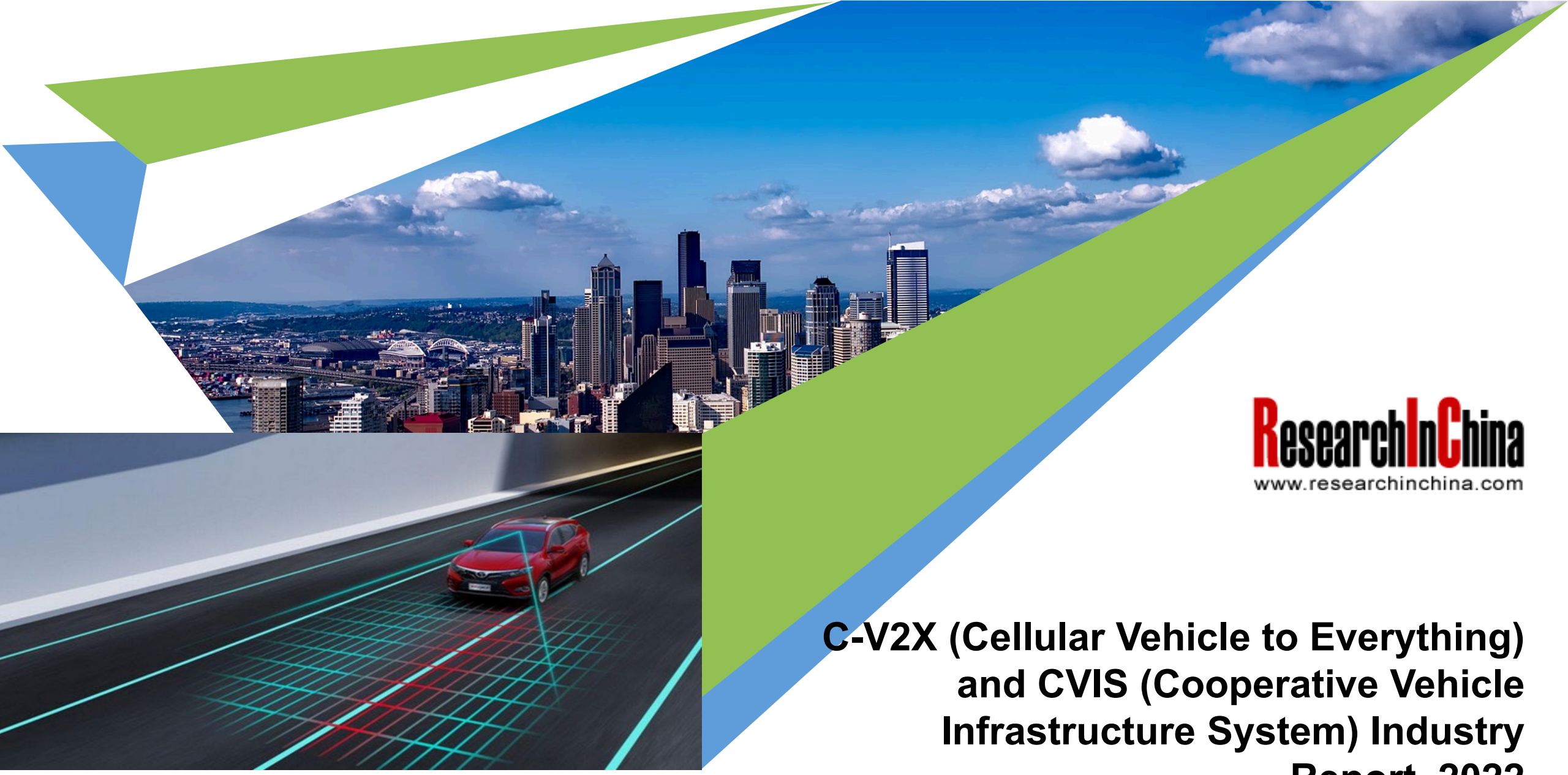

ResearchInChina
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C-V2X (Cellular Vehicle to Everything) and CVIS (Cooperative Vehicle Infrastructure System) Industry Report, 2022

Sept. 2022

More than 20 production passenger car models were equipped with C-V2X, with a rising penetration.

According to our statistics, from January to June 2022, the production passenger cars packing C-V2X technology reached about 46,000 units, with installation rate up to about 0.5%, the figures projected to reach 2 million units and 10% in 2026. We forecast installation rate growth based on following three considerations:

Consideration 1: Strategy for Innovation-driven Development of Intelligent Vehicles points out that by 2025, vehicle wireless communication networks (LTE-V2X, etc.) will provide regional coverage, and the application of new-generation vehicle wireless communication networks (5G+C-V2X) in some cities and highways will be phased in. This may be one of the reasons why automakers used more C-V2X modules in the past two years. In the future they can upgrade V2X functions over air (OTA) in the light of coverage of vehicle wireless communication networks.

In addition, China also has a plan for the penetration of autonomous driving. 5G+C-V2X is a crucial supplement to autonomous driving capabilities. Through the lens of technology development trends, OEMs also need to make some deployments ahead of time.

Consideration 2: in June 2022, Audi acquired China's first "LTE-V2X Safety Warning Function Certification" at International Forum on Testing and Certification Technology for Intelligent Connected Automobile Products, indicating the application effectiveness of telematics warning function and powering OEMs in installation of C-V2X technology

In addition, the 2022 C-V2X Cross-industry Pilot Plugfest indicates first-stage application practices (e.g., safety warning function and traffic information prompt) and second-stage application verifications (e.g., cooperative lane change and roadside perception data sharing).

Technology Evolution in C-V2X Cross-industry Pilot Plugfests, 2018-2022

Time	Event
2018	• Held the world's first cross-communication module, cross-terminal, cross-vehicle interconnection demonstration event ("three crosses" for the first time)
2019	• Add cross-safety platform, and highlight the demonstration of V2X communication security authentication mechanism
2020	• Add HD map and positioning, and explore the strategy of first deflecting the GNSS coordinate and then encrypting it • Adopt a new digital certificate format and increase the cloud control platform
2021	• Demonstration of first-stage application by production cars • First demonstration of second-stage application
2022	• First-stage application practices in all scenarios • Second-stage application verifications

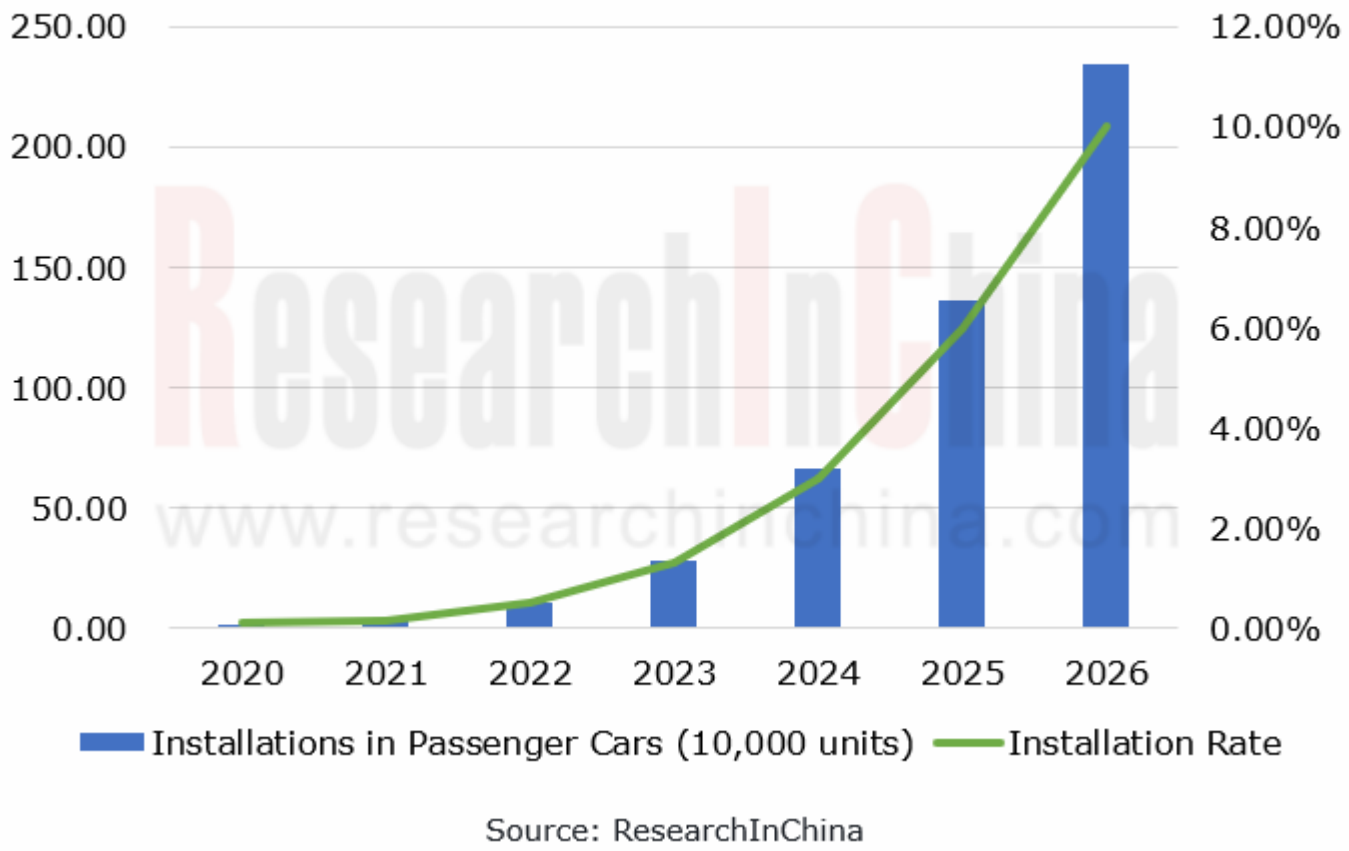
Source: ResearchInChina

More than 20 production passenger car models were equipped with C-V2X, with a rising penetration.

Consideration 3: the rising penetration of passenger car OEM 5G modules will facilitate the pre-installation of C-V2X. In August 2022, Ministry of Industry and Information Technology indicated its attempts to research and plan 5G-V2X frequency use in a timely manner, in a bid to promote coordinated development of current LTE-V2X and future 5G-V2X technological regimes. In the future the realization of autonomous driving is inseparable from 5G and C-V2X technologies. It is predicted that in 2024, the penetration of 5G in passenger cars will exceed 10%.

As a whole, by our conservative estimate the installation rate of C-V2X in 2024 will be around 3% and higher than 10% in 2026.

Installations and Installation Rate of C-V2X in Passenger Cars in China, 2020-2026E



Source: ResearchInChina

Installation of C-V2X in Some Production Passenger Cars

Our statistics show that since the mass production and installation of C-V2X in 2020, China has had more than 20 production models carrying C-V2X technology, of which the full range of quite a few models was equipped with it as a standard configuration: Hongqi E-HS9, HiPhi X, NIO ET7, Ford's new-generation Mondeo, EVOS, Mustang Mach-E, Edge PLUS, etc.

Installation of C-V2X in Some Production Passenger Cars

OEM	Model	Time To Market	V2X-enabled Edition
SAIC-GM Buick	2021 GL8 Avenir	Dec. 2020	V2X is optional for the full range, with price of RMB10,000.
SAIC	MARVEL R	Feb. 2021	The "R PILOT Intelligent Driving Growth Package" is optional for MARVEL R Pro Edition, and the 5G-V2X function is upgraded via FOTA. The optional price is RMB30,000.
Great Wall Motor	TANK 500	Mar. 2022	It is optional for the Zaojing Sport Five-seat Edition and Zaojing Business Five-seat Edition, and standard for the customized edition. The optional "Intelligent Package" includes navigation on highway (NOH) and 5G + V2X, with price of RMB20,000.
Ford	Mustang Mach-E	Apr. 2021	Standard for the full range
	EDGE PLUS	Dec. 2020	Standard for the full range
Ford (Lincoln)	2022 Adventurer	Jun. 2021	Standard for the full range
GAC	AION V	Jun. 2020	Optional 5G Pioneer Package, with price of RMB9,600
FAW Hongqi	E-HS9	Dec. 2020	Standard for the full range
HiPhi	HiPhi X	Sept. 2020	Standard for the full range
NIO	ET7	Jan. 2021	Standard for the full range
BAIC BJEV	ARCFOX αS	Apr. 2021	Standard for Huawei Inside (HI) Edition

Source: ResearchInChina

V2X Deployment

In function's term: in current stage, V2X technology is often used to enable basic safety functions such as traffic light signal push, green wave speed, green light startup alert, red light warning, intersection collision warning and road information broadcasting, still playing a minor supporting role in intelligent driving.

For now, automakers' vigorous C-V2X deployments probably aim to provide sufficient redundancy for subsequent high-level autonomous driving systems, and to improve future V2X function upgrades via OTA.

Lincoln: the V2X technology mounted on 2022 Lincoln Adventurer allows the car to know in advance how long a traffic light will remain before approaching intersection and work out whether to safely pass the intersection in current speed before green light turns red, and gives the corresponding prompts – if it can, displaying green ripples on the floating center console, and if not, issuing audible and visual warnings.

In terms of installation form: from the mass-production solutions installed by OEMs, it can be seen that V2X terminals as independent devices can be integrated into vehicles, or V2X modules can be integrated into conventional T-BOX or further into smart antennas, and may be integrated into domain controllers in the future.

Anhui Jianghuai Automobile Group: in August 2022, it launched a new vehicle OEM C-V2X product created with Datang Gaohong Zhilian Technology - 5G+C-V2X Information Domain Controller that integrates Gaohong Zhilian's automotive C-V2X module DMD3A and C-ITS protocol stack. In the future, they will jointly work on pre-research on C-V2X and ADAS integration and enable mass production of modules and application in vehicles.

Chinese players have built a complete C-V2X industry chain, providing technical support for mass production

The C-V2X industry chain is long and involves multiple players. This report summarizes and analyzes the high-quality suppliers in the C-V2X industry chain, including top 15 suppliers of C-V2X vehicle terminals, top 14 suppliers of C-V2X modules, top 10 suppliers of C-V2X software stacks, top 10 suppliers of roadside units (RSU), top 10 suppliers of C-V2X solutions, and top 6 suppliers of C-V2X chipsets.

Take C-V2X module as an example:

From the software and hardware layout, it can be seen that Chinese companies have built a complete C-V2X industry chain.

Supplier		Typical Product
QUECTEL	Quectel	**AG55xQ Series:** include four models, i.e., AG550Q (5G + DSSS + C-V2X), AG551Q (5G + DSSS), AG552Q (5G + DSDA) and AG553Q (5G + DSDA + C-V2X), and use 3GPP Rel-15 technology
HUAWEI	Huawei	**MH5000:** use Balong 5000 chip, a single-core multi-mode chip, and support SA/NSA dual networking
MORNINGCORE	Morningcore Technology	**CX7101:** based on self-developed chips, support complete protocol stacks, e.g., NEBULA, Neusoft and nFore, and various V2X application algorithms
neoway有方	Neoway Technology	**A590:** developed on Qualcomm automotive-grade chips; support the integration of 5G cellular network and CV2X technology
高鸿智联	Gaohong	**DMD3A:** developed on Morningcore CX1860 chip, small size, low power consumption, easy to integrate
ALPSALPINE	Alps Alpine	**UMCC1:** use Morningcore CX1860 chip and the Cellular V2X All in One module, and take the application processor and V2X protocol stack as the standard All in One
Fibocom	Fibocom	**AX168-GL:** the main chip integrates dual-core ARM Cortex A7 application CPU and safety CAN MCU
GOSUNCN 高新兴	Gosuncn	**GM860A:** 5G-V2X module; developed on Qualcomm SA515M chip, and supporting deployment of SA and NSA networks
ZTE中兴	ZTE	**ZM8350:** provide PC5 interface; adapt to Linux embedded operating system and ITS protocol stack
ublox	Ublox	**VERA-P3:** built-in u-blox UBX-P3 DSRC/802.11p V2X chip
SIMCom	SIMCom	**SIM8800E/SIM8800CE:** support 5G communication and V2X functions, and internally integrate high-precision positioning RTK
nFore	nFore Technology	**F9312Q:** adopt Morningcore CX1860 chip, and integrate national standard-compliant C-V2X communication protocol and security stacks
MobileTek	Mobiletek Communication	**WG7101:** adopt Morningcore CX1860 chip, support C-V2X PC5 direct communication, with built-in AP processor, and comply with the IATF16949 automotive quality management system standard
LONG UNG	Longsung Technology	**VX610:** automotive-grade 5G NR sub-6Ghz module, using 3GPP Rel 15 technology

Source: ResearchInChina

C-V2X chip: technology keeps iterating

For C-V2X chips pose a high technical barrier, currently only a few companies like Qualcomm, Autotalks, Huawei and Morningcore Technology have the capacity of mass production and supply. Although Chinese players have broken foreign monopoly, their market shares are still low. Most C-V2X modules on market still use chips from Qualcomm and Autotalks. Huawei HiSilicon chips are largely supplied for Huawei C-V2X modules. Besides private use, Morningcore Technology's chips are also provided to Gaohong Zhilian, Mobiletek Communication, nFore Technology and Alps Alpine among others.

At present, Chinese and foreign companies are all working hard on C-V2X chip technology interaction to meet mass production and application requirements.

Autotalks: TEKTON3 and SECTON3, the third-generation C-V2X chipsets launched in July 2022, are the world's first V2X chipsets that support 5G-V2X for Day 2 scenarios (compatibility to any Day 1 vehicle) and introduce Functional Safety certification. First samples are expected to be available in early 2023, and the first cars equipped with the new chipsets are set to be available in 2025.

Morningcore Technology: the first-generation CX1860 and the two series of second-generation chips, CX1910 and CX1911 have been rolled out. The leading SDR SoC technology is used for performance optimization and continuous technology evolution through software reconfiguration.

Morningcore Technology's first-generation chip CX1860 is the industry's first C-V2X SoC that integrates baseband and application processors. The second-generation chips CX1910 and CX1911 are developed and mass-produced for OEMs, offering big improvements in communication capability, application processing capability and CVIS application scenarios. They enable the smooth evolution to the latest communication standards, and support more advanced intelligent driving scenarios.

Morningcore Technology's C-V2X Chip Industry Line

Source: Morningcore Technology

C-V2X module: Chinese suppliers are dominant

Our statistical results show that domestic players prevail in the C-V2X module market. In addition to C-V2X modules, major suppliers are also working to deploy 5G+C-V2X modules. Examples include Quectel AG55xQ Series, Huawei's second-generation MH5000, Neoway A590, and Gosuncn GM860A.

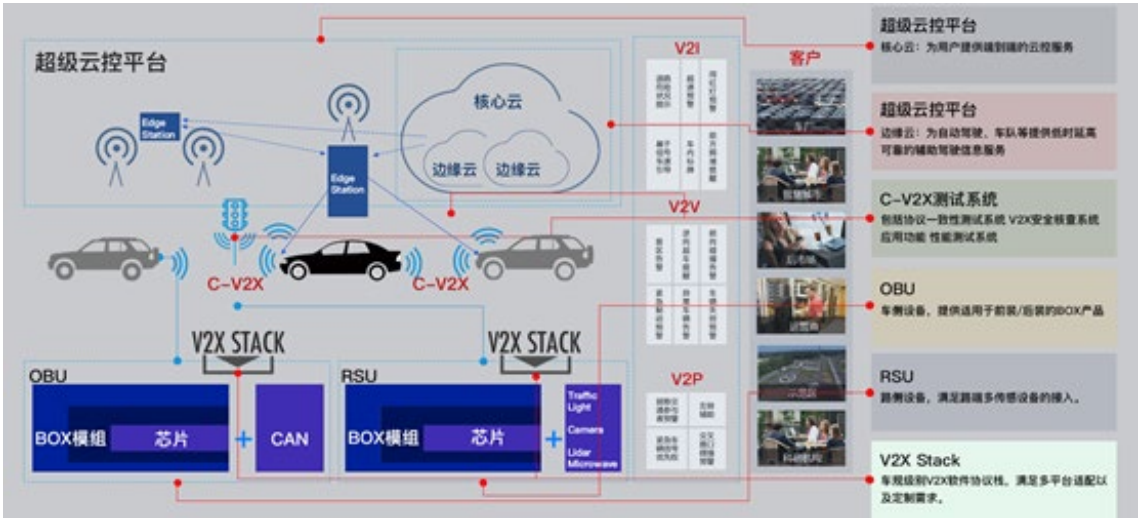
Quectel: the mainstream C-V2X module supplier boasts abundant product lines expanded from initial C-V2X module AG15 to LTE-A + C-V2X module AG52x Series, 5G+C-V2X module AG55x Series and AG215S AP module, and further integrating such functions GNSS and 5G.

Quectel's C-V2X modules have been spawned and mounted on vehicles. Currently all the V2X-enabled production models on offer like Buick GL8 Avenir, Hongqi E-HS9 and HiPhi X use Quectel's C-V2X modules.

C-V2X software protocol stack: independent development can sharpen competitive edges

V2X software protocol stack is the core technology and competitive edge in the V2X field. In view of current market demand, customers prefer custom or secondary development based on original V2X standard protocol stacks. Industry providers therefore are trying hard to develop C-V2X software protocol stacks on their own. At present in China, Neusoft Group, NEBULA LINK, Gosuncn, Baidu, ISMARTWAYS and the like have the self-development capability.

Neusoft Group: as a key C-V2X standard setter and commercialization promoter, Neusoft Group has deeply partaken in the formulation of 46 international/Chinese V2X industry standards, and 49 V2X invention patents. It has introduced China's first self-developed complete V2X protocol stack product VeTalk, and has complete CVIS solutions and end-to-end C-V2X products. Up to now, the company's self-developed cooperative vehicle-infrastructure system (CVIS) has been widely used by major OEMs and intelligent connected vehicle demonstration areas in China. Its 5G TBOX was the first one to be certified by the Ministry of Industry and Information Technology, and has secured mass production orders of several leading domestic automakers.



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