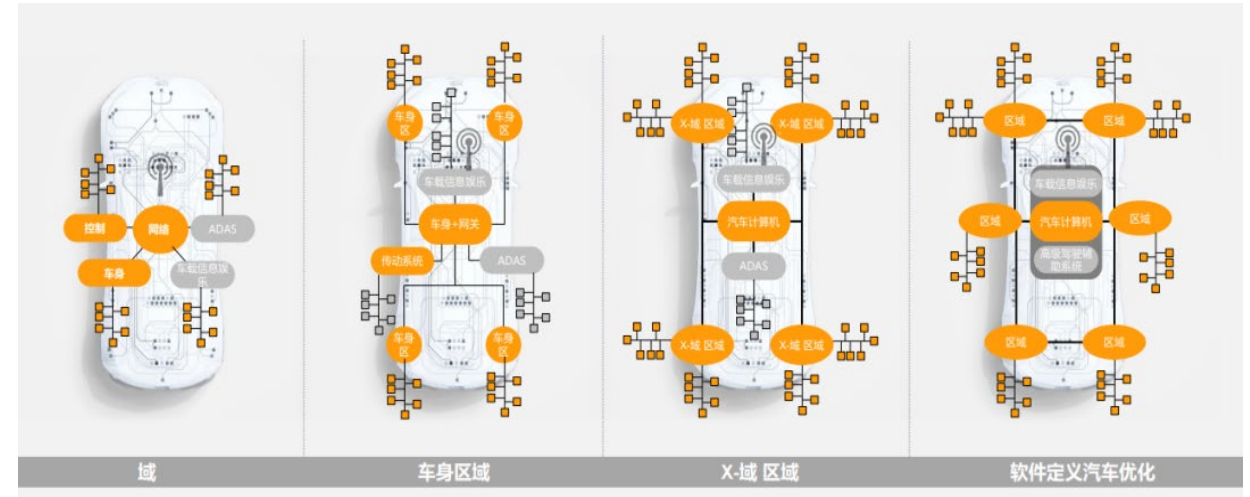


# E/E Architecture Research: How will the zonal EEA evolve and materialize from the perspective of supply chain deployment?

The “quasi-central computing + zone” architecture can be further subdivided into many types:

- Body-zonal architecture: The controller of the body zone is connected to the central computing unit through the high-speed Ethernet backbone network, and the central computing unit integrates the functions like vehicle control, body control and gateways, simplifying the network topology, wiring harness layout and weight;
- X-domain zonal architecture: The functional zone is combined with the body zone, and the X-domain uses a more powerful processor unit, which can independently call the sensors in the zone and process data;
- Software-defined vehicle (SDV) optimized architecture: With centralized and service-oriented computing, the central computer of vehicle has powerful processing capability and makes all decisions, while zonal controllers supply power and perform the instructions issued by the central control unit.

## Development Path of NXP's Brand New E/E Architecture



Source: NXP



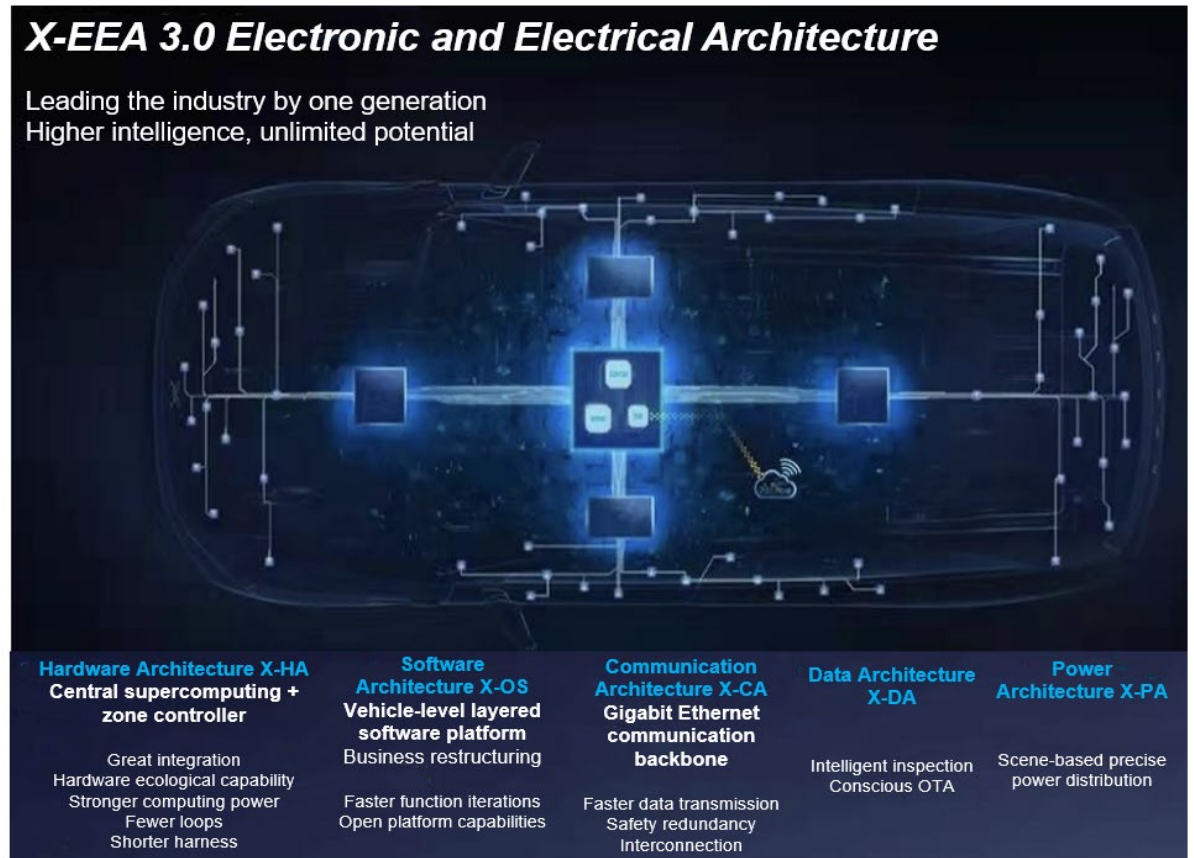
# Under zonal architecture, MCUs tend to feature high performance and multi-core

In the future central integrated E/E architecture, the central processing unit communicates with zonal controllers through Ethernet, while zonal controllers communicate with sub-ECUs, sensors and actuators through CAN/LIN bus.

Physically, the zonal controllers logically concentrate multiple ECUs, proposing a higher requirement for the computing power of MCU in the zonal controllers. In the traditional ECUs with simple functions, a single-core MCUs with low performance are qualified, while zonal controllers often require multi-core MCUs. In a multi-core MCU, each core can run a single function, while multi-core can realize multiple functions, thus realizing the integration of multiple ECU functions.

**X-Soul Architecture of GAC Aion GA3.0** The newly-launched Hyper GT is the world's first model that uses NXP S32G3 as the central computing unit processor. The "central computing unit" developed by Continental adopts the latest "NXP S32G399 high-performance gateway computing chip". The basic middle layer of the software architecture of the front and rear zonal controllers adopts atomic service packaging and standardized interfaces, and the middle layer uses enhanced composite services and can be implemented independently.

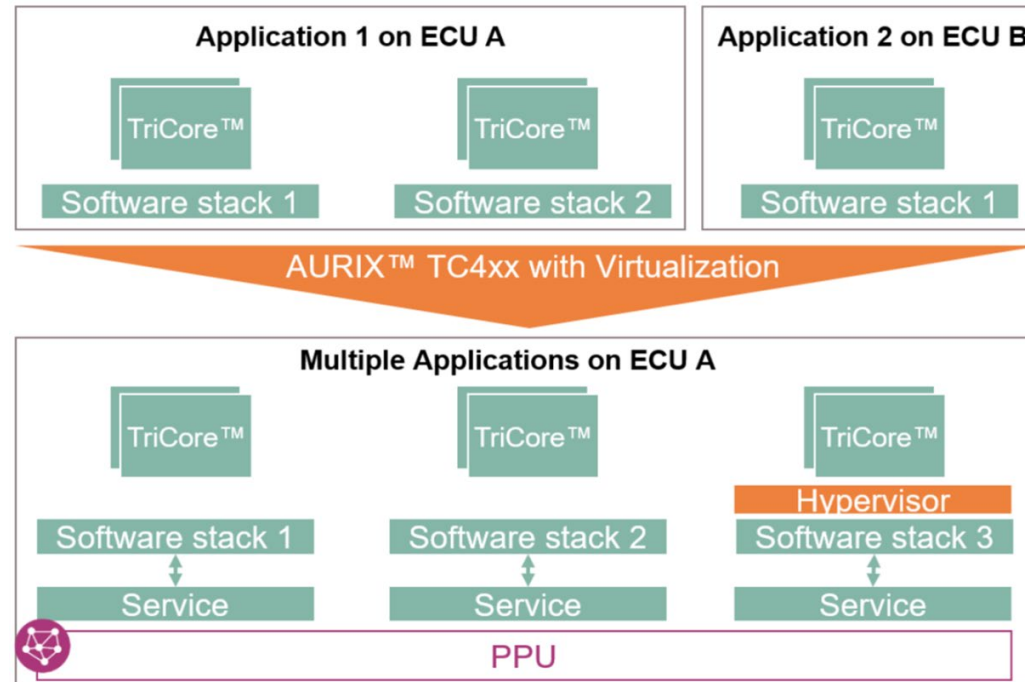
**Xpeng's X-EEA3.0:** For the first time in China, it has attained a communication architecture with Gigabit Ethernet as the backbone and supports multiple communication protocols, making vehicle data transmission faster. The central computing unit and zonal controllers of X-EEA3.0 adopt Renesas' flagship MCU based on the third-generation RXv3 CPU core. On the basis of X-EEA3.0, Xpeng G6 has further mass-produced and deployed the new Fuyao X-EEA3.5.



# Under zonal architecture, MCUs tend to feature high performance and multi-core

## Application Fields of Infineon TC4xx

**Infineon's 3rd-generation AURIX™ TC4xx MCU:** High-performance AURIX™ TC4xx family mainly meets the new requirements of the central computing and zonal control. It is equipped with up to six TriCore™ 1.8 embedded cores, each with a clock frequency of up to 500MHz; integrated with a PPU coprocessor, it can realize fast vector operation, basic neural network algorithms and other complex mathematical algorithms. In future regional controllers, PPU can be used in some information security algorithms for modeling, model predictive control, and anti-intrusion detection.



Source: Infineon

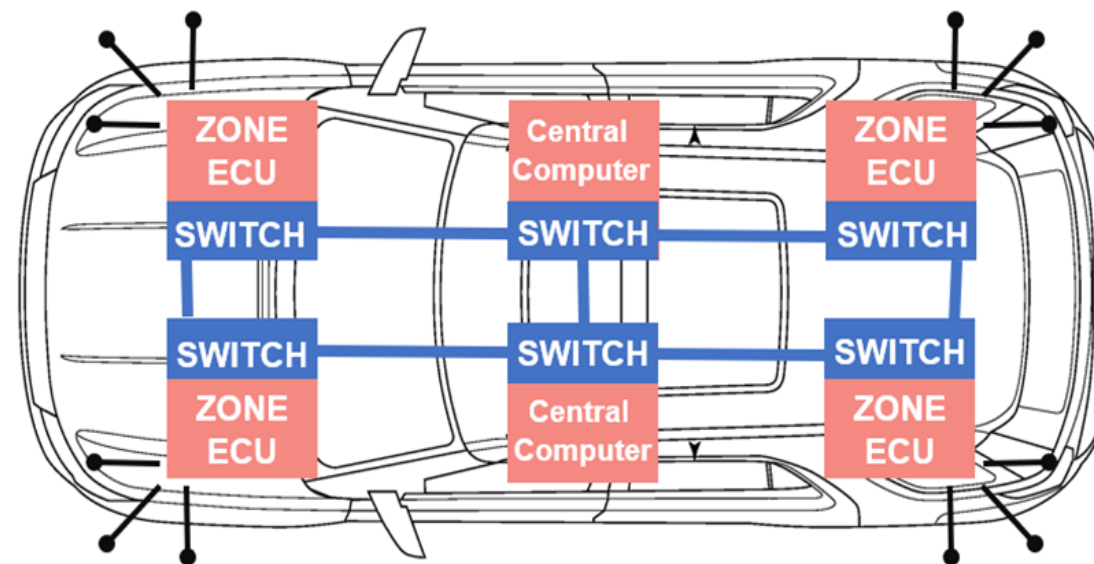
# Under zonal architecture, the demand for automotive Ethernet PHY and switch chips soars, so that the price fluctuates sharply.

The interface circuit of automotive Ethernet is mainly composed of MAC controllers and PHY chips. In terms of integration method, embedded chip vendors generally integrate the MAC inside the MCU/CPU. For example, Infineon's AURIX integrates MAC into the main MCU, and also integrates CRE/DRE, the dedicated hardware communication routing module; whereas, the PHY chip is provided by the OEM or controller supplier as an independent chip.

The global Ethernet switch/PHY chip market size hit about USD800 million in 2023, and it is expected to reach USD2.5 billion in 2028. It is estimated that each car will use 2-4 Ethernet switch chips and 2-4 PHY chips on average by 2028.

Since 2023, the short-term price of some Ethernet PHY and switch chips of Broadcom BCM89 family has soared several times, with a single chip valued USD30-40. The BCM8955X family is Broadcom's third-generation automotive Ethernet switch solutions, which are mainly used in ADAS, infotainment systems and gateways. At present, Broadcom mainly promotes the BCM8957X family, which is the only automotive Ethernet switch in the world that supports the 802.3ch standard.

In a typical central computing + zonal architecture, each zonal gateway contains an Ethernet switch, and each vehicle requires at least 6-7 Ethernet switch chips. At present, Marvell, Broadcom, NXP and other automotive network communication chip vendors have proposed the next-generation network architecture.



Source: Marvell

OEMs forecast that the central computing + zonal architecture will only come true in 2025 by virtue of 10G bandwidth. In June 2023, Marvell announced the Brightlane Q622x family of central Automotive Ethernet switches to support the zonal networking architectures of next-generation vehicles. Central Automotive Ethernet switches are high-bandwidth, high-performance devices optimized to coordinate data traffic between zonal switches, which aggregate traffic from devices located within a physical zone of a car like processors, sensors, actuators, storage systems and others.

# Under zonal architecture, the demand for automotive Ethernet PHY and switch chips soars, so that the price fluctuates sharply.

*In the 10 Gigabit automotive Ethernet chip market, only Marvell and Broadcom can provide 10G+ Ethernet switches.*

Broadcom

- Launched in 2020, BCM8989X is the industry's first IEEE 802.3ch standard compliant automotive 10G/5G/2.5GBASE-T1 MACsec PHY.
- In 2020, Broadcom announced BCM8957X, the first automotive L2/L3 switch with MACsec support and PHY interfaces supporting data rates of 10 Mbps to 10 Gbps.
- **In 2022, Broadcom announced BCM8958X, the world's first 50G automotive Ethernet switch, which highlights 55 Gb/s switching capacity.**

Marvell

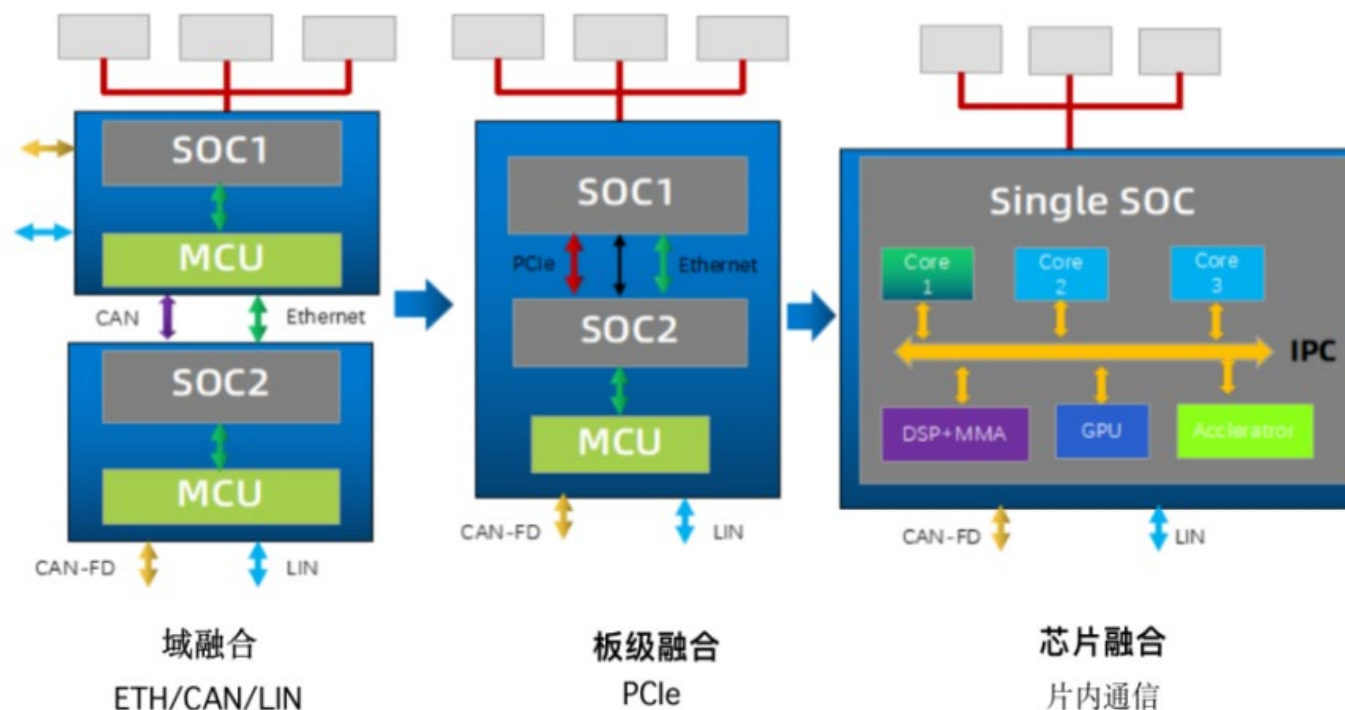
- Unveiled in 2021, 88Q4364 is a single-pair Ethernet PHY that implements the Ethernet physical layer portion of 2.5G/5G/10GBASE-T1 as defined by the IEEE 802.3ch standard.
- In 2023, Marvell announced Brightline Q622x family of central Automotive Ethernet switches, among which **Brightlane Q6223 switch delivers 90 Gbps of bandwidth**, nearly 2x the capacity of currently available automotive switches, and **Brightlane Q6222 contains nine ports for 60 Gbps.**

Source: ResearchInChina

# Under zonal architecture, the on-chip high-speed communication of central computer requires PCIe switches

## Development of Automotive Communication Architecture amid EEA Evolution

Driven by Chat GPT, the demand for AI servers has skyrocketed, and PCIe Switch chips represented by Broadcom SS26 are in shortage with the price swelling. In the next-generation E/E architecture, expensive PCIe switches are required by connection between multi-SoC cascade, SSD storage based on PCIe and the central SoC.



Source: Xpeng



# Under zonal architecture, the on-chip high-speed communication of the central computer requires PCIe switches

The cross-domain communication of automobiles will be based on PCIe, which can improve the communication efficiency to dozens of gigabytes compared with the previous Ethernet, and PCIe Switch enables the on-chip communication. Ethernet Switches are mounted on different SoCs in the central computing unit. The external sensors are connected in series through the Ethernet switches of zonal ECUs.

- Qualcomm's first-generation autonomous driving system, Ride3.0, uses PCIe switches in the automotive industry for the first time, that is, Microchip's PM43028B1-F3EI priced at about \$100 dollars, higher than that of SA8155P and almost 4-5 times that of Ethernet switches.
- Visteon's dual Qualcomm 8155 cockpit domain controllers are internally connected via the PCIe bus. Two 8155 SoCs are connected through PCIe bus, with the transmission rate of 16Gbps, which can efficiently transmit the real-time video input of ADAS.
- SiEngine Technology has customized the high-speed interconnection bus SE-LINK for ECARX to realize the simultaneous operation of two "Longying No.1" chips. Two Antora 1000 platforms are connected to get Antora 1000 Pro. It can provide double computing power while maintaining the transmission speed, wherein the transmission speed of PCIe 3.0 Lane reaches 7.28 GT/s.

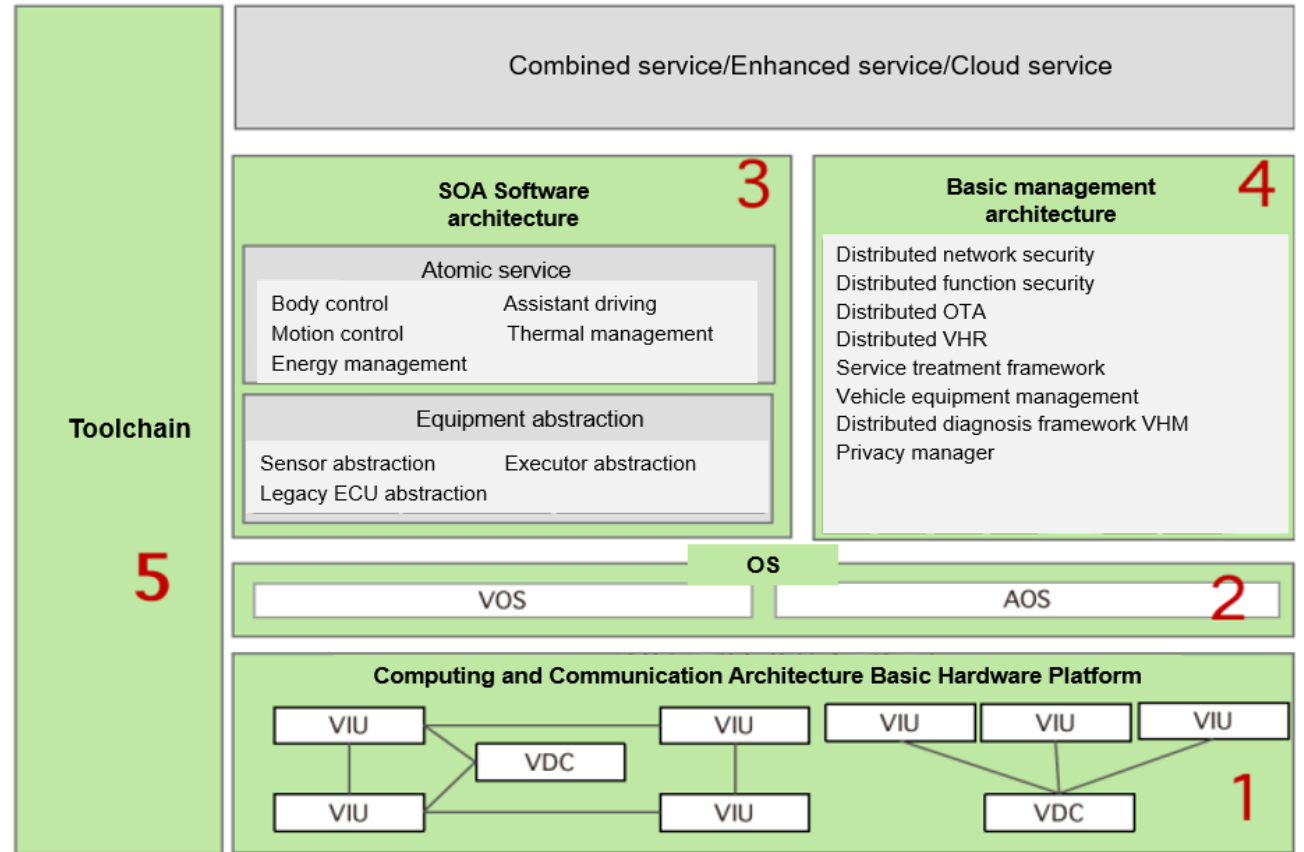
# EEA Evolution drives the upheaval of underlying OS of vehicle

Adaptive AUTOSAR introduces the service-oriented architecture (SOA) and support for POSIX system, suitable for high-computing SoCs. SOA or the service-based middleware platform is also known as the automotive OS.

The SOA of GAC's X-Soul architecture has realized standardized layered interfaces, software modularization, function atomization, remote function configuration and so on through the layered decoupled basic software architecture platform. GAC's X-Soul architecture is China's first product developed based on the ASF (AUTOSEMO Service Framework) technical specification. On the basis of the SOA, the GAC Rubik's Cube scenario co-creation platform has been mass-produced with GAC Aion Hyper GT.

In April 2023, Huawei released the iDVP intelligent digital base, which is a SOA that allows zonal access and central computing. iDVP includes a hardware platform and a software platform. The hardware platform refers to the basic hardware platform of the computing and communication architecture, and the software platform includes an operating system, a basic management framework and a SOA software framework. In order to facilitate users to develop software on iDVP, Huawei has developed a supporting tool chain.

## Huawei's iDVP Intelligent Digital Base



Source: Huawei

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- 5.9.11 Cross-domain/Central Computing Software Platform (3): Huawei iDVP
- 5.9.12 Cross-domain/Central Computing Software Platform (4): EnjoyMove EMOS
- 5.9.13 Cross-domain/Central Computing Software Platform (5): ThunderSoft Vehicle Operating System
- 5.9.14 Cross-domain/Central Computing Software Platform (6): Benz MB.OS





## Beijing Headquarters

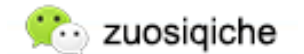
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