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Multi-Domain Computing and Zone Controller Research Report, 2022

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Multi-domain Computing and Zone Controller Research: Five Design Ideas Advance Side-by-side

In the trend for higher levels of autonomous driving, intelligent vehicles pose more stringent requirements in the aspects such as computing power, communication bandwidth, software, and security. This trend facilitates the evolution of automotive E/E architectures from the domain centralized to the multi-domain integrated, and then to the (quasi) central computing architecture. At present, there are primarily the following five types of automotive multi-domain computing design ideas:

Five Multi-Domain Computing Design Ideas and Cases

Multi-Domain Computing	Layout Mode	Cases
Chassis Domain + Body Domain + Power Domain	• Chassis, body and power domains are integrated into a vehicle central control domain	• OEMs: the classic three-domain integrated architectures of Volkswagen, GAC, Li Auto, ZEEKR, etc. consist of three domains: vehicle central control, intelligent cockpit and intelligent driving; • Tier 1 suppliers: Continental, ZF and Aptiv among others have launched body, power and chassis three-domain integrated products.
Cockpit Domain + Body Domain	• Integrate body and cockpit domains	• **OEMs:** Geely Auto OS, jointly built by ECARX under Geely and Baidu Apollo, integrates the cockpit intelligent domain with the vehicle control domain, enabling four functions: human-vehicle interaction, full-vehicle intelligent control, edge AI, and open ecosystem; • **Tier 1 suppliers:** based on Qualcomm 8295 chip, PATEO CONNECT+ deploys the integration of cockpit and body domains.
Cockpit Domain + Intelligent Driving Domain	• Autonomous driving and intelligent cockpit domains are integrated into another high-performance computing unit	• **OEMs:** SAIC Z-ONE adopts cockpit-driving integrated HPC and central control HPC, and configures four zone controllers to build a dual-domain integrated architecture; • **Tier 1 suppliers:** Bosch, Technomous, ThunderSoft, etc. all plan to launch cockpit-driving integrated solutions.
Chassis Domain + Intelligent Driving Domain	• Chassis and intelligent driving domains are integrated into one domain controller	• **OEMs:** NIO rolled out an intelligent chassis controller (ICC), a cross-domain integrated solution that combines the systems in the charge of the intelligent driving domain controller and chassis domain controller ICC.
(Quasi) Central Computing + Zone Controller	• Enable cross-domain integration through (quasi) central computing platform + zone controller	• OEMs: all global OEMs are stepping up their efforts to develop the (quasi) central computing platform + zone controller architecture; • Tier 1 suppliers: Bosch, Continental, Neusoft Reach, Desay SV and the like have got down to the development of central computing platforms, preparing for central computing architectures.

Source: ResearchInChina

iMotion's IDC High/Low Speed Driving and Parking Integrated Domain Controller Solution

The driving and parking integration & the cockpit and driving integration are the important directions multi-domain computing heads in.

In terms of the driving and parking integration, the low-speed parking function used to be integrated into the cockpit domain to constitute a so-called cockpit-parking integrated solution. With the evolution to high computing power platforms, 2022 will be beyond doubt the first year of the development of L2+ driving and parking integration, and more vehicles will support multi-scenario autonomous driving, for example, turn signals for automatic lane change, ramp-to-ramp autonomous driving, home-AVP, and fully automated parking.

Cockpit-driving integration is the direction many OEMs and Tier 1 suppliers work towards. It is expected that mass production and installation of cockpit-driving integrated solutions will be achieved during 2024-2025. From chip vendors, it can be seen that the Qualcomm 8795 chip that allows multi-domain integrated computing of cockpit and autonomous driving will be produced in quantities in 2024 at the earliest; Chinese suppliers like ThunderSoft and Haomo.AI have set about research and development; in addition to autonomous driving, NVIDIA Orin X will also fully integrate the development of cockpit applications to enable the fusion of autonomous driving and in-cabin algorithms through the NVIDIA DRIVE IX software stack.

iMotion concentrates on developing autonomous driving domain controllers. Following the acquisition of the orders for more than 100,000 sets from ZEEKR 001 in October 2021, the company's high computing power autonomous driving controllers have been designated by multiple first-tier OEMs like Great Wall Motor, Chery, Geely and SMART for a range of their vehicle models.

iMotion also launched a domain controller IDC product that integrates driving and parking capabilities like urban NOA and AVP. The IDC product has IDC MID (standard) and IDC HIGH (upgrade) versions, of which the standard version is to be delivered and mounted on new vehicle models of quite a few leading automakers in 2022.

Configuration of iMotion's Driving and Parking Integrated Domain Controller IDC Product

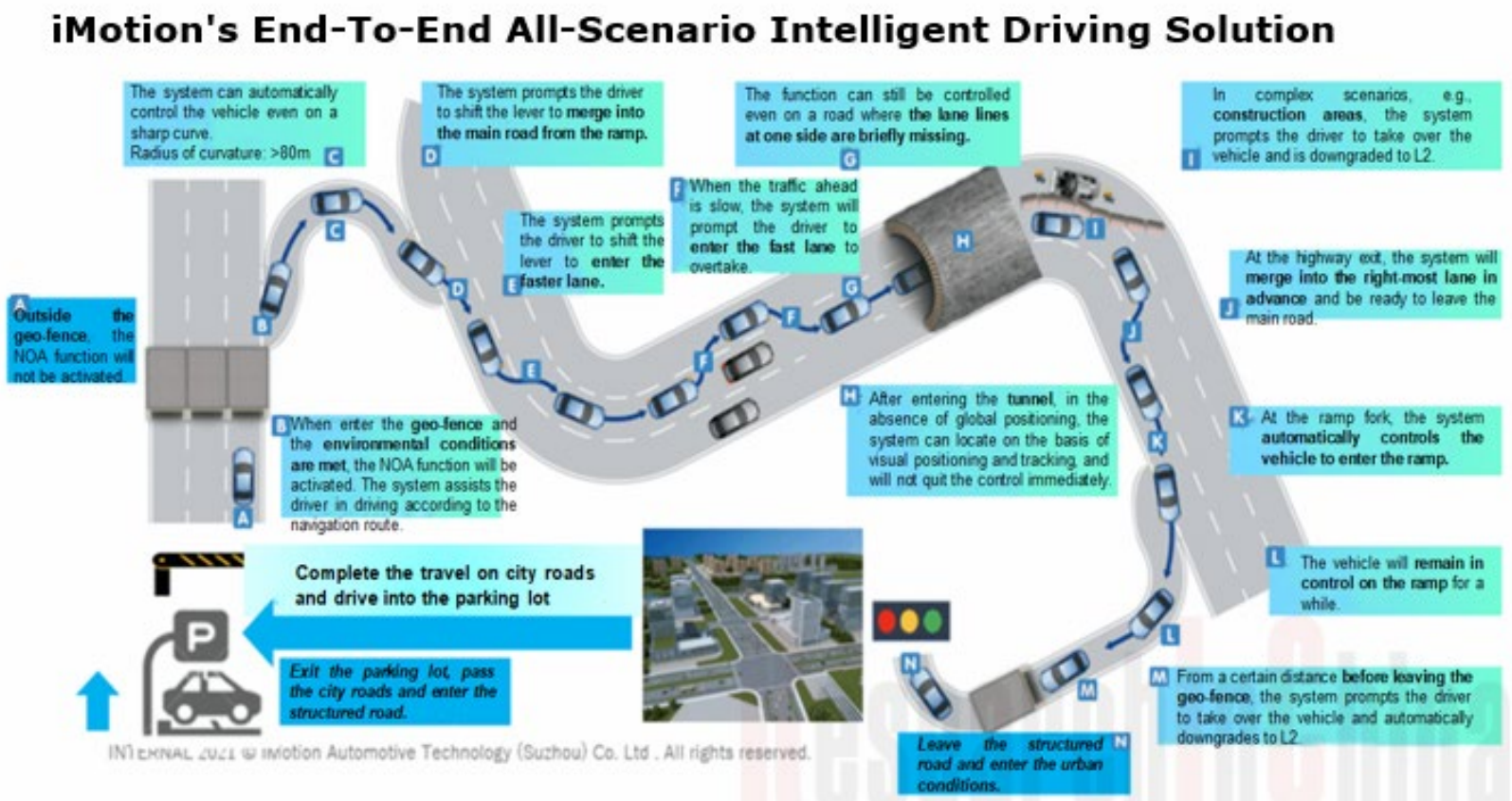
IDC MID	IDC HIGH
• Computing power: 8+TOPS • Functions: NOA and L2 driving, and HPA and 360-degree panoramic view • Hardware configuration: 4R5V12U • Main control chip: TI TDA4VM • Operating systems: Linux, AUTOSAR CP, etc. • Interfaces: 5-channel camera input interfaces, 8-channel CAN-FD, 2-channel Gigabit Ethernet	• Computing power: 100+TOPS • Functions: all autonomous driving functions, e.g., safety assurance, driving assistance, low-speed parking, automated driving assistance, etc.

Source: iMotion

iMotion's End-To-End All-Scenario Intelligent Driving Solution

iMotion's end-to-end all-scenario intelligent driving solution takes the driving and parking integrated domain controller as the carrier. Based on L2++ intelligent driving and intelligent parking, this solution collects and trains unknown scene data and updates optimized algorithms by using hardware embedded points and remote software OTA update technology, and optimizing and verifying the big data closed-loop. It constantly improves intelligent driving algorithms in a bid to adapt to more complex scenarios, find application in ever more scenarios and eventually to be available to all scenarios.

In addition to driving and parking integration, the integration of intelligent driving and intelligent cockpit domains is also a megatrend. iMotion is working with its partners to explore multi-domain integrated solutions.



Source: iMotion

Neusoft Reach's Driving and Parking Integrated Domain Controllers Keep Upgrading and Iterating

Neusoft Reach's fourth-generation autonomous driving domain controller X-Box is a new standard L2+ domain controller product developed according to the SDV development model. Based on Horizon Journey 5 Series AI chips, the product offers L2+ driving and parking functions, and supports the access of 8M cameras, 4D point cloud radars and LiDAR, with scenarios covering highways, urban expressways, some urban roads and multiple types of parking lots.

Source: Neusoft Reach

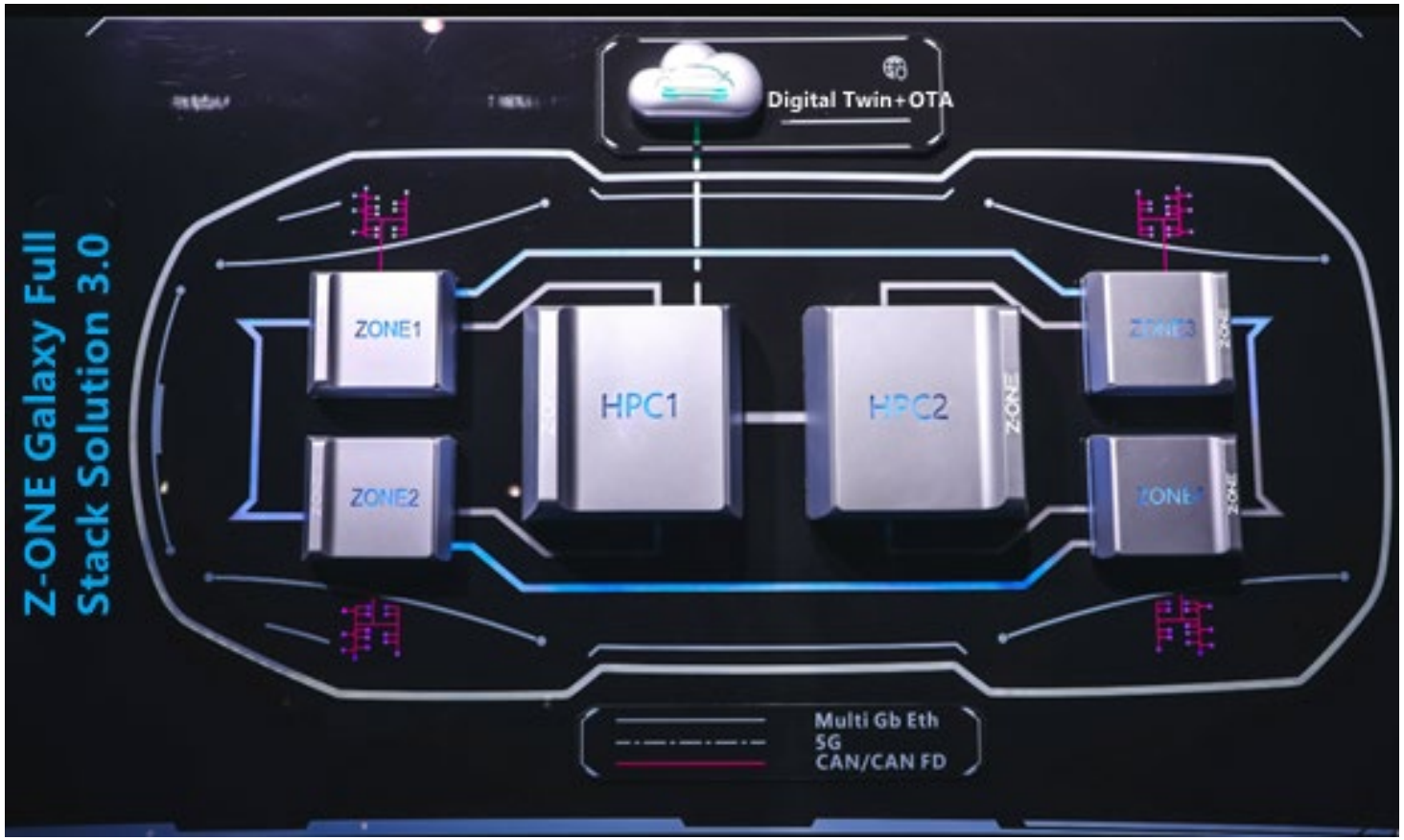
X-Box adopts the SOA software architecture design scheme, that is, software and algorithms are developed using the modular and service-oriented development model. The product enables cooperative device-cloud autonomous driving under the data closed-loop mechanism, and supports new-generation automotive E/E architectures. It enables intra-domain and cross-domain service subscription and discovery, flexible software deployment, and rapid iteration of application layer, and realizes such functions as fully open system architecture, open multi-dimensional full-stack software capability and joint development, allowing partners to quickly develop applications and reuse software. It also provides an abundance of software development tools for developer partners.

Meanwhile, in terms of safety and security X-Box is developed according to the ISO 26262 functional safety and the ISO 21434 cybersecurity standards. It implements the minimal risk strategy in typical driving and parking scenarios, and deploys secure boot/storage/upgrade/communication modules in connection systems at the vehicle, cloud and smartphone ends. It helps automakers to provide driving safety and cybersecurity guarantees for consumers. Neusoft Reach offers autonomous driving domain controller solutions for automakers at different tiers through standardized hardware, software platforms, and tool-based services.

SAIC Z-ONE's Cockpit-Driving Integrated HPC

SAIC Z-ONE plans to spawn a two-domain integrated E/E architecture in 2024, that consists of two high-performance computing units (HPC) and four zone controllers. Thereof, the cockpit-driving integrated HPC will be used to create the modular and scalable software and hardware integrated architecture that combines intelligent cockpit and high-level autonomous driving.

SAIC Z-ONE's Dual Domain Integrated Architecture Full Stack Solution 3.0



Source: Internet

Mass Production of Three-Domain Integrated Architectures of Some Automakers

The vehicle central control domain has been the first to be mass-produced.

Some OEMs currently make crucial deployments in the integration of vehicle body, chassis and power domains into one central control domain that then combines with intelligent cockpit and intelligent driving domains to form a classic three-domain architecture. From time nodes, it can be seen that multiple vehicle models based on three-domain architectures were mass-produced and marketed during 2021-2022. The three-domain integrated architectures next will further introduce zone controllers for a smooth evolution to zonal architectures.

Mass Production of Three-Domain Integrated Architectures of Some Automakers

Automaker	Time	Three-domain Integrated Architecture	Application Vehicle Model
Volkswagen	2020	E3	ID Family
Li Auto	2022	LEEA 2.0	L9
Great Wall Motor	2022	GEEP 4.0	Models based on new EV/HEV platforms, and gradually available to the full range of models
GAC	2023	Protoss Architecture	High-end Aion models
SAIC	2021	Z-ONE Full Stack 1.0	Models of IM Motors and Rising Auto
FAW Hongqi	2023	FEEA 3.0	Hongqi EV-Concept
Volvo	2022	SPA2	XC90 EV Edition
Changan Automobile	2022	CIIA 2.0	Full range of models based on Changan Deep Blue EPA1 Platform

Source: ResearchInChina

Li Auto’s Three-Domain Integrated Architecture: LEEA 2.0 / Aptiv’s Central Vehicle Controller (CVC)

Li Auto’s three-domain integrated architecture: LEEA 2.0

In June 2022, Li Auto unveiled L9, its newest model that adopts three-domain integrated architecture. The whole car is divided into three domains: central control domain, autonomous driving domain and intelligent cockpit domain. The central control domain controller fuses with power, body and some chassis functions, enabling multi-domain integration.

Central Domain Controller of Li L9

Source: Internet

Aptiv’s Central Vehicle Controller (CVC)

At the CES 2022, Aptiv showed Central Vehicle Controller (CVC), its body, power and chassis three-domain integrated controller. The CVC can serve as a power and body controller, propulsion and chassis controller, data network router, gateway, firewall, zone master and data storage hub all rolled into one – or it can perform a mix of some of those functions. It is applicable to zonal architectures.

Tesla's ZCU Configuration Scheme

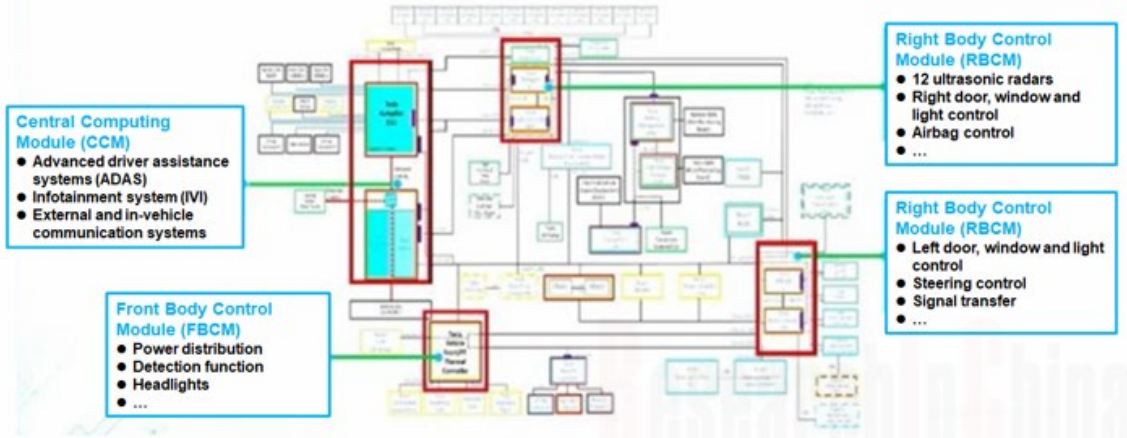
Zone controllers are the key component that carries "multi-domain + central computing".

Zonal Control Unit (ZCU) is the central hub and the zonal data center for different types of sensor collector/actuator drivers in the physical zones of vehicles. It is an effective solution to carry physical interfaces of vehicles, distribute power and balance different input/output controls in the zones, thus supporting cross-domain integration inside smart cars.

The ZCU can cut ECU usage, lowering much of the cost of wiring harnesses, and reduce weight and communication interfaces, saving space and enabling higher utilization of computing power. At present, most OEMs have planned the use of 2 to 6 ZCUs in their next-generation multi-domain computing architectures.

In Tesla's case, the central computing architecture of Model 3 uses three ZCUs respectively in the front body control module, the left body control module and the right body control module. They take on power distribution, drive and logic control in all physical zones. Tesla Model Y uses fewer ZCUs (2 units), cancels the front body control module, and integrates the function into the left and right body control modules, which means further integration of ZCU functions.

Zone Controller Configuration of Tesla Model 3

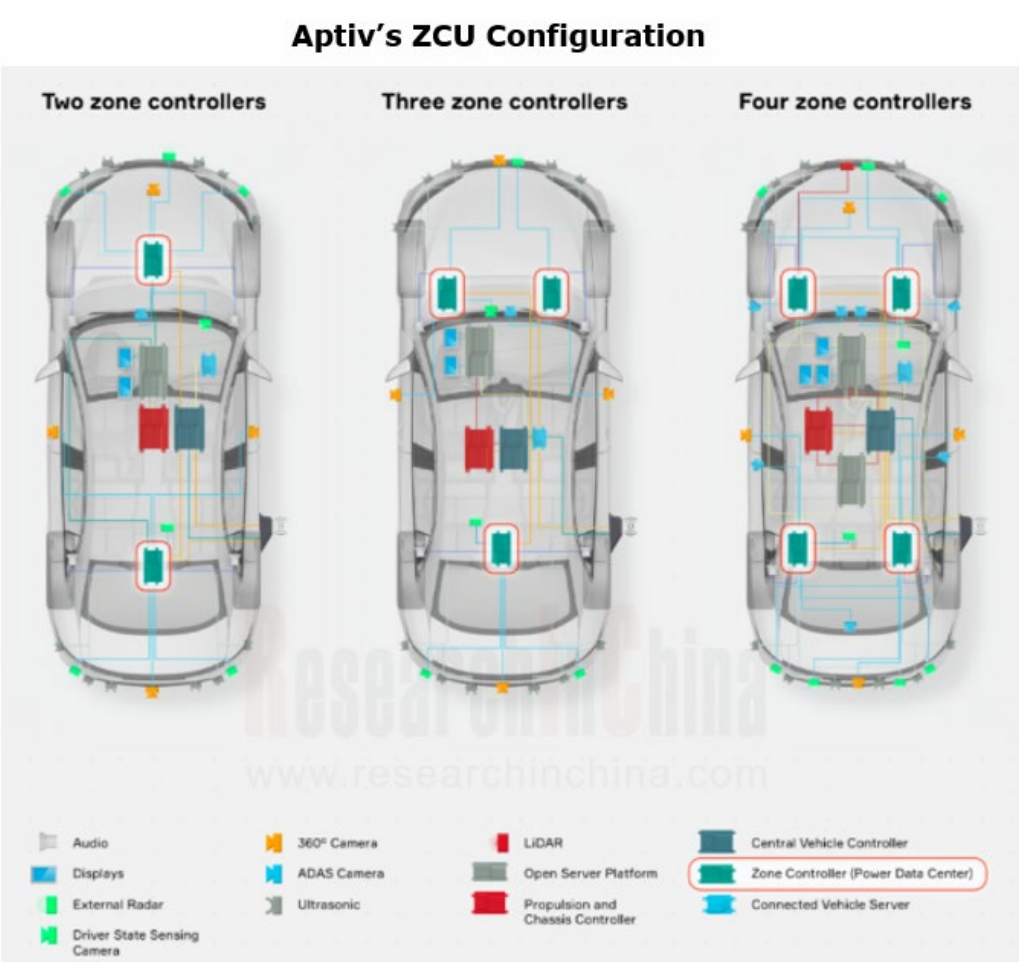


Source: Internet

Aptiv's ZCU Product - Power Data Center (PDC)

In January 2022, Aptiv introduced Power Data Center (PDC), its zone controller product that is installed on the front and rear sides of the vehicle body.

Aptiv PDC abstracts the inputs/outputs (I/O) of sensors and actuators around the vehicle from the computing power (OSP, CVC, etc. responsible for processing), and also significantly simplifies hardware interchangeability by eliminating the device layer's dependence on the computing layer via standardized service-based APIs.



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