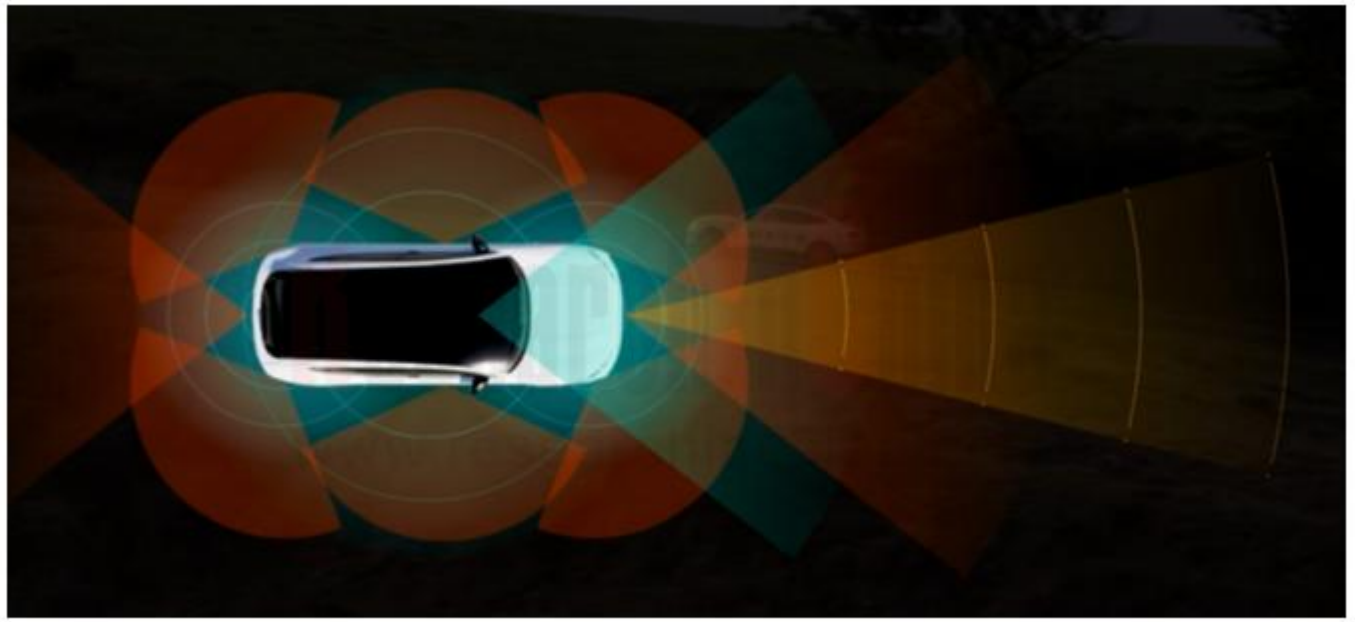
ResearchInChina
www.researchinchina.com

# Automotive Millimeter-wave (MMW) Radar Industry Report, 2024

Dec. 2024

# Radar research: the pace of mass-producing 4D imaging radars quickens, and the rise of domestic suppliers speeds up

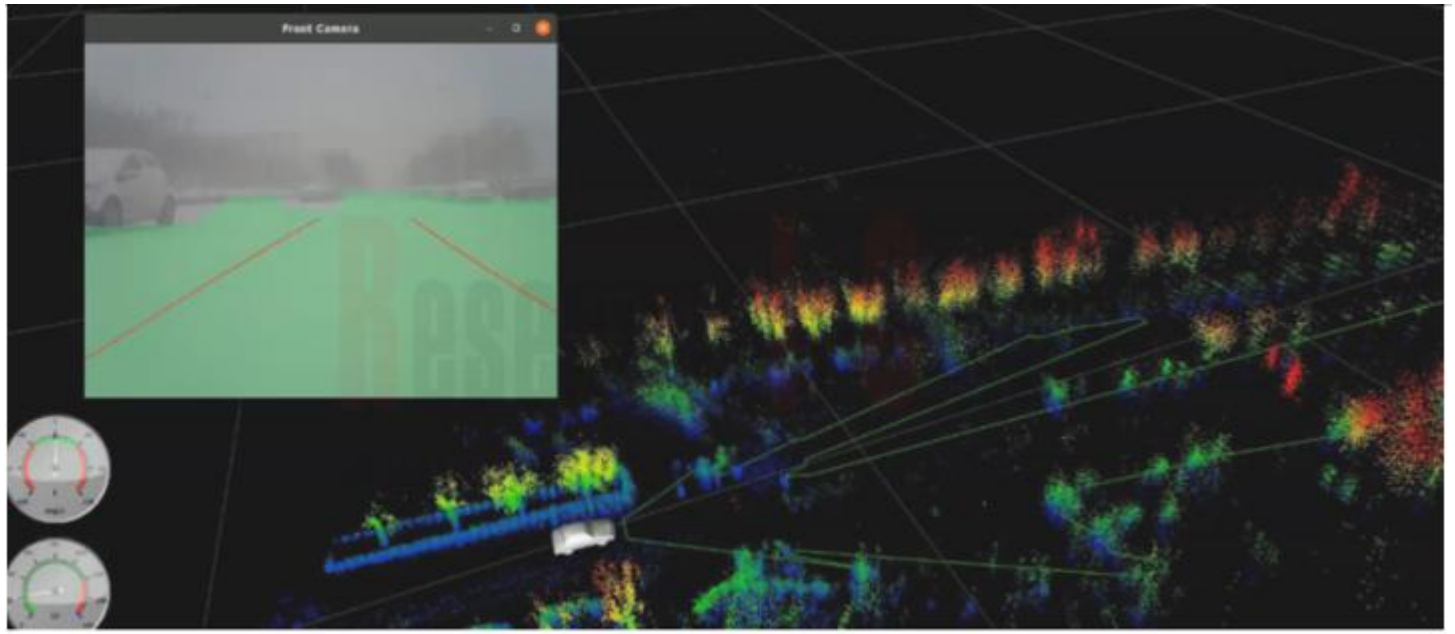
At present, high-level intelligent driving systems represented by urban NOA are facing more complex driving environments and roads. This poses higher capability requirements for the perception system, requiring it to provide a longer detection range, a wider detection angle, and a higher accuracy. Wherein, radars, as a part of the perception system, can deliver stable performance in rain, snow, fog and low-light environments, especially high-performance 4D imaging radar which can enhance the overall perception capability of the autonomous driving system.



Source: Aptiv

# 4D radar can partially replace LiDAR

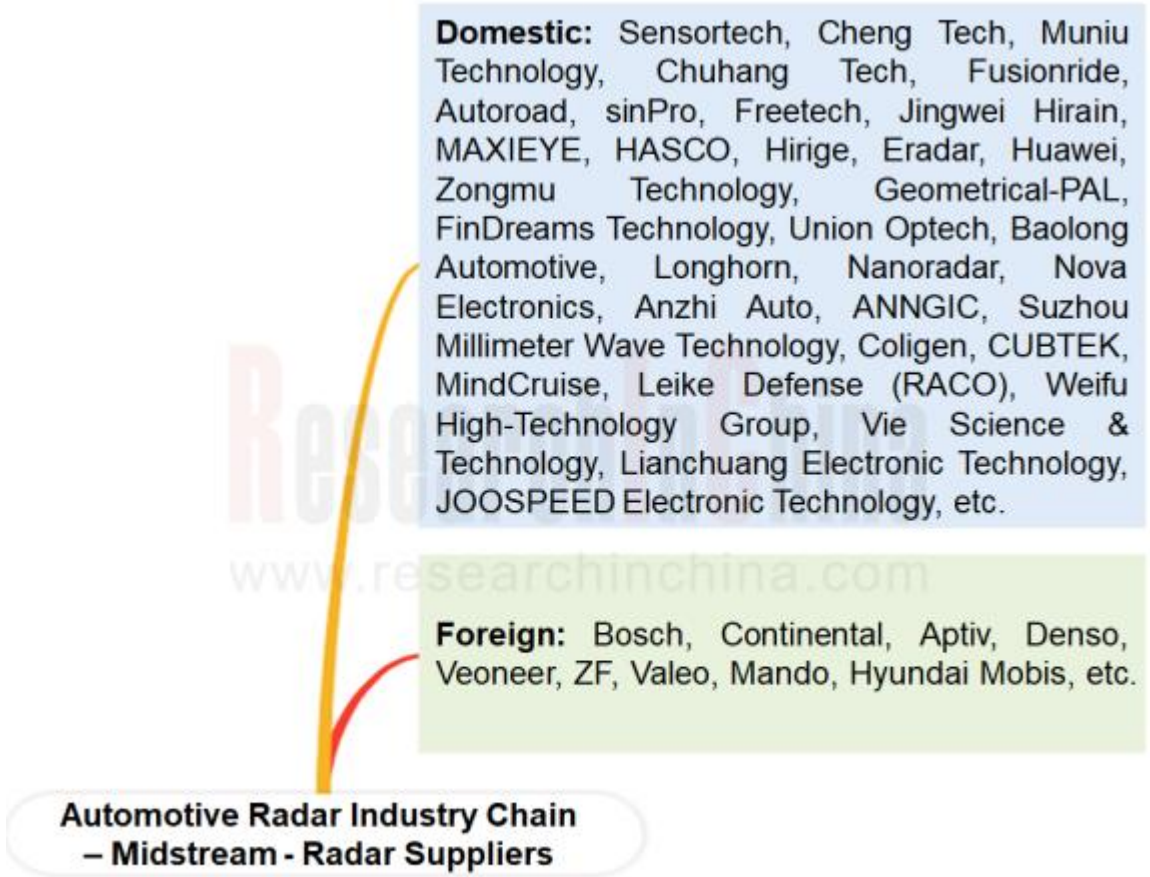
Compared with 3D radar, 4D radar (distance, speed, horizontal azimuth, vertical height) provides point cloud functions by increasing the number of transmitting and receiving channels. From 3T4R (12 channels) to 6T8R (48 channels), and to 12T16R (192 channels) and even to 48T48R (2,304 channels), it offers increasingly high accuracy of point cloud imaging, gradually replacing traditional radars. In the case of multi-radar networking, it can partially replace LiDAR.



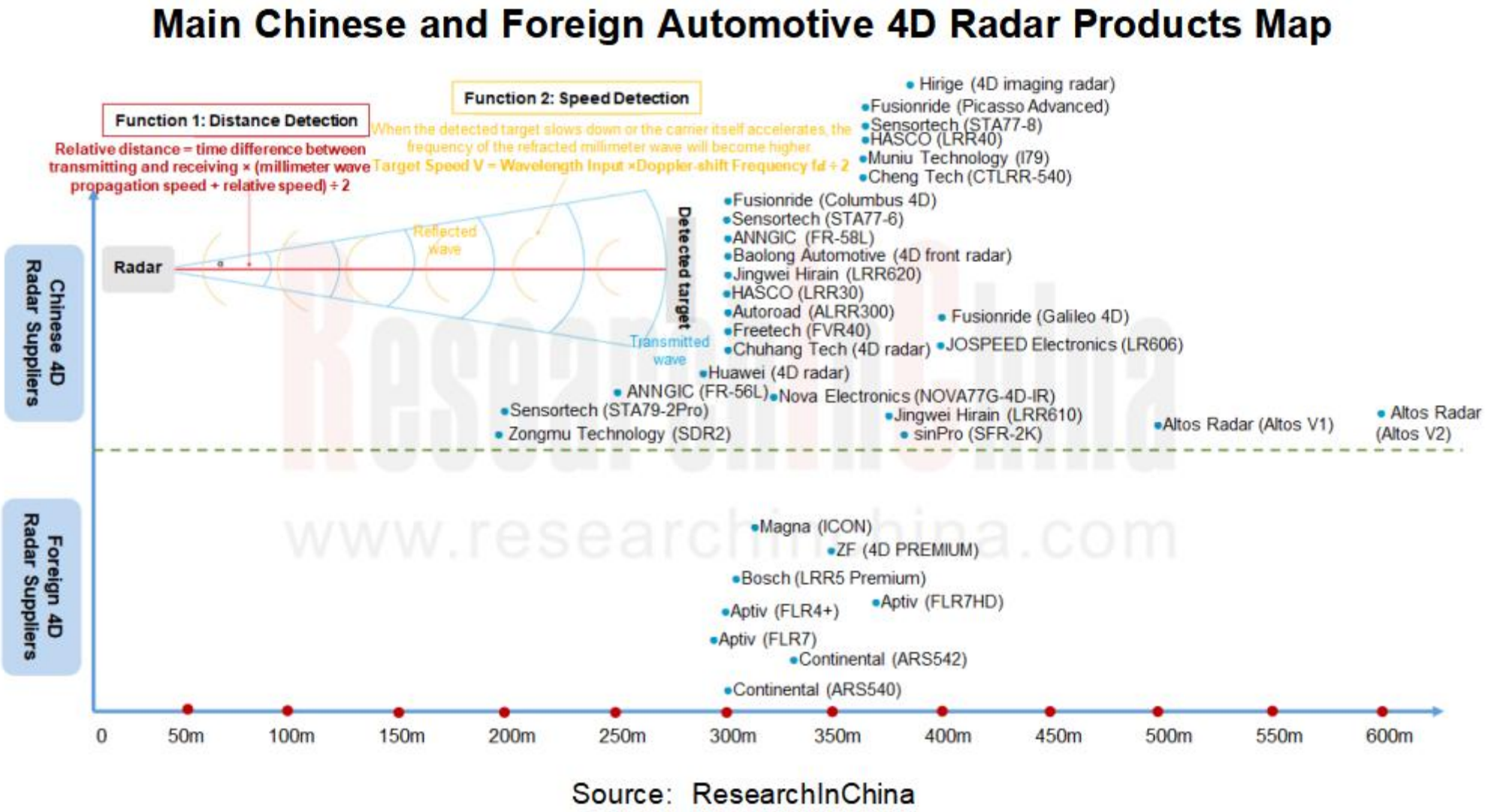

Source: Jingwei Hirain

# The installations and installation rate of radars in passenger cars in China ramp up

With the rising installations and installation rate of ADAS, the installations and installation rate of radars in passenger cars in China ramp up. According to the data from ResearchInChina, in 2023 radars were installed in 10.933 million passenger cars in China, with an installation rate of 52.0%; from January to July 2024, 6.531 million cars were installed with radars, with the installation rate up to 57.3%. At present, there are many players in the automotive radar market, especially more new domestic entrants intensifying the industry competition.




Source: ResearchInChina



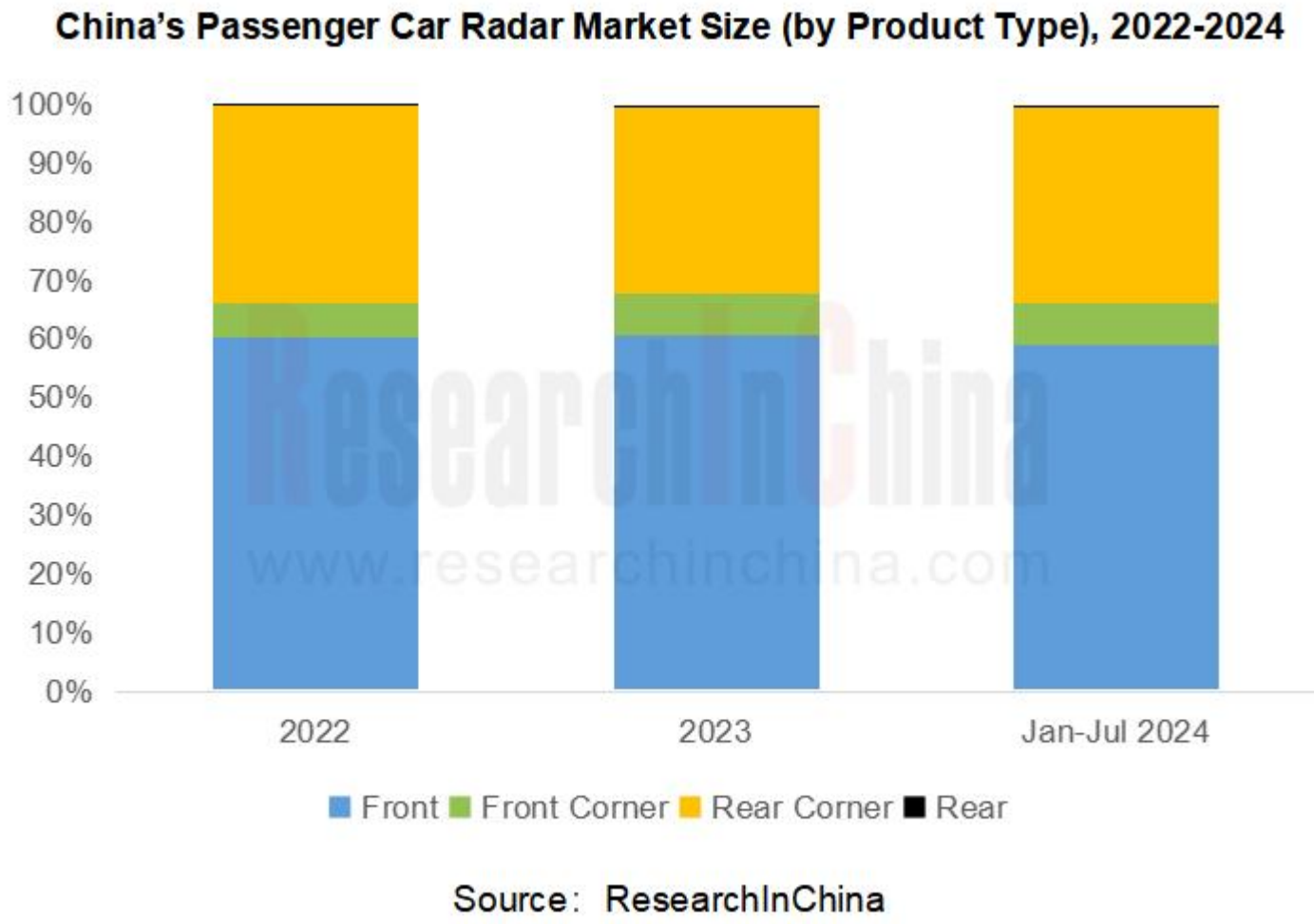

Source: ResearchInChina

# China's radar market is valued at over RMB6 billion in 2024, and domestic radar suppliers begin to grab higher market share

1. **China's radar market is valued at over RMB6 billion in 2024, and domestic radar suppliers begin to grab higher market share.**

Combining the industry average price of front/corner radars and the installations of radars, ResearchInChina's data shows that China's passenger car radar market was worth RMB5.82 billion in 2023, up by 13.0% year on year; from January to July 202 the market was valued at RMB3.01 billion, increasing by a small margin of 3.4% on a like-on-like basis. It is expected that the market size will exceed RMB6 billion in 2024.

In terms of product type, front radars boast high value and the largest installations, sweeping about 60% of the overall market; rear corner radars follow, with a market size of RMB1 billion from January to July 2024, or more than 30% of the overall market; front corner radars make up about 7% of the overall market; rear radars are seldom used, taking a lower than 1% share.



# Bosch, Continental, and Denso are the top three front radar suppliers in China

Moreover, by installations, Bosch, Continental, and Denso are the top three front radar suppliers in China, with a combined market share of more than 70%. However, under the impact of domestic suppliers, they have seen a declining share year by year (the share of the TOP3: 84.1% in 2022, 82.1% in 2023, and 74.6% from January to July 2024); while the share of domestic suppliers such as Sensortech, Cheng Tech and Huawei is expanding. From January to July 2024, the market share of the three companies totaled 13.3%.

In the context of cost reduction and efficiency improvement and fierce competition, ever more OEMs have begun to choose diverse suppliers that can provide cost-effective radars. As technology advances and the mass production and application of products accelerate, domestic radar suppliers have begun to enter the supply chain systems of more OEMs in the fields of front radars (including 4D radar) and corner radars (including 4D radar), scrambling for bigger market share in the segments.

For example, in October 2023, sinPro completed the industry's first fully automatic 4D imaging radar production line, expected to produce 800,000 units annually after operation. In August 2024, sinPro’s self-developed automotive dual-chip 4D imaging radar SFR-2K was officially mass-produced and rolled off the production line, supporting models such as NIO ET9 and ONVO L60. In addition, Chuhang Tech has a production base in Anqing City, China, with annual capacity of more than 1.8 million radars (including 4D radars); Cheng Tech’s total annual capacity of radars is up to over 13 million units (including 4D imaging radars).

# Relationships between Foreign Radar suppliers and TOP3 OEMS

**Relationships between Foreign Radar Suppliers and TOP3 OEMs, Jan-Jul 2024**

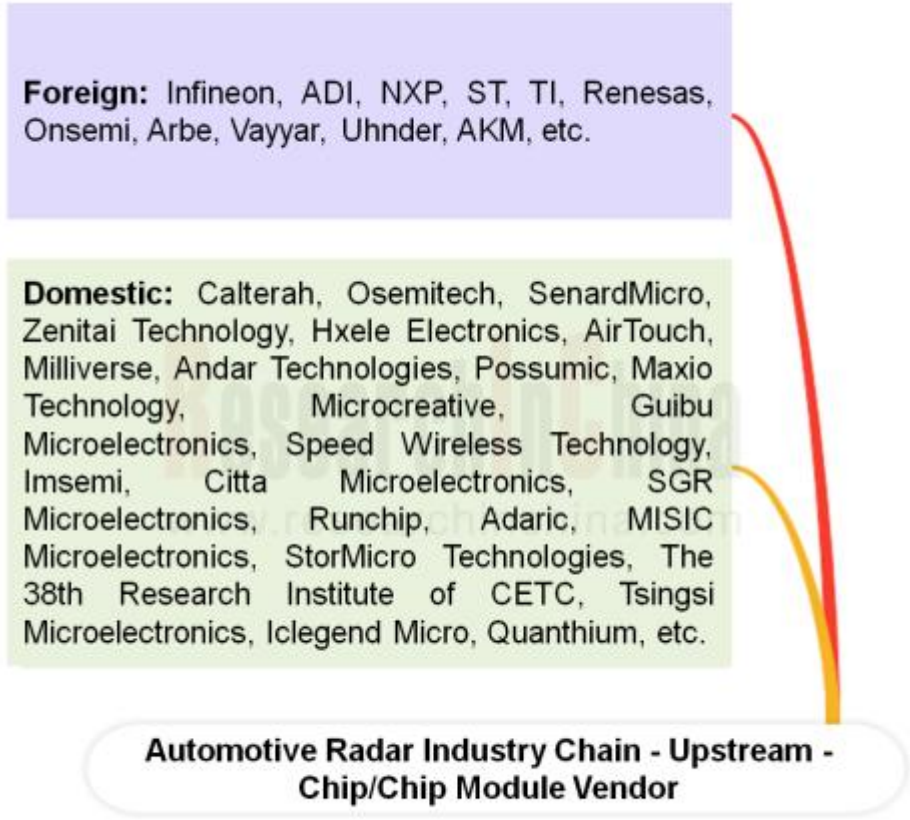
| Radar Supplier | Supported OEM (TOP3) | |
|---|---|---|
| | Front Radars (Incl. 4D Radars) | Corner Radars |
| Bosch | Volkswagen, Audi, Honda | BYD, Volkswagen, Denza |
| Continental | Volkswagen, BMW, Mercedes-Benz | Toyota, Nissan, Xiaomi Auto |
| Denso | Toyota, Honda, Mazda | Toyota |
| Aptiv | NIO, Ford, Lincoln | BMW, NIO, Haval |
| ZF | MG, Dongfeng Aeolus, Rising Auto | |
| Veoneer | Volvo, Geely, Lynk & Co | Mercedes-Benz, BYD, Honda |
| Valeo | | Nissan, Hyundai, EXEED |
| Hyundai Mobis | Hyundai, Kia | Hyundai |
| FORVIA Hella | | Volkswagen, Cadillac, Buick |

Source: ResearchInChina

# Four development trends of radar technology

**2. Four development trends of radar technology**

At present, the upstream end of the automotive radar industry chain is still dominated by foreign chip/chip module vendors. The main players include Infineon, ADI, NXP, ST, TI, Renesas, onsemi, Arbe and Uhnder. Yet domestic radar suppliers are also developing rapidly, and quite a few start-ups have emerged. Domestic players are led by Calterah, Osemitech, and SenardMicro.




Source: ResearchInChina

## Chip Products of Some Chinese Radar Chip Vendors

| Vendor | Representative Chip | Transceiver Solution | Features |
|---|---|---|---|
| Calterah | CAL77S344-AR | Alps-Pro 4T4R 77/79 GHz | • Fully integrated automotive-grade radar ROP® SoC<br>• Support waveguide antennas<br>• AEC-Q100 Grade 2<br>• ASIL-B functional safety certification |
| SenardMicro | Kestrel342 | 76~81GHz, 3T4R | • Released in April 2024.<br>• TX output power higher than 15dBm, RX noise figure as low as 15dB, phase noise of -97dBc/Hz ~-98 dBc/Hz at 1MHz frequency offset<br>• Based on Cheetah's 4T4R baseline product, SenardMicro plans to launch the CMOS 8T8R chip in August.<br>• Subsequently, SenardMicro will conduct multiple external tests on the two chips of Cheetah 4T4R and 8T8R, and core customers will carry out module development and testing. |
| | Cheetah | 76~81GHz, 4T4R | • In July 2024, it was successful in internal testing. |
| Zenitai Technology | CRM21046 | 4T6R/8T12R | ** |
| Hxele Electronics | HRM768134G40A | 76~81GHz, 3T4R | ** |
| | HRM768144S40A | ** | ** |
| Microcreative | Taurus3-mini | ** | ** |
| Andar Technologies | ** | ** | ** |
| Osemitech | ** | ** | ** |
| AirTouch | ** | ** | ** |
| Milliverse | ** | ** | ** |
| Possumic | ** | ** | ** |
| Maxio Technology | ** | ** | ** |

Source: ResearchInChina

# The evolution of radar technology, especially the development of satellite architecture, helps create more cost-effective 4D radar products

In radar design, the first thing to consider is how to improve antenna efficiency. At present, the industry is developing from microstrip antenna to waveguide antenna technology. For waveguide antennas have low energy loss, suppliers like Bosch and Continental use it. Air waveguide antennas have even lower capacity loss. Suppliers working to promote it include Aptiv (4D radar FLR4+), and XretinAI Technology (compared with microstrip antennas of the same size, its Quasi-Air Integrated Waveguide (AIW) antennas enable a gain boost of about 5dB).

Secondly, the antenna packaging technology is evolving from AoB to AiP (Antenna in Package), to reduce antenna feeder loss. A few companies such as Calterah have launched ROP? (Radiator-on-Package) technology, which uses solder balls to connect RF signals, has higher channel isolation, and offers a longer detection range and a wider FOV. The more advanced packaging technology LoP is being used by Continental in the production of its sixth-generation radar chips. LoP (Launch on Package) enables the electromagnetic waves emitted by the radar to propagate directly from the chip through the air waveguide, avoiding the higher energy loss and high cost caused by etching the antenna on the circuit board, achieving low cost and also improving the radar's detection performance.

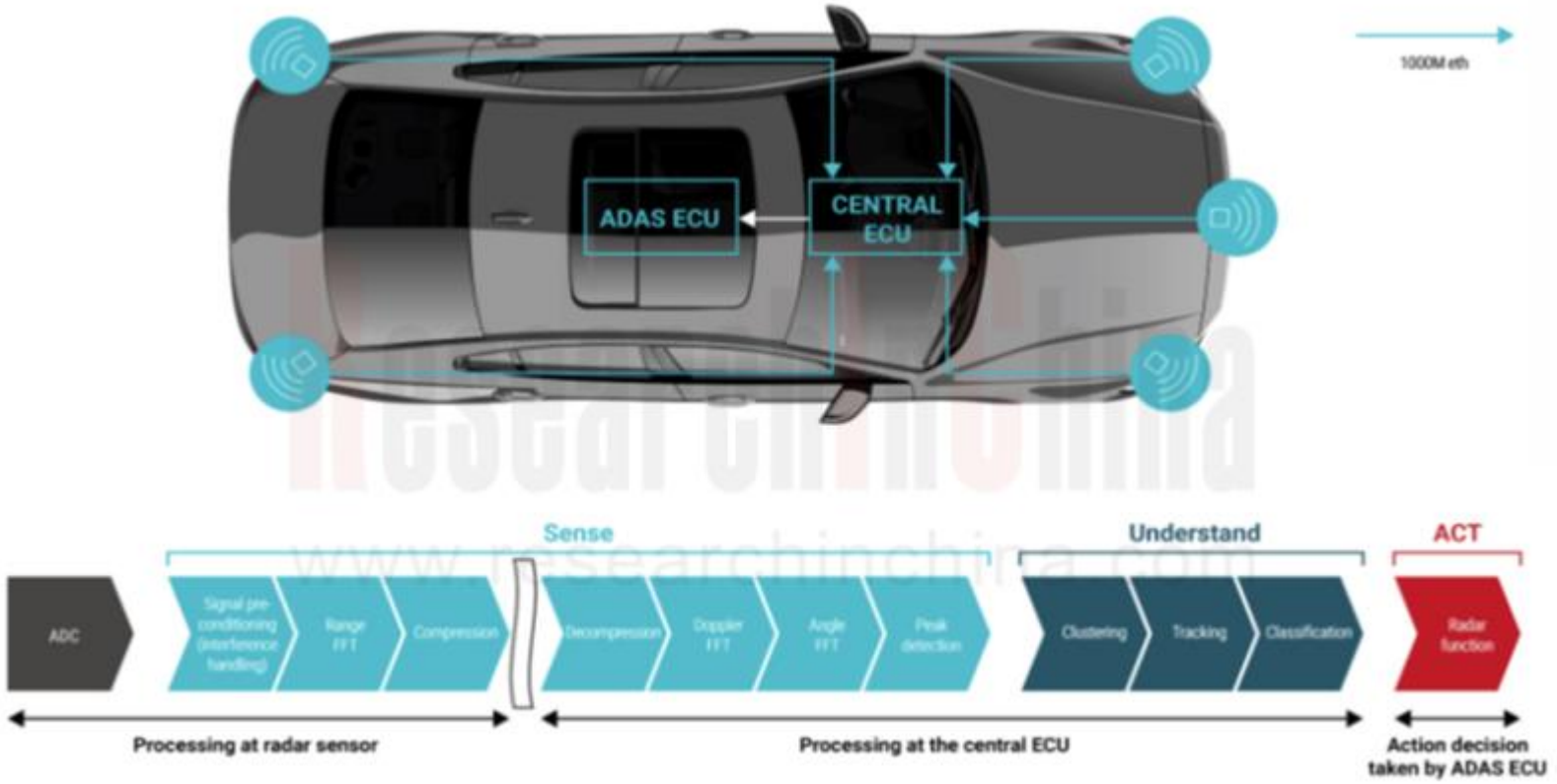
Signal anti-interference is also a factor that must be taken into account. For example, one of the unique benefits of Uhnder's single 4D digital imaging radar chip with 192 virtual channels (12T 8 x 2R) is the use of advanced digital code modulation (DCM) technology, which can effectively improve the anti-interference performance of the radar system and resist interference signals in various complex environments. In addition, to prevent multiple vehicle radars from transmitting RF signals at the same time in overlapping frequency bands, Continental adopts the intelligent time synchronization approach to prevent interference between the vehicle radars. Moreover to avoid interference from radars on other vehicles when the vehicle is traveling, Code is added to the waveform and Decoding is performed as the echo signal is received. This encryption method is used to shield the interference from other vehicle radars.

In radar design, the most critical thing is that the signal processing architecture is developing towards satellite architecture. This distributed architecture can leave most of the signal processing and object recognition tasks to the central processing unit, thereby exploiting the computing power and computing resources of the central processing unit. The higher computing power and more software processing are a solution to stable detection and other problems of radars in the case of a complex scenario and multiple objects.

# Satellite radars also face many challenges

Satellite radars use the RF front-end and some pre-processing modules as radar modules, and integrate all the computing power into the vehicle central computing module. As communication means get optimized, some pre-processing modules can be transferred to the central computing module, thus forming a pure RF front-end radar. For example, the Altos RF Series is a non-computing front-end radar module, a radar solution deeply integrating domain controllers, with price about half of similar models with processors. It uses the computing resources of the intelligent driving domain controller or the central domain controller to generate high-quality point clouds.

Yet satellite radars also face many challenges. ① Processing large amounts of data increases the hardware cost of domain controllers. ②Mainstream high-compute chips' support for and compatibility with radar algorithms need to be improved and optimized. ③ OEMs now still mainly use the object-level data output by satellite radars, and have technical difficulties in using ADC data directly. So OEMs are less willing to switch between satellite radars and traditional radars, and more actual cases are needed to promote market acceptance.




Source: TI

## Satellite Architecture Layout of Same Suppliers

| Vendor | Satellite Architecture Chip | Features |
|---|---|---|
| TI | AWR2544 on-chip radar sensor designed specifically for satellite architecture | • It has an integrated 77GHz transceiver with 4T4R, which provides longer detection range and better performance.<br>• It also includes a cost-optimized radar processing accelerator and a throughput-enhanced 1Gbps Ethernet interface for generating and streaming distance FFT compressed data.<br>• The device is also designed with TI's Launch on package (LOP) technology. |
| Aptiv | 7th-generation 4D corner radar | • At CES 2024, exhibited the seventh-generation 4D corner radar, supporting satellite architectures such as SRR7 and SRR7+. |
| Ambarella | In December 2022, announced centralized 4D imaging radar architecture, using CV3 master chip | • It allows both central processing of raw radar data and deep, low-level fusion with other sensor inputs - including cameras, lidar and ultrasonics.<br>• This architecture enables dynamic allocation of the CV3's processing resources, based on real-time conditions, both between sensor types and among sensors of the same type. For example, in extreme rainy conditions that diminish long-range camera data, the CV3 can shift some of its resources to improve radar inputs. Likewise, if it is raining while driving on a highway, the CV3 can focus on data coming from front-facing radar sensors to further extend the vehicle's detection range while providing faster reaction times. |
| Fusionride | In April 2023, showcased a satellite radar system architecture solution | • Reuse algorithms, successfully transplant mature radar signal processing platform algorithms to the domain controller system environment, make full use of hardware resources, improve radar performance, and achieve a detection range of 350m.<br>• Reduce the cost of a single radar product, wiring harness and installation costs, and the overall system solution cost by 30%.<br>• With large bandwidth communication, the overall bandwidth up to 6Gb, it enables high-speed transmission of raw radar data, and is compatible with the standard interfaces of existing mainstream domain controllers based on GMSL serialization and deserialization solutions.<br>• Implemented on domestic chips, improve product cost performance, and provide a complete domestic solution. |
| XretinAI Technology | In December 2023, launched a 4D radar central computing system | • In December 2023, based on Black Sesame's chip Huashan-2 A1000, introduced a 4D radar central computing system to uniformly process radar raw data in the domain controller. |

Source: ResearchInChina

# Table of Content (1)

# Table of Content (2)

# Table of Content (3)

# Table of Content (4)

# Table of Content (5)

# Table of Content (6)

# Table of Content (7)

# Table of Content (8)

# Table of Content (9)

# Contact


**Beijing Headquarters**

TEL: 13718845418
Email: report@researchinchina.com


Website: ResearchInChina

WeChat: Zuosiqiche


**Chengdu Branch**

TEL: 028-68738514
FAX: 028-86930659


zuosiqiche