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Intelligent Vehicle Multi-Domain Computing Industry Report, 2024

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1. Several ideas and strategies for cross-domain integration of OEMs

Intelligent Vehicle Multi-Domain Computing Industry Report, 2024 mainly studies following:

- ◆ Typical multi-domain computing architecture ideas, including Tier 1's cross-domain computing product layout and ideas, OEMs' cross-domain product layout and ideas, etc.
- ◆ Multi-domain computing platform, including central control domain, digital chassis +intelligent driving + cockpit integration domain, cockpit-driving integration domain, quasi-central computing platform, central computing platform and other products;
- ◆ Research on the impact of multi-domain computing on automotive software, MCU, VCU, and ECU;
- ◆ Research on the layout, mass production, and cooperation of OEMs in multi-domain computing;
- ◆ Research on the development, the latest technology layout, and product dynamics of Tier1s in multi-domain computing at home and abroad.

With the increasingly stringent requirements for advanced autonomous driving in terms of computing power, communication bandwidth, software, and security, automotive electronic and electrical architecture (EEA) has gradually evolved from a domain-centralized architecture to a multi-domain integration, and then to a central computing architecture. At present, the main integration ideas for automotive multi-domain computing are as follows:

- ◆ The central control domain integrates body, chassis, power, gateway, etc.;
- ◆ Digital chassis integrates intelligent driving, cockpit, etc.;
- ◆ Cockpit-driving integration computing platform;
- ◆ Quasi-central computing platform (One Box, multi-board, multi-core);
- ◆ Central computing platform (One Box, mostly single board, equipped with single or multiple high-performance chips, using board-level interconnection technology).
- ◆ At present, Leapmotor and Voyah have evolved into a central computing platform, Xpeng has entered a quasi-central computing platform, and most players have also entered the stage of domain integration, among which the development of cockpit-driving integration computing platform is relatively booming.

Cross-domain Integration Ideas of Some OEMs and Tier1s





Cross Domain Type	Fusion	Solution Advantages	Typical Product	SOP
Central control domain	Body, chassis, power, gateway, etc.	<ul style="list-style-type: none"> ✓ Synergy between power and chassis to provide vehicle performance; ✓ Reduce the number of ECUs and complexity of wiring harnesses in power and chassis domains to lower costs 	<ul style="list-style-type: none"> ✓ UAES: VCU8.6 vehicle motion domain controller ✓ Continental: vehicle control high-performance computer (HPC) ✓ Jingwei Hirain: CCP 	✓ Volkswagen, ZEEKR, etc.
Digital chassis + intelligent driving + cockpit cross-domain fusion platform	Chassis, intelligent driving, cockpit, etc.	<ul style="list-style-type: none"> ✓ The integration of the chassis and intelligent driving domains provides execution support to achieve L3 and higher-level intelligent driving functions. 	<ul style="list-style-type: none"> ✓ Bosch: intelligent chassis VDC 2.0 system ✓ NIO: intelligent chassis controller (ICC) ✓ Geely: AI digital chassis 	✓ NIO, Geely, etc.
Cockpit-driving integration computing platform	Cockpit, intelligent driving, gateway, etc.	<ul style="list-style-type: none"> ✓ In terms of hardware, reduce the investment in domain controllers and chips, and the number of wiring harnesses to lower hardware costs ✓ Achieve computing power sharing, enabling more reasonable distribution of high compute requirements 	<ul style="list-style-type: none"> ✓ Banma Zhixing: cockpit-driving-parking integration solution ✓ Baidu: cockpit-driving integrated software-chip fusion intelligent computing platform ✓ PATEO: cockpit-driving integration domain controller 	✓ Leapmotor, Geely, Neta, Dongfeng, GAC, SAIC, etc.
Quasi-central computing platform	Intelligent vehicle control, intelligent driving, cockpit	<ul style="list-style-type: none"> ✓ Achieve hardware resource sharing and data sharing 	<ul style="list-style-type: none"> ✓ PATEO: central computing module (CCM) ✓ Neusoft: C5 vehicle human-computer interaction platform ✓ Xpeng: central supercomputing (C-DCU) 	✓ Xpeng, etc.
Central computing platform	Intelligent driving, cockpit, body control, power	<ul style="list-style-type: none"> ✓ Greatly reduce the number of controllers 	<ul style="list-style-type: none"> ✓ Leapmotor: central supercomputing platform 	<ul style="list-style-type: none"> ✓ Leapmotor Four Leaf Clover Platform ✓ Voyah Tianyuan Platform

Source: ResearchInChina

Summary of Cross-domain Integration Mass Production Models of some OEMs

Summary of Cross-domain Integration Mass Production Models of some OEMs

With the development of autonomous driving, cross-domain integration is imperative, and OEMs are accelerating the implementation of cross-domain integration models.

OEM				
Cross-domain platform	Four Leaf Clover Architecture	XEEA3.5 Platform	Modular Scalable Platform (MSP)	NT2.0 Platform
Typical models	C10	G6/G9, etc.	L6	ET7/ET5/ES8/ES6, etc.
Cross-domain fusion	<ul style="list-style-type: none"> ✓ Central supercomputing: integrate cockpit, intelligent driving, power and body domains 	<ul style="list-style-type: none"> ✓ Central supercomputer (C-DCU), integrated cockpit + central gateway + body control 	<ul style="list-style-type: none"> ✓ Intelligent driving + cockpit 	<ul style="list-style-type: none"> ✓ Intelligent driving + cockpit (central computing platform ADAM)
Realized functions	<ul style="list-style-type: none"> ✓ Intelligent cockpit: higher human-computer interaction efficiency, better intelligent experience, and unconscious OTA updates (under multi-domain control, each controller unit must be upgraded separately in each OTA update); ✓ Intelligent driving: realize 25 high-level driving assistance functions such as NAP and NAC; 	<ul style="list-style-type: none"> ✓ Each OTA update covers many personalized functions, and the development efficiency can be improved by 30% after standardizing the service structure; ✓ The multi-scenario intelligent cockpit allows for personalized customization; 	<ul style="list-style-type: none"> ✓ Intelligent driving: create map-free urban NOA ✓ Intelligent cockpit: DZT virtual-real space dynamic area tracking technology, which can solve the enduring problem's in driving scenarios 	<ul style="list-style-type: none"> ✓ The higher computing power brings faster cockpit computing speed and quicker response, and smoother vehicle experiences. ✓ Through cross-domain fusion and computing power sharing, support NOMI GPT (multimodal perception large model deployed only on the end side) for the first time, and achieve quick response without networking
Cost advantage	<ul style="list-style-type: none"> ✓ Core electronic components are all self-developed, covering 70% of the vehicle cost 	<ul style="list-style-type: none"> ✓ The overall vehicle R&D cost is reduced by 50%; ✓ The software adaptation cost of in-vehicle intelligent systems is reduced by 85%; ✓ The cost of voice dialogue service is reduced by 50%. 	<ul style="list-style-type: none"> ✓ / 	<ul style="list-style-type: none"> ✓ Compared with the cockpit-driving separated domain controller, reduce the volume by 40%
Supply chain	<ul style="list-style-type: none"> ✓ Medium-configuration edition: Qualcomm SA8295P + NXP S32G ✓ High-configuration edition: Qualcomm SA8295P + NXP S32G+ NVIDIA Orin-X*2 	<ul style="list-style-type: none"> ✓ Steel Mate Zone Controller ✓ Central supercomputer (C-DCU) OEM by Hangsheng Electronics ✓ Qualcomm SA8295P + Renesas third-generation MCU 	<ul style="list-style-type: none"> ✓ Z-ONE Central Brain ZXD ✓ All-domain motion control platform (VMC) ✓ Z-ONE Galaxy Full Stack 3.0 cloud-pipe-end integrated SOA software platform ✓ NVIDIA Orin X*1 + Qualcomm SA8295P + NXP S32G3 	<ul style="list-style-type: none"> ✓ Qualcomm SA8295P + NVIDIA Orin X*4 ✓ Self-developed foundation model NOMI GPT

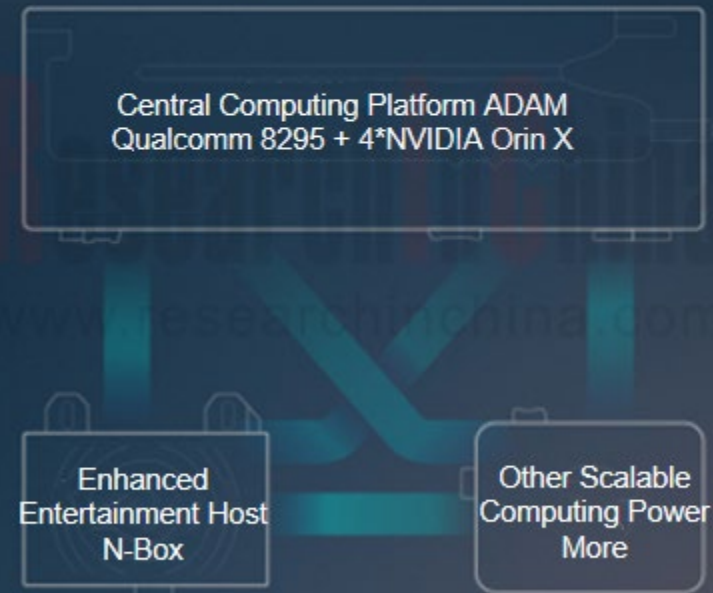
Source: ResearchInChina

The ADAM cross-domain solution of NIO's central computing platform integrates two chips on the same circuit board. The central computing platform ADAM can eliminate the need for encoding and decoding between different domains in the car, eliminating the need for encoding and decoding chips, power supplies, heat dissipation, wiring harnesses, etc. It directly replaces Gigabit Ethernet through etching circuits on the circuit board, and the cross-domain data bandwidth between intelligent driving and cockpit is greatly increased from Gigabit to 16Gbps, achieving a transmission rate increase of more than 10 times.

In addition, through cross-domain computing power sharing, each large computing power demand can be more rationally allocated, allowing intelligent driving chip NVIDIA Orin X and intelligent cockpit chip 8295 to solve their respective tasks.

Scalable Vehicle Heterogeneous Computing Power

The industry's first scalable architecture aggregates brains with different capabilities to work together



Source: NIO

Neta Haozhi Supercomputer XPC-S32G

In June 2024, Neta, NXP, HiRain, and Wind River jointly released the first integrated gateway domain control product--Haozhi Supercomputer XPC-S32G, which will be launched in 2024H2 with the new Neta S model.

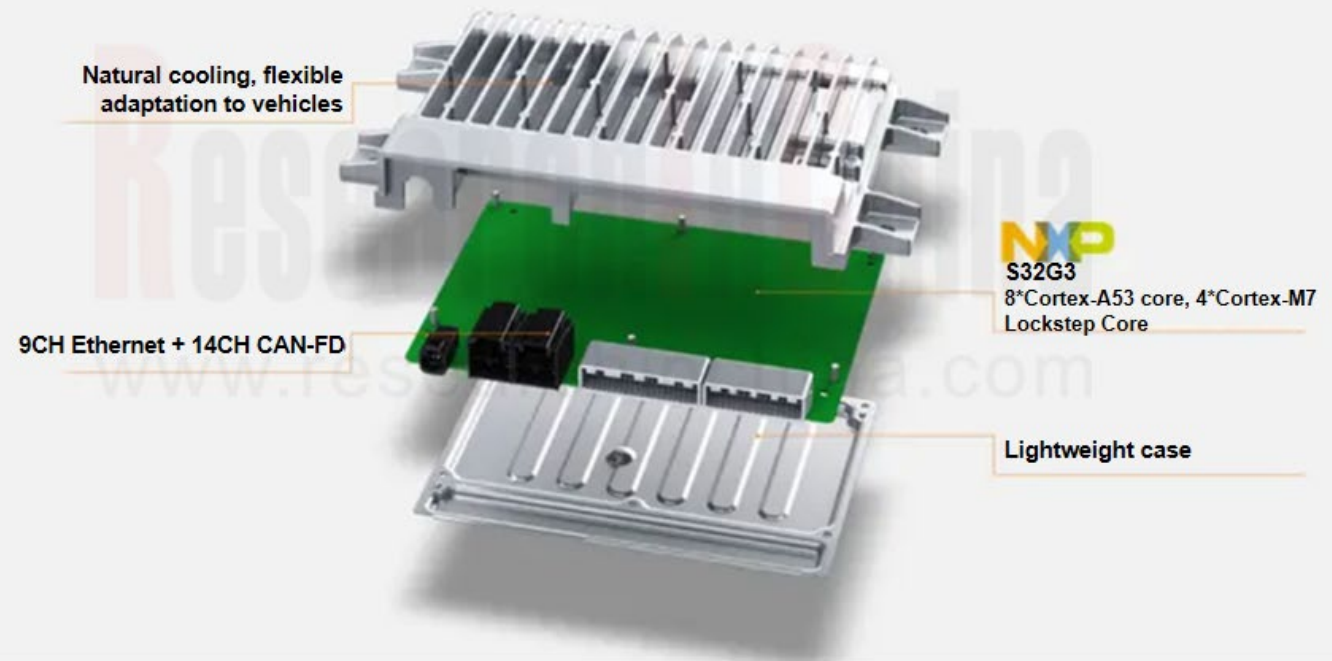
Haozhi supercomputer XPC-S32G is based on the growing EEI architecture of Neta Shanghai Platform: Equipped with NXP's high-performance S32G3 automotive network processor based on Arm Cortex-M7 and Cortex-A53; Equipped with Wind River's advanced RT-Linux operating system solution;

Equipped with a SOA software architecture based on a powerful integrated development environment.

Neta plans to use Haozhi Supercomputer XPC-S32G as the basis for the vehicle network backbone system and service-oriented SOA architecture. The system can be understood as the "hub" of in-vehicle communication backbone network, with nine functions of central gateway, vehicle thermal management, battery energy management, power torque management, remote diagnosis, calibration, full data collection, SOA-type service gateway, edge computing and OTA Master, which can realize the interconnection of high-security cross-domain functional data, as well as automotive cyber security defense, and is responsible for vehicle control management, ensuring information output with extremely low delay, and has future-oriented vehicle function iteration capabilities.

Haozhi Supercomputing XPC - S32G

Integrated gateway domain control: intelligent gateway, power control, energy management, thermal management, body control, OTA, intelligent diagnosis, etc.



Source: Neta





2. Cross-domain integration products of Tier1 suppliers: from cockpit-driving integration platform, central cross-domain platform, quasi-central computing platform, central computing platform and other dimensions

Product development direction (1): cockpit-driving domain + functional domain (gateway, network connection, body, chassis, etc.) integration

Since 2024, OEMs have successively implemented the cross-domain integration architecture and gradually iterated to the central computing platform. In the process of cross-domain integration, "cockpit-driving integration" and "cockpit-driving + other domains" concentrate the computing power of the whole vehicle, closer to the central computing platform, and are currently one of the mainstream directions of cross-domain integration. Judging from the current supply layout, most of the solutions for cockpit + cockpit-driving integration are done.

In order to meet the mainstream development trend, Tier1s has also increased its cross-domain Product R&D, such as ECarx, JoyNext, AutoLink, PATEO, Continental, Desay SV and other suppliers, have launched relevant cross-domain integration solutions.

Cross-domain Integration Solutions of Some Tier1s

Product Model	Product Model	Chip	Software	Fused Function Domain	SOP and Application
	Antora® 1000	1*Longying No.1	Cloudpeak Cross-domain Software Platform	Cockpit-parking integration	Galaxy E5
	Central computing platform	1*Longying No.1		Cockpit-driving integration	Planned SOP in 2025
		2*Longying No.1		Cockpit-driving integration	Planned SOP in 2025
		1*Longying No.1 + Huashan A1000		Cockpit-driving integration	Planned SOP in 2025
	Cross-domain computing platform nCCU	Black Sesame Wudang C1296	CoreFusion Cockpit-driving Integration Software Open Platform	Cockpit-driving integration + gateway + connectivity (5G+V2X)	/
	Cockpit-driving integration cross-domain computing platform	Qualcomm Snapdragon SA8775P + Renesas RH850U2A8	Support multiple operating systems, layered software SOA, and flexible deployment of application software	Cockpit-driving integration	Expected to be mass-produced for Neta cars in 2025
		Qualcomm Snapdragon SA8775P + Renesas RH850U2A16		Cockpit-driving integration + signal gateway	
		Qualcomm Snapdragon SA8775P + NXP S32G		Cockpit-driving integration + gateway (SOA gateway)	
	Central computing module (CCM)	Qualcomm 8295 + Horizon Journey 5*2	Support users' personalized configuration via SOA, and provide full-stack services from bottom to top	Integrate flagship cockpit, ADAS, autonomous driving and body functions, gateway, 5G, V2X	Planned SOP in 2025

Source: ResearchInChina

ECarx's cross-domain integration solutions are divided into two types: "cockpit-parking" and "cockpit-driving". The single-chip "cockpit-parking integration" solution based on "Longying No. 1" chip has been installed in mass production model of Galaxy E5, realizing the integration of intelligent cockpit and automatic parking functions.

The cockpit-driving integration solution is planned for mass production on the model in 2025 and is divided into two series:

- One is a cost-effective solution for basic "cockpit-driving-parking" functions, such as "Car Brain Antola Series", which adopts cockpit SoC Longying No. 1 with strong AI computing power. On the basis of original cockpit capability, an additional 2MP binocular camera can support development of "cockpit-driving-parking" functions, including HWA (highway assistance), ALC (automatic lane change assistance), APA (automatic parking assistance), RPA (remote control parking), as well as DMS (driver monitoring system), full scene voice interaction, HMI (human-machine interface) and other functions.
- The second is a high-performance solution for high-order "cockpit-driving-parking" functions, such as "Car Brain Series". Through the single-board integration of two high-performance SoCs of intelligent cockpit + intelligent driving, cockpit-driving is realized. Through Ecarx Yunshan cross-domain software platform, the computing power can be reasonably allocated to each demand module. PCIe high-speed data transmission is used, and the transmission efficiency is more than 10 times higher than that of the traditional. With the high computing power of the two SoCs, it supports high-order autonomous driving functions of L2 + and above to match the demand of the mainstream market for high-order autonomous driving. At the same time, the scalable design of the overall architecture also provides better flexibility for the future chip computing power allocation. The integrated software and hardware greatly improve development efficiency and significantly reduce BOM cost of the solution.

Product development direction (2): body electronics extend to central control, integrating digital chassis, power, new energy systems, etc

Traditional body electronics are gradually developing cross-domain central controller products, which are further integrated with chassis, power, and new energy systems.

Taking UAES as an example, in order to meet the hardware and software needs of customers in the new EEA of future automobiles, UAES established Cross-Domain Control Business Unit (Advanced Connection Business Unit) in April 2021, which was integrated from the former Electronic Controller Business Unit and the Body Electronics Business Unit. Beginning in 2024, the organizational structure will be further integrated, and all low-voltage controller businesses will also be merged into the Cross-Domain Control Business Unit.

The Cross-Domain Control Business Unit launched hardware products such as in-vehicle computing platform (VCP), zonal controller (ZECU), body domain controller and smart grid management module (PNG), as well as service-based software architecture (SOA) and USP software development platform.

In 2023, UAES has acquired and synchronized the development of "central computing + zonal controller + SOA" platform on the new architecture for 8 customers, and realized the mass production of the first zonal controller product in Chinese market in June 2023. Through zonal architecture, nearly 20 independent ECUs can be integrated, and the communication rate can be increased from 2M to up to 1000M.

Cross-domain Integration Product Deployment of UAES

Cross-domain Integration Product Deployment of UAES

BCM	SOP	Master MCU	Communication	Integrated Functions	Cross-domain
Vehicle motion domain controller (VCU8.6)	2024	/	<ul style="list-style-type: none"> In addition to communication modes like CAN/LIN/Ethernet, add FlexRay communication 	<ul style="list-style-type: none"> Integrated management of vehicle motion, involving propulsion, braking, steering, suspension: transverse, longitudinal and vertical control Integrated management of vehicle motion, suitable for intelligent skateboard chassis, shortening development time 	<ul style="list-style-type: none"> VCU + chassis + power control
Zone control unit (ZCU)	2023.7	Infineon TC389	<ul style="list-style-type: none"> Support 4CH CAN, 6CH LIN, 1CH ETH, network management and signal routing 	<ul style="list-style-type: none"> Support control over body-related functions such as interior and exterior lights, door locks, wipers, speakers, seats, and body anti-theft; Support control over new energy power and chassis functions such as air conditioning thermal management, electronic parking brake (EPB), and high-voltage interlock; Integrate complex algorithms such as window anti-pinch, tailgate anti-pinch and PEPS; 	<ul style="list-style-type: none"> Body + chassis + power + intelligent power distribution
Vehicle computing platform (VCP)	2022.12	NXP S32G	<ul style="list-style-type: none"> Support 18CH CAN, 12CH 100M/Gigabit Ethernet, USB2.0 	<ul style="list-style-type: none"> VCP integrates the original gateway, BCM, VCU and other functions; Integrate functions related to power and body domains, including vehicle control, BCM and gateway, as well as driving assistance functions in some projects; 	<ul style="list-style-type: none"> BCM + central gateway + VCU
Body domain controller (BDU8.1)	2021	/	/	<ul style="list-style-type: none"> Integrate keyless entry and one-button startup, active entry and approach lighting, seat adjustment and memory, multi-color ambient light control, light show control, big data collection, vehicle OTA update, remote diagnosis and other system functions; 	<ul style="list-style-type: none"> BCM + gateway
Body control module (BCM)	2019	Renesas R-Car M3	<ul style="list-style-type: none"> Support 9CH high-speed CAN, 6CH LAN, 3CH Gigabit Ethernet and 10CH 100M Ethernet 	<ul style="list-style-type: none"> Mainly used for body electrical control, while also integrating intelligent fault diagnosis, intelligent power saving, bus communication and other functions; BCM2.5 integrates PEPS function; BCM3.0 integrates vehicle air conditioning control function; BCM3.5 integrates ripple anti-pinch function; 	<ul style="list-style-type: none"> N/A

Source: ResearchInChina

3. Cross-domain integration software platform: a foundation for enabling cross-domain computing

Single-chip fusion deployment of multiple function sets will make software complexity increase significantly, which brings new concerns for OEMs, but also an urgent need to solve the problem, ECARX, NESINEXT, ThunderSoft, ArcherMind Technology and others have launched relevant cross-domain software solutions.

ECARX Cloudpeak Cross-Domain Software Platform

In response to the development trend of cross-domain integration, central computing, and the actual mass production needs of global delivery, ECARX has launched ECARX Cloudpeak cross-domain software platform for the global smart car market, which is designed with SOA concept to ensure standardization and modularization of components, covering the underlying system software (Cloudpeak Virtualization), multi-operating systems, middleware, upper-layer application modules, and global application ecosystems. It can be combined with its different computing platforms to form a complete solution, easily realizing cross-domain functionality. It has been deployed on multiple mass-produced models.



Source: ECARX

In the Lynk & Co Z10 smart cockpit solution to be released, thanks to ECARX Cloupeak's interconnection of cockpit and intelligent driving systems, the image information sensed by sensors associated with intelligent driving is processed and presented on the central control screen in real time. At the same time, it integrates the lane-level navigation of cockpit domain and NOA function of intelligent driving domain, perfectly presenting a "human-computer co-driving" interface, realizing an immersive interactive experience that restores the real physical world.

NESINEXT CoreFusion cockpit-driving integration software open API

NESINEXT and Black Sesame Intelligent jointly create the open API of cockpit-driving integrated software, which is developed based on Wudang C1296 chip, which can solve the difficulties and pain points of single SoC cross-domain fusion function deployment, and can provide OEMs and ecological partners with full-stack, efficient, and low-cost development of operating system-level software bases, power builder chains, and ecosystems.

JoyNext has a mature tool chain, creating an intelligent cockpit framework, intelligent driving AP/CP middleware and automation adaptation tools that can support C1200 series chip platform. JoyNext and Black Sesame Intelligence have cooperated for many years, and have carried out in-depth cooperation in the fields of cockpit-driving integration operating system-level software base, power builder chain and complete ecosystem.

Under the trend of central computing architecture, the in-vehicle operating system has begun to evolve from a domain operating system to a vehicle operating system. By integrating the functions of cockpit operating system, intelligent driving operating system, and safety vehicle control operating system through central computing platform, the development efficiency of OEMs can be improved.

NESINEXT CoreFusion Cockpit-Driving Integration Software Open Platform

Parameter	Description
Underlying hardware SOC	<ul style="list-style-type: none"> Black Sesame Wudang C1296
Main software components	<ul style="list-style-type: none"> Intelligent cockpit framework, intelligent driving AP/CP middleware and automated adaptation tools enable customers to achieve quick product adaptation and speed up the mass production of multi-domain fusion and cross-domain computing products.
MCU software deployment	<ul style="list-style-type: none"> Classic AUTOSAR
MPU software deployment	<ul style="list-style-type: none"> Applicable to Adaptive AUTOSAR, AUTOSAR standard development and configuration tools
Sensor access scheme	<ul style="list-style-type: none"> Based on each sensor driven independently, provide AUTOSAR-compliant ADIs (Automated Driving Interfaces).
Sensor communication mode	<ul style="list-style-type: none"> Data exchange and management with the communication middleware layer via SOA, and DDS/SOMEIP underlying protocol
Multi-OS data sharing mode	<ul style="list-style-type: none"> Based on the MessageBox network self-developed by Black Sesame Technologies, this solution provides efficient data exchange between OSs in the SoC. This method can be based on shared memory or standard DDS/SOMEIP, and the application can be flexibly configured according to the scenario. Based on the built-in 10 Gigabit Ethernet switch of Wudang C1296, The solution provides standard Ethernet exchange between OSs in the SoC and external ECUs. Based on standard DDS/SOMEIP, it supports vehicle SOA management.
Data connection mode	<ul style="list-style-type: none"> The 10 Gigabit switch subsystem of Wudang C1296 can accelerate data forwarding of high-speed CAN2CAN, ETH2ETH, CAN2ETH, etc.
Development and configuration tools	<ul style="list-style-type: none"> The solution includes a range of complete tools such as MBDT C1296 toolkit, ADI configuration tool, DDS Box, and SWC design and development tools.
Mass production	<ul style="list-style-type: none"> Production-ready reference solution

Source: ResearchInChina

NIO intelligent electric vehicle global operating system Tianshu SkyOS is the underlying operating system of NIO vehicle, establishing a comprehensive and three-dimensional technical system for vehicle R&D, so that various devices can be organically integrated to achieve efficient collaboration.

SkyOS has built a "1 + 4 + N" technology cluster, covering multiple fields such as vehicle control, intelligent driving, cockpit, mobile Internet, etc., and has become a comprehensive and leading intelligent digital technology base. The NIO full stack has developed four sub-core systems, including "SkyOS-M", "SkyOS-L", "SkyOS-R" and "SkyOS-C".

- ◆ **SkyOS-L:** The first domestic alternative to AutoSAR and a large-scale commercial real-time operating system. In comparison with AUTOSAR, SkyOS-L can execute stably whether it is a high-priority, medium-priority or low-priority instruction. AUTOSAR is not as accurate as SkyOS-L in medium-priority and low-priority instructions.
- ◆ **SkyOS-M:** It is a micro-kernel architecture, running in the central brain, mainly controlling the body, chassis, suspension, etc. The kernel is more stable than the traditional Linux, and the service isolation is better. At the same time, on the basis of security isolation, there are four layers of monitoring and three layers of recovery security mechanism.
- ◆ **SkyOS-C:** A deeply customized operating system based on Android, carrying the functions of a smart cockpit, self-developed TOX protocol stack, more stable data transmission, and AI intelligent experience including NOMI.
- ◆ **SkyOS-R:** Increase the load capacity of the system.

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