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China Autonomous Driving Domain Controller Research Report, 2023

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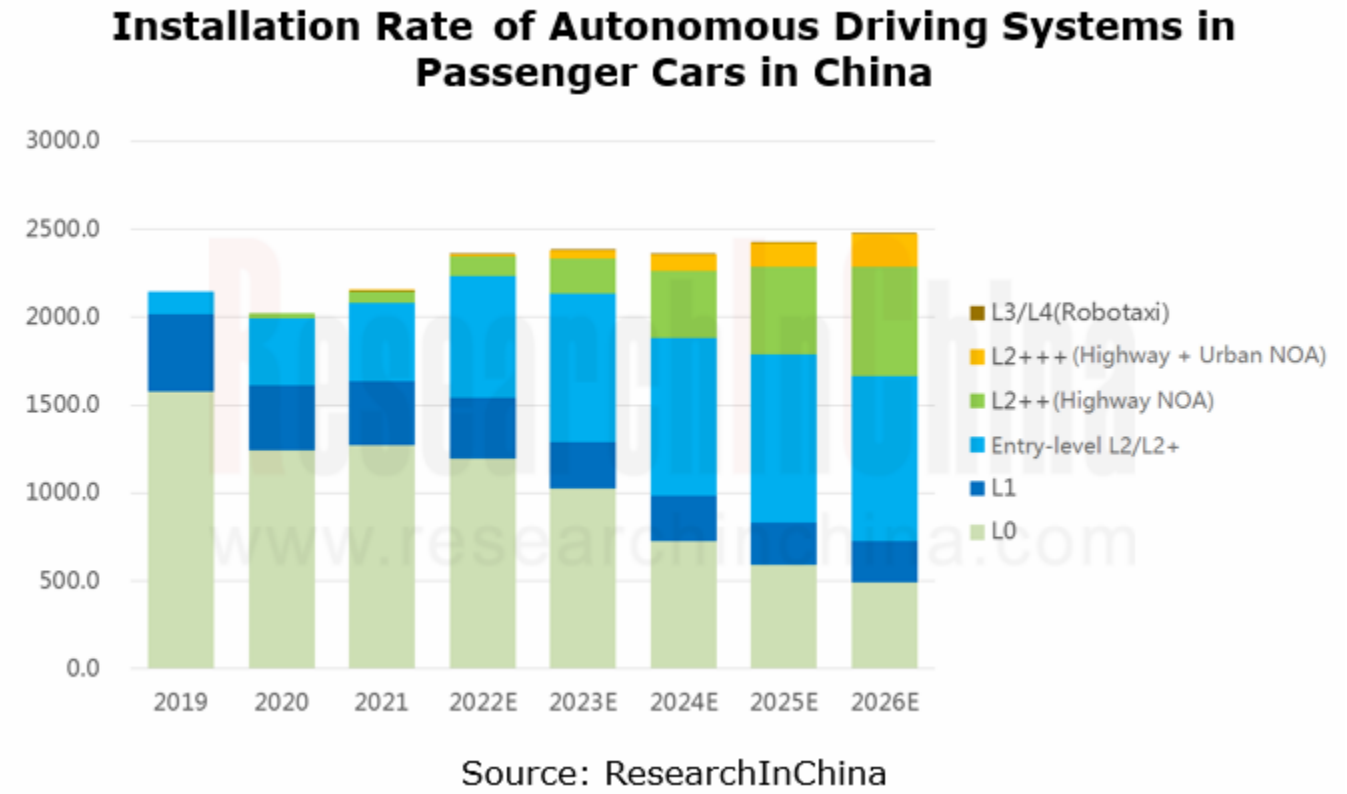
Autonomous driving domain controller research: explore computing power distribution and evolution strategies for driving-parking integrated domain controllers.

In China, at this stage the industry is concentrating efforts on mass production and application of L2++ or L2+++ autonomous driving that is infinitely close to L3. In this process, various new solutions mushroom, including new technologies (BEV perception, data closed loop, etc.), new functions (urban NOA, highway NOA, home zone parking pilot (HPP), valet parking, etc.), new architectures (domain centralized EEA, cross-domain fusion EEA, etc.), new sensors (4D imaging radar, LiDAR, etc.), new chips (high-compute chip integrated BEV framework, etc.), new communication protocols, and new development concept (SOTIF).

By 2026, the sales of passenger cars equipped with OEM L2++ (supporting highway NOA and driving-parking integration) are expected to reach 6.236 million units; the sales of passenger cars with OEM L2+++ (supporting urban NOA + AVP) are expected to reach 1.833 million units.



The autonomous driving development path is becoming clear, and the industry heads in the direction of “cost reduction” and “efficiency improvement”.

The development path of autonomous driving system tends to be clear, and "cost reduction" and "efficiency improvement" have been a megatrend for the industry. By Black Sesame’s estimate, the BOM cost of domain controllers can be controlled within RMB3,000 in the case of 10V (camera) NOA function, supporting 50-100T physical computing power; in addition, by 2024, the cost of a complete 100TOPS NOA solution (domain controller and chip + HD map and positioning module + system integration and development + test and verification, based on BEV algorithms and without LiDAR) is expected to drop significantly to less than RMB7,000 from the current RMB15,000.

The computing power distribution and evolution strategies for driving-parking integrated domain controllers have become clear, highlighting the following solutions:

Entry-level L2/L2+: many vehicle models have already packed L2 driving assistance functions, and most of them use intelligent front-view all-on-ones such as 1R1V/3R1V solution, with low mass production costs, and the average computing power of platforms lower than 5 TOPS; L2 often adopts chips with low-to-medium computing power, such as Horizon Robotics J2/J3, Ambarella CV Series, Mobileye EyeQ3/4 and EyeQ6L upgrade version, TI TDA4VL, and Renesas R-CAR V3H.
L2++: in 2023, lightweight driving-parking integration and highway NOA are the key functions spawned by major OEMs, most of which use 5R5V or 5R6V configuration scheme coupled with high precision positioning and HD map modules, to realize end-to-end highway NOA, HPP and other functions. Such systems mostly use 1-3 cost-effective SoCs and 5-20TOPS domain controller platforms. Moreover, to further reduce the cost, single-chip driving-parking integrated domain controllers are becoming a trend.
L2++ Pro: with lower chip costs, lightweight driving-parking integrated domain controllers tend to offer higher computing power of 30-70 TOPS, and can run 6V, 7V, 9V, 10V and 11V perception solutions to enable more powerful vision algorithms; at the chip level, the evolution route has been presented, for example, new products like TI TDA4VH, black sesameA1000, RenesasR-Car V4H, and EyeQ6H are scheduled to start volume production and be installed in vehicles during 2023-2024.
L2+++: the key functions of high performance driving-parking integration and urban NOA are infinitely close to L3. Based on BEV perception algorithms, the urban NOA allows for "getting rid of HD map", and can carry 1-3 LiDARs or 4D imaging radar and >100TOPS computing platforms. At the chip level, chip vendors design high-compute chip architectures actively compatible with BEV perception algorithms and deliver their BEV algorithm framework to customers.
L3/L4: mainly used in Robotaxies at present. It is expected that in 2023 China will release the L3 autonomous driving standards. It will still take a very long time from draft and final draft release to system R&D, and then to SOP and deployment.

Typical driving-parking integrated domain controllers

Typical driving-parking integrated domain controllers that often adopt 5R5V, 5V6R and 5R11V help to enable highway NOA functions such as HWA (highway assist), TJA (traffic jam assist) and AES (automatic emergency steering), as well as parking functions like APA (automated parking assist), HPA (home-zone parking assist) and RPA (remote parking assist). With 1-3 additional LiDARs, they can realize urban NOA.

Neusoft Reach X-Box 4.0: with Horizon Robotics J5 and SemiDrive X9 high-compute chips and a 5R11V sensor solution, it supports access to 11 HD cameras, 4D radars, ultrasonic radars and 8MP cameras, and meets ISO 26262 functional safety and ISO 21434 cyber security standards, so as to enable highway NOA.

To cut down cost and improve efficiency, in addition to common solutions, other solutions such as 6V, 7V and 9V have also come out. Players reduce the use of radars, enhance vision-only algorithms and introduce BEV perception algorithm framework. Some Tier 1 suppliers even propose introduction of BEV perception algorithm framework into platforms with computing power of over a dozen TOPS, so as to further lower the threshold to enable urban NOA.

QCRAFT 6V1R Highway NOA Solution: compared with 5V5R solutions, the Horizon Robotics J5-based solution has a higher cost of domain controllers but saves the cost of 4 radars. On the whole there is not a big difference in their cost. QCRAFT's 6V1R solution highlights visual perception algorithm, and also brings the fisheye camera in the perception results during driving. Based on this hardware, the 6V1R solution allows for deployment of the BEV framework, and provides better experience and a longer service life than 5V5R solutions.

DJI Vision-only Driving-parking Integrated Solution: with computing power of 32TOPS, it is supposed to use a TI TDA4VH SoC. The perception solutions include a pair of DJI vehicle-specific front-view IMU stereo cameras, a rear-view mono camera, and four surround view fisheye cameras. Based on the powerful online real-time visual perception, decision and planning capabilities, this driving-parking integrated solution can enable all functions except urban NOA without relying on HD maps (the 7V configuration coupled with HD maps to realize urban NOA).

Emerging carmakers already stay one step ahead, and conventional OEMs are also accelerating architecture upgrade and high-level NOA implementation.

OEMs are stepping up E/E architecture evolution. Take BYD as an example:

e3.0 Architecture: launched in 2021, the architecture integrates five major functional domains: power, chassis, safety, entertainment, and body electronics. The electronic parts of each functional domain are laid out in a centralized way. The 12-in-1 body domain features four domain controllers and self-developed vehicle operating system (BYD OS) in the new E/E architecture;

Central Computing Platform + Zone Controller Architecture: in 2024, the central computing platform + zone controller architecture was introduced to create BYD OS, a vehicle operating system which consists of two parts: BI OS for the chassis control domain; BU OS for intelligent cockpit and intelligent driving assistance.

BYD's previous autonomous driving systems mostly used the front-view all-in-one solutions from Bosch, ZF and Veoneer. Although the old solutions have yet to fall into disuse in full, BYD is also building closer partnerships with chip vendors and integrators such as Nvidia, Horizon Robotics, Huawei, Baidu and Momenta on high-end models like Denza, Yangwang and Xingji.

At the end of 2021, BYD and Momenta announced the establishment of a new joint venture called “DiPi Intelligent Mobility Co.” to develop NOA, an advanced autonomous driving system to be mass-produced and deployed in 2023. This solution is expected to be equipped with dual Desay SV IPU04 ORIN autonomous driving domain controllers.

In general, in the fierce low-cost competition among automakers, autonomous driving system Tier 1 suppliers, domain controller Tier 1 suppliers and even SoC vendors are accelerating their pace of hardware and algorithm innovations in a bid to seek out most cost-effective solution combinations that provide better performance experience.

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