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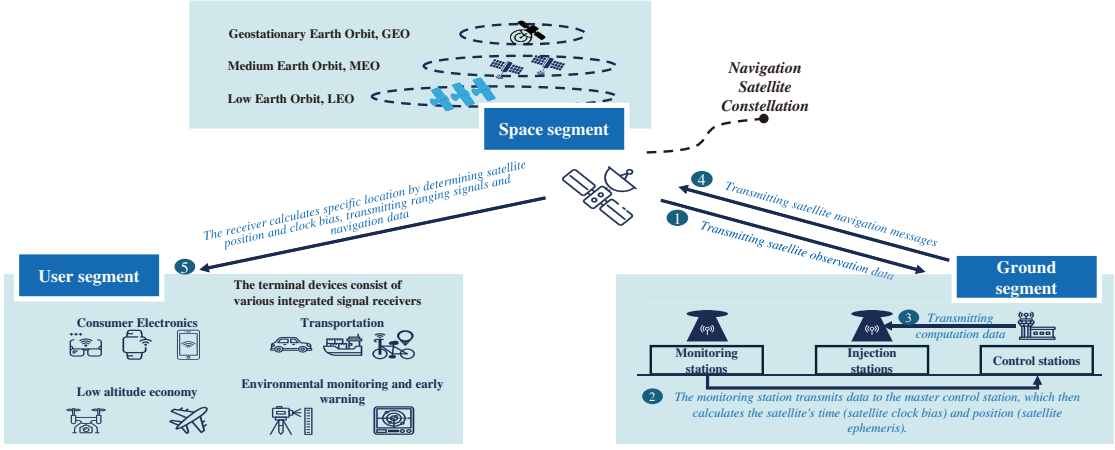
OVERVIEW OF THE GLOBAL GNSS SPATIAL POSITIONING SERVICE INDUSTRY

Definition of GNSS

GNSS are navigation satellite systems capable of providing global coverage and consist of three segments: the space segment (navigation satellite constellation), ground segment (system operation management facilities), and user segment (receiver equipment). The space segment consists of dozens of satellites in multiple orbital types that form the navigation constellation; the ground segment includes the master control station, injection stations, and monitoring stations, primarily responsible for continuous tracking, monitoring, and the reception and transmission of navigation signals; the user segment consists of terminal devices with built-in signal receivers that receive and process navigation signals from satellites.

These three parts of the GNSS work together to achieve user positioning functionality. First, satellites transmit observational data to the monitoring stations; second, the monitoring stations send this data to the master control station, which computes satellite time offsets (clock bias) and positions (ephemerides), and sends this data to the injection stations; finally, the injection stations relay the satellite clock errors and ephemerides to the satellites in the form of navigation messages. Satellites then send ranging signals and navigation data, and the user receiver calculates the distance between the receiver and the satellite, subsequently solving for satellite positions and clock errors based on the navigation message, ultimately calculating the user's location from this data.

Illustration of the interaction between GNSS space segment, ground segment, and user segment



There are four operational GNSS worldwide: China's BeiDou navigation satellite system (BDS), the United States' GPS, Russia's GLONASS, and the European Union's Galileo.

Comparison Analysis of Four Global GNSS

Name	BeiDou navigation satellite system (BDS)	GPS	GLONASS	Galileo
Country/Region	China	United States	Russia	European Union
Logo				
First launch year	2000	1978	1982	2005
Orbit type	MEO+GEO+IGSO	MEO	MEO	MEO
Number of satellites	60 (36 MEO+12 GEO+12 IGSO)	31	26 (24 operational+2 spares)	32 (27 operational+5 spares)
Positioning accuracy(1)	0.5~10m	0.1~10m	1.5~10m	~1m
Timing accuracy(2)	20ns	30ns	50 ns	30ns
Velocity accuracy(3)	0.2m/s	0.1m/s	0.2m/s	0.2m/s
Main functions	Positioning, navigation, timing, short message communication, international search and rescue, precise point positioning, etc.	Positioning, navigation, timing, international search and rescue, etc.	Positioning, navigation, timing, international search and rescue, etc.	Positioning, navigation, timing, international search and rescue, etc.
Technological Maturity (4)	Late-mover advantage; strong high-precision and autonomous capabilities; rapidly expanding globally	Most mature system; stable constellation, leading accuracy, complete ecosystem	Stable but aging technology; domestic focus, lagging in accuracy and ecosystem	Highly modernized; civilian high-precision focus; still maturing
System Compatibility(5)	High	High	Moderate to High	High

Source: *CIC*

Note:

(1) Typical horizontal positioning error under open service conditions, expressed in meters or centimeters, reflecting the system's positioning capability.

(2) The precision of the standard time signal provided by the system to ground users, usually measured in nanoseconds (ns).

(3) The system's estimated velocity error based on the Doppler effect, measured in meters per second.

(4) The overall advancement level of the system in terms of satellite constellation deployment, signal design, service capabilities, and ecosystem integration, reflecting its maturity of large-scale application.

(5) The interoperability between different GNSS at the signal and service levels. GPS, BeiDou, and Galileo are mutually compatible, whereas GLONASS has slightly lower compatibility due to differences in signal structure.

Definition and categorization of GNSS spatial positioning services

GNSS spatial positioning services refer to positioning, navigation, and timing services using global satellite navigation systems. These services center around GNSS chips and modules, extending to GNSS devices and solutions. GNSS spatial positioning services can be mainly categorized into the following three types: 1) **GNSS chips** — Integrated circuits that combine the signal receiving and processing functions required for GNSS operations, enabling navigation and positioning by receiving signals transmitted from satellites; 2) **GNSS modules** — Electronic components that integrate a GNSS chip, peripheral circuitry, and the corresponding embedded control software; 3) **GNSS devices and solutions** — Products and integrated solutions that incorporate GNSS chips and modules to provide users with location information and navigation guidance, including hardware devices and software development.

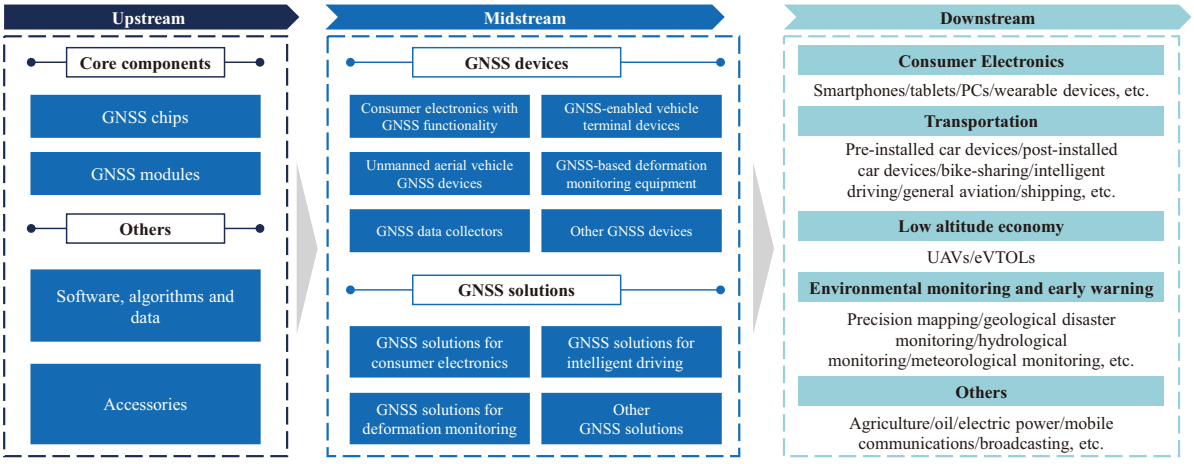
Value chain of global GNSS spatial positioning services

The upstream of the global GNSS spatial positioning services comprise core components such as GNSS chips and modules. In addition, it also relies on the coordinated support of software, algorithms, data and accessories. The design capabilities of GNSS chips affect chip performance, sensitivity, power consumption, size, and cost, directly impacting the competitive edge of GNSS device products.

The midstream consists of various GNSS devices and solutions, which serve as carriers for realizing GNSS spatial positioning services. GNSS devices include consumer electronics with GNSS functionality, GNSS-enabled vehicle terminal devices, unmanned aerial vehicle GNSS devices, GNSS-based deformation monitoring equipment, GNSS data collectors and other GNSS devices.

The downstream involves consumer electronics, transportation, low-altitude economy, environmental monitoring and early warning and others. With the rapid development of IoT technology in consumer electronics, intelligent driving, and unmanned aerial vehicles, the application scope of GNSS spatial positioning services is increasingly extensive, playing a pivotal role in an interconnected world.

Value Chain of Global GNSS Spatial Positioning Services



Source: CIC

Key technologies of the global GNSS spatial positioning services industry

Category	Key Technology	Analysis
Design technology	RF technology	• RF units are responsible for receiving the waveform signals emitted by satellites and amplifying them into digital signals. RF technology encompasses signal amplification, frequency conversion, filtering, analog-to-digital conversion, gain control, and multi-mode, multi-frequency signal processing. Its primary objective is to enhance the reception quality and processing accuracy of signals, achieving higher positioning accuracy and operational stability.
	Baseband technology	• Baseband units are the core components of navigation receivers. Their main functions include capturing, tracking, and demodulating data from specified satellite signals, as well as providing information such as pseudo-range and carrier phase of the satellite signals. Development of this technology focuses on performance, low power consumption, integration, and compatibility.
	Low power technology	• Low power consumption technology pertains to RF and baseband circuits. It includes multi-power domain design, DC-DC power supply SoC (System on Chip) integration, and designs aimed at achieving extremely low standby power consumption, along with advanced algorithm designs. This technology can significantly reduce chip power consumption, maximizing the standby and operational time of chip-level terminals.
	SoC integration technology	• SoC integration technology combines multiple functional modules into a single chip, resulting in a smaller size, lower power consumption, and higher performance. By integrating RF and baseband designs into a SoC, chip resource reuse is achieved, allowing parallel processing of different satellite systems by a universal hardware engine. This approach greatly conserves chip resources and reduces design and production costs.
Positioning technology	High-precision positioning algorithms	• High-precision positioning algorithms, such as real-time kinematic differential (RTK) technology and precise point positioning (PPP) technology, rely on pseudo-range and carrier phase corrections. Relevant technologies are undergoing continuous iterative upgrades. Meanwhile, the integration of PPP with RTK for high-precision positioning is emerging as the development trend for future high-precision positioning technologies. These algorithms must facilitate multi-system, multi-frequency joint positioning while optimizing cost and operating within the constraints of limited chip memory capacity and processor working frequency.
	Inertial navigation technology	• Inertial navigation technology uses gyroscopes and accelerometers to measure the angular velocity and linear acceleration of a carrier's motion. This data is processed in real-time to calculate the carrier's three-dimensional attitude, speed, and position. By embedding integrated inertial navigation deep coupling combination filters, multi-source sensor tracking loops, and various algorithms for anti-multipath and carrier hop detection, the overall performance of combined positioning can be improved.
	Anti-interference technology	• Satellite signals are weak when they reach the ground and are susceptible to interference. To mitigate this interference and enhance positioning accuracy, chips must employ multiple techniques, including multi-dimensional matrix operations, frequency domain interference detection, multi-channel adaptive digital notch filters, memory optimization, differential derivation, ionospheric processing, and dynamic filtering.
Security technology	Secure location information encryption technology	• Chips must incorporate built-in hardware encryption units to secure transmitted data, ensuring confidentiality and reducing the risks of location information being stolen or tampered with during transmission. This provides a fundamental layer of security for industry applications that rely on location data.

Source: CIC

Market size of global GNSS spatial positioning services

With the ongoing development of mobile Internet and IoT, the global GNSS spatial positioning service market is expected to grow. In 2025, the global GNSS spatial positioning service market size was RMB2,383.0 billion with a CAGR of 1.3% from 2021 to 2025, mainly due to weaker consumer electronics demand following the pandemic-driven surge, lengthening device replacement cycles and

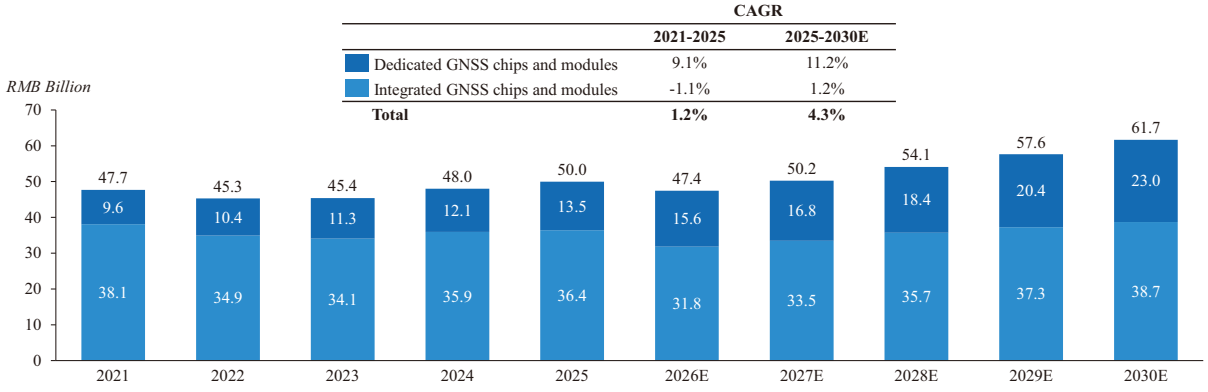
softer consumer spending. The market size of global GNSS spatial positioning services is expected to reach RMB3,123.0 billion by 2030, with a CAGR of 5.6% from 2025 to 2030, supported by the gradual expansion of emerging applications, such as automotive intelligence and low-altitude economy-related services.

Market size of global GNSS chips and modules

GNSS chips and modules constitute the foundational layer of the GNSS spatial positioning services industry. Global sales of GNSS chips and modules increased from RMB47.7 billion in 2021 to RMB50.0 billion in 2025, representing a CAGR of 1.2% during the period, due to weaker consumer electronics. Looking ahead, with the further expansion and application of spatial positioning services in transportation applications such as intelligent driving, as well as applications related to the low-altitude economy, the global GNSS chips and modules market is expected to reach RMB61.7 billion by 2030, representing a CAGR of 4.3% from 2025 to 2030.

The global GNSS chips and modules market is categorized into two primary segments based on packaging formats: Dedicated GNSS and Integrated GNSS chips and modules components. Integrated GNSS chips and modules are major smartphone and tablet SoC chips that apart from navigation chips, they also integrate wireless communication functions, such as CPU, GPU Wi-Fi, which are not mainly related to satellite communication. Dedicated GNSS chips and modules focused primarily on satellite signal reception, baseband processing and navigation output rather than on general-purpose system control. The sales value of Dedicated GNSS chips and modules segment was RMB13.5 billion in 2025, achieving a CAGR of 9.1% form 2021 to 2025. Looking ahead, this segment is projected to maintain its momentum, outpacing the market with a forecasted CAGR of 11.2% from 2025 to 2030, reaching RMB23.0 billion in 2030.

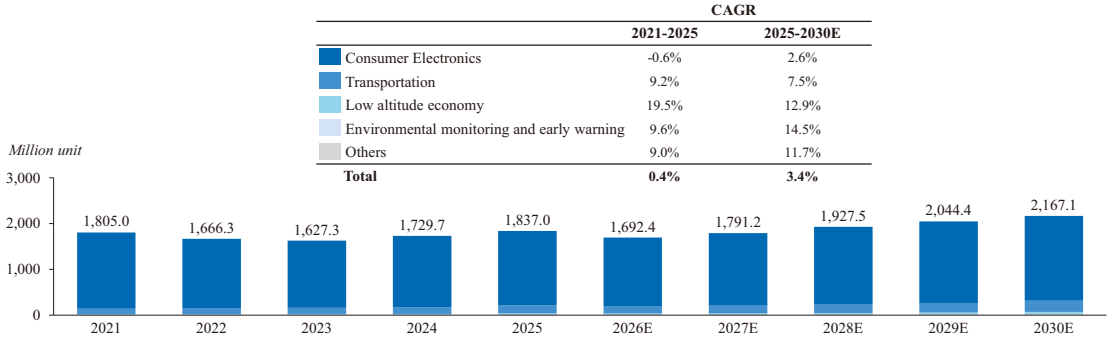
Sales Value of Global GNSS Chips and Modules, by packaging format, 2021-2030E



Source: EUSPA, GNSS & LBS Association of China, CIC

Consumer electronics are the largest downstream applications of GNSS chips and modules. On the supply side, with the accelerated domestic production of chips, the impact of geopolitical factors on GNSS chips has become relatively limited, and the supply-demand balance of GNSS chips is gradually improving. With the iterative upgrades of electronic products through artificial intelligence, the demand for products such as smartphones and wearable devices is expected to recover in the next five years. At the same time, the popularization of intelligent vehicles and drones causes the penetration rate of GNSS applications in environmental monitoring and early warning to increase. The demand for GNSS equipment in other application fields, such as agriculture and power, is also rising steadily. By 2030, the shipment volume of global GNSS chips and modules is projected to increase to 2,167.1 million units, with a CAGR of 3.4% from 2025 to 2030.

Shipment Volume of Global GNSS Chips and Modules, by Application Area, 2021-2030E



	2021	2022	2023	2024	2025	2026E	2027E	2028E	2029E	2030E
Consumer Electronics	1,664.9	1,514.1	1,467.7	1,563.3	1,628.3	1,506.9	1,585.3	1,698.0	1,782.0	1,852.5
Transportation	120.1	130.1	135.6	140.0	171.1	150.6	166.5	184.0	207.6	246.1
Low altitude economy	15.0	16.6	18.4	20.1	30.6	26.8	30.6	35.6	43.7	56.1
Environmental monitoring and early warning	0.4	0.5	0.5	0.6	0.6	0.9	0.9	1.0	1.1	1.2
Others	4.5	5.0	5.2	5.8	6.4	7.2	8.0	8.9	10.0	11.1
Total	**1,805.0**	**1,666.3**	**1,627.3**	**1,729.7**	**1,837.0**	**1,692.4**	**1,791.2**	**1,927.5**	**2,044.4**	**2,167.1**

Source: EUSPA, GNSS & LBS Association of China, CIC

In 2025, major GNSS spatial positioning services markets such as Europe and Japan, accounted for approximately 25% and 13% of the global GNSS spatial positioning service market, respectively. With the continued adoption of GNSS-enabled applications in areas such as intelligent transportation, industrial automation and precision agriculture, as well as the increasing penetration of multi-system GNSS in end-user devices, the overseas GNSS market is expected to experience steady growth.

OVERVIEW OF THE CHINA'S GNSS SPATIAL POSITIONING SERVICE INDUSTRY

Market size of China's GNSS spatial positioning services

With the development of mobile Internet, intelligent driving and shared mobility, as well as the active promotion of the BeiDou industry by the Chinese government, the market size of China's GNSS spatial positioning service market expanded from RMB494.9 billion to RMB607.6 billion during 2021 to 2025, with a CAGR of 5.3%. Despite the slowdown in the consumer electronics market, China's GNSS spatial positioning service market has experienced key growth over the past five years, driven by the Chinese government's policy support for the BeiDou industry and the widespread promotion of the BeiDou system. As the BeiDou industry gradually integrates into the digital economy, its application in transportation management, the low-altitude economy, agriculture, and water conservation will provide a broad market for BeiDou products, effectively promoting the growth of China's GNSS spatial positioning service market. It is expected that by 2030, China's GNSS spatial positioning service market will reach RMB1,025.4 billion, with a CAGR of 11.0% from 2025 to 2030.

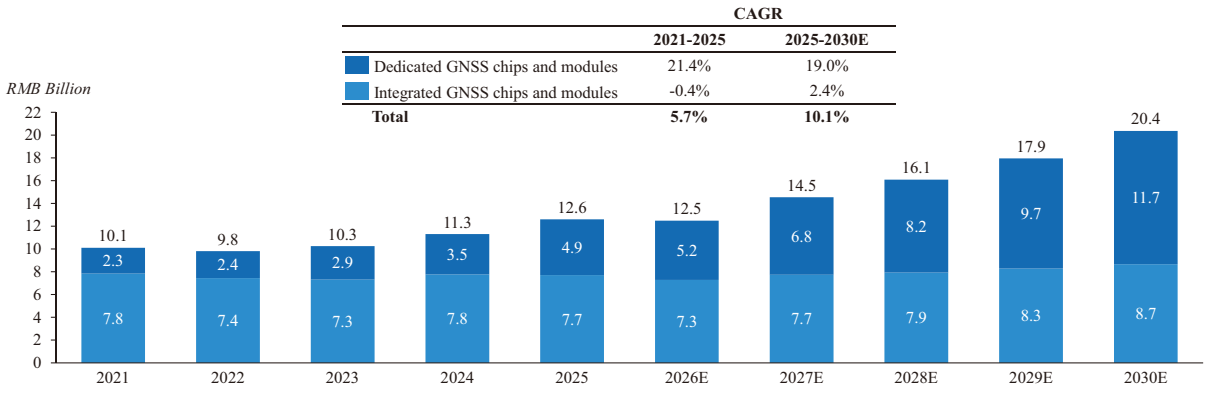
Market size of China's GNSS chips and modules

Sales of China's GNSS chips and modules increased from RMB10.1 billion in 2021 to RMB12.6 billion in 2025, representing a CAGR of 5.7%. Benefiting from the continued promotion of the BeiDou Navigation Satellite System and government policies encouraging the adoption of BeiDou applications, China's GNSS chips and modules market maintained steady growth during the period. Looking ahead, supported by the increasing penetration of BeiDou related applications, sales of China's GNSS chips and modules are projected to grow at a CAGR of 10.1% from 2025 to 2030, reaching RMB20.4 billion by 2030.

The sales value of dedicated GNSS chips and modules in China increased from RMB2.3 billion in 2021 to RMB4.9 billion in 2025, representing a CAGR of 21.4%. The growth was mainly attributable to the implementation of the Technical Specifications for Electric Bicycle Safety (GB17761-2024), which requires all electric bicycles compliant with the new national standard to integrate BeiDou's standalone positioning modules from September 1, 2025, thereby significantly boosting demand for dedicated GNSS chips and modules. The market is expected to further grow to RMB11.7 billion by 2030,

representing a CAGR of 19.0% from 2025 to 2030, driven by the continued expansion of BeiDou related applications in transportation, low-altitude applications and professional sectors such as emergency management.

Sales Value of China's GNSS Chips and Modules, by packaging format, 2021-2030E



Source: GNSS & LBS Association of China, CIC

Market drivers and market trends of China's GNSS chips and modules

- **Consumer electronics and transportation fields will continue to drive the scaled adoption of GNSS.** Consumer electronics and transportation fields will emerge as the primary battleground for GNSS's large-scale deployment, accelerating the technology's evolution from an industry standard to a public necessity. In the smartphone sector, BeiDou's short-message communication capability, enabled by RF-baseband integrated chips, delivers offline connectivity without requiring SIM or number changes, while integration with 5G+AI technologies enhances features like lane-level navigation and automated emergency alerts. In the smart wearable devices sector, GNSS improves multimodal behavioral sensing, enabling precise tracking and activity logging for vulnerable groups with real-time safety monitoring. Transportation sector continues to benefit from policy tailwinds, with penetration rising in emerging fields. Policies such as the "Three-Year Action Plan for Large-Scale BeiDou Applications (2023–2025)" (北斗規模應用三年行動計劃(2023–2025)) have accelerated the adoption of Beidou applications. Under policies supporting BeiDou, IoT equipment that does not support BeiDou functionality is required to cease operation within prescribed timeframes, while dual-mode devices are required to be replaced with devices supporting BeiDou services. These policy initiatives have further driven demand for BeiDou chips and modules and supported the expansion of the BeiDou industrial ecosystem. According to the "Plan of Action to Launch a Large-scale Renewal of Transportation Equipment" (交通運輸大規模設備更新行動方案) issued by 13 ministries including the Ministry of Transport in May 2024, the "long-distance buses, tourist coaches, hazardous goods trucks, and heavy-duty trucks (兩客一危一重)" vehicle industry will become a key sector for promoting advanced equipment and Beidou terminal applications. By 2025, China's ministry-specified machines for the "long-distance buses, tourist coaches, hazardous goods trucks, and heavy-duty trucks" are expected to be fully upgraded. Under the "Technical Specifications for Electric Bicycle Safety (GB17761–2024)" (電動自行車安全技術規範(GB17761–2024)), all electric bicycles complying with the new national standard must integrate BeiDou's standalone positioning modules since September 1, 2025. For the low-altitude economy, the GNSS & LBS Association of China designated BeiDou in 2025 as core spatiotemporal infrastructure for low-altitude economy, advancing UAV/eVTOL air-ground coordination. This mandates BeiDou high-precision navigation and positioning networks synergized with 5G/AI to establish a three-dimensional navigation network to support large-scale applications of UAV logistics and urban low-altitude transportation. GNSS's applications are also expanding from precision surveying to geological disaster monitoring and hydrology monitoring, with steady penetration growth.

- **Advancements in chip technology have accelerated the pace of domestic substitution.** Domestic GNSS chips feature integrated SoC design that incorporates radio frequency, baseband, memory, and power management. This functionality has reduced the chip size and enhanced cost advantages. With strong policy support, core technologies in the upstream are maturing, and the industrial chain structure is becoming increasingly robust. Domestic market players are seizing market opportunities to develop high-performance GNSS chips that are multi-frequency, multi-system, miniaturized, and highly integrated. They are also actively expanding production capacity to accelerate the replacement of imported GNSS chips.
- **Wide application of multi-frequency multi-system technology.** The use of GNSS navigation satellite system is gradually moving towards high-precision and high-reliability fields. To enhance the performance of single-system satellite positioning, GNSS chip manufacturers have invested in developing dual-system or multi-system joint positioning chips and modules. By leveraging signals from multiple satellite systems for calculation to jointly participate in positioning, these solutions improve positioning accuracy, reliability, and user experience. Meanwhile, with the development of chip-level dual-frequency/multi-frequency combined positioning technology, a single chip can simultaneously receive and process signals from multiple frequency points, further enhancing positioning accuracy and reliability. Therefore, the integrated application of multi-frequency and multi-system technologies has significantly improved navigation and positioning performance as well as user experience.
- **Expansion of application files for short message services.** The short message service (SMS) of the BeiDou navigation satellite system is a unique feature. BeiDou SMS chips integrate the short message communication function, providing positioning services and two-way communication in areas lacking mobile communication network coverage. In 2025, China Time and Space (中國時空) proposed promoting the market for SMS through its "Industrial Cooperation — Core of Time-Space Action Plan (產業合作 — 時空之芯行動計劃)." The core policies include jointly developing low-cost consumer-grade chips with chip manufacturers, launching BeiDou SMS that allow users to "retain their SIM cards and numbers" in collaboration with the three major telecom operators. Additionally, due to their reliability for emergency communication during natural disasters and their usefulness in remote area exploration where ground networks are unavailable, devices with SMS functionality have become increasingly important. Growing public awareness of safety has led to their application across various industries, including transportation, long-distance communication, landslide monitoring, and emergency rescue. Meanwhile, the integration of BeiDou SMS with high-precision positioning technologies has enabled the early commercialization of communication-navigation integrated applications. Through the development of "BeiDou short message communication + high-precision positioning" solutions, industry participants have accumulated experience in integrating communication and positioning functions, while fostering collaboration among chip vendors, telecom operators, positioning service providers and downstream application developers. This has accelerated the development of indigenous communication-navigation integrated solutions and established an important foundation for the future large-scale deployment of LEO communication-navigation integration technologies. In 2025, the cumulative number of public users of BeiDou SMS exceeded 10 million, while multiple consumer-grade communication-navigation integrated chips had entered commercial deployment, demonstrating the growing commercial viability of communication-navigation integrated applications.
- **Low-Earth-Orbit ("LEO") communication-navigation integration is becoming an important development trend in the GNSS chips and modules industry.** Building upon the technological foundation established by existing communication-navigation integrated applications, the continued deployment of LEO satellite infrastructure is expected to enhance satellite communication capabilities and further expand the coverage, continuity and commercial applicability of communication-navigation integrated services. Through the integration of communication and navigation functions, communication-navigation integration helps improve the accessibility, reliability and service availability of positioning solutions, particularly in remote areas and regions with insufficient terrestrial network coverage. As communication-navigation integrated services continue to evolve, they are expected to support the development of emerging

sectors such as transportation, consumer electronics and the low-altitude economy, while fostering a broader range of innovative application scenarios. At the same time, the growing demand for integrated communication and positioning services is driving GNSS chips to evolve from standalone navigation chips towards highly integrated multi-mode SoCs capable of supporting navigation, satellite communication and high-precision positioning functions. In 2025, multiple domestically developed low-power communication-navigation integrated chips entered mass production, integrating BeiDou-3 positioning and 5G communication functions while reducing chip size by approximately 30% and lowering costs by approximately 40%, demonstrating the accelerating commercialization and industrial adoption of communication-navigation integrated chip solutions. This trend is creating new opportunities for product innovation and commercialization across the GNSS industry chain.

- **The GNSS chips and modules industry is exhibiting a trend of consolidation, shifting from fragmentation toward greater concentration.** As overall industry competition intensifies and technical standards continue to evolve, some small and medium-sized players have limited resources for sustained R&D investment. At the same time, emerging application scenarios — such as those requiring high-precision and low-power consumption — are placing higher demands on chip performance and algorithm sophistication. In this context, leading enterprises are pursuing external acquisitions to enhance their system-level solution capabilities. Profitable companies are expected to accelerate resource integration and market expansion by targeting market participants with insufficient investment in continuous technological research and development.

Price trend of China's GNSS chips

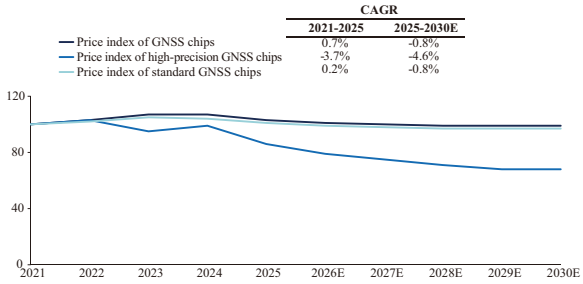
From 2021 to 2025, the price of high-precision GNSS chips declined, primarily due to intensified market competition, the increasing maturity of Real-Time Kinematic ("**RTK**") and other high-precision positioning technologies, and the gradual narrowing of technological differences among market participants. Despite maintaining certain technological barriers, average selling prices were affected by increasing market penetration and a more competitive industry environment. Looking ahead, prices of high-precision GNSS chips are expected to continue declining at a more moderate pace before gradually stabilising, as technological maturity increases and competition shifts towards chip performance, integration and reliability. By contrast, standard-precision GNSS chips have already reached relatively low price levels, leaving limited room for further price reductions. As a result, their prices are expected to remain broadly stable over the forecast period.

The overall industry average price is expected to decline slightly in the coming years and gradually stabilise thereafter. Given the wide variety of GNSS chips and the significant differences in pricing across product types, the industry average price reflects a composite structural outcome.

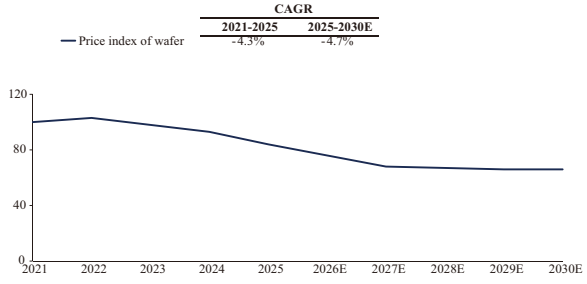
Price trend of raw materials

Driven by global imbalances in the supply and demand for semiconductor fabrication services and capacity constraints, wafer manufacturing costs rose to a historical high in 2022. Subsequently, with capacity expansion, easing demand, and inventory digestion, the industry entered a cost-down cycle. Looking ahead, as the strategic importance of mature-node capacity increases and supply chain costs become relatively more stable due to the accelerated localization of domestic semiconductor supply chains amid geopolitical factors, the room for further cost reduction is expected to narrow significantly, and wafer costs are likely to gradually stabilize.

Price index of China's GNSS chips, 2021-2030E



Price index of wafer in China, 2021-2030E



Notes: The price index uses 2021 as the base year, with the index value set at 100 for that year.
Source: *CIC*

OVERVIEW OF CHINA'S COMMUNICATION CHIPS, MEMORY CHIPS AND RF CHIPS INDUSTRY

Definition and market size of communication chips

Communication chips refer to integrated circuits that implement communication functions. They are responsible for processing data, enabling signal transmission, improving network connections, and providing support for various communication protocols.

From 2021 to 2025, the market size of China's communication chip industry rose from RMB121.9 billion to RMB215.3 billion. The application of new materials, AI and machine learning technologies, and the upgrade of process technologies will undoubtedly boost chip performance, reduce costs, and accelerate product development. In fields such as 5G, the Internet of Things, and intelligent driving, the application scenarios for communication chips will become even broader, and market demand will continue to grow. It is expected that from 2025 to 2030, the market size of China's communication chip industry will reach RMB309.0 billion, with a CAGR of 7.5%.

Definition and market size of memory chips

Memory chips, or semiconductor memories, are storage devices that use semiconductor circuits as the storage medium and are used to store binary data. They represent the specific application of the concept of embedded system chips in the storage industry. By embedding software into a single chip, they achieve multifunctionality and high performance, as well as support for various protocols, different hardware, and diverse applications.

As technologies like artificial intelligence, the Internet of Things, and cloud computing continue to empower China's emerging industries, the demand for storage capacity in terminal devices such as smartphones, PCs, intelligent vehicles, and servers is constantly increasing. In 2025, the market size of China's memory chips reached RMB458.0 billion. In the future, as the application scenarios for memory chips continue to expand and the demand for data storage in various devices increases, the downstream market will consistently impose new requirements regarding the capacity, stability, speed, and lifespan of memory chips. It is projected that by 2030, the market size of China's memory chips will reach RMB767.8 billion, with a CAGR of 10.9% from 2025 to 2030.

Definition and market size of RFFE (radio frequency front-end) chips

Radio frequency front-end (RFFE) chips are a category of integrated circuits used in wireless communication systems to process RF signals between the transceiver and antenna. As a critical component of wireless communication devices, RFFE chips are responsible for the transmission and reception of RF signals, as well as functions such as signal amplification, filtering, switching and impedance matching. By enhancing signal strength while suppressing unwanted harmonics and noise, RFFE chips help improve signal quality, transmission efficiency and connection reliability, ensuring stable and efficient wireless communications.

The development of China's RFFE chip industry shows a positive trend, with market demand continuously driven by 5G deployment, IoT, and other emerging wireless technologies. In 2025, the market size of China's RFFE chip industry reached approximately RMB36.9 billion. Looking ahead, the development of RFFE chip-related technologies will trend towards higher integration, lower power consumption, and smaller form factors. Domestic enterprises are expected to benefit from national policy support and industrial chain collaboration, creating more opportunities for innovation and commercialization. By 2030, the market is projected to reach RMB55.3 billion, with a CAGR of 8.5% from 2025 to 2030.

COMPETITION OVERVIEW OF THE GLOBAL AND CHINA'S GNSS CHIPS AND MODULES INDUSTRY

Competitive landscape of global GNSS chips and modules providers

The global GNSS chips and modules industry exhibits a relatively high level of concentration. Based on the shipment volume of GNSS chips and modules, the top ten market players accounted for approximately 82.8% of the market share in 2025.

Currently, the leading companies in the global GNSS spatial positioning service industry are located in the United States and Europe. These players have secured a significant market share due to their technological advantages and mature value chains.

Chinese players, leveraging their rapid response to market dynamics and customer needs, efficient product iteration, and excellent cost control, have shown strong momentum for growth. With the vigorous rise of the BeiDou navigation satellite system and the catalyst of domestic substitution policies, Chinese players have steadily enhanced their R&D capabilities in core satellite navigation positioning technologies and have gradually caught up with international peers, achieving competitive performance in certain areas such as chip design and core algorithms. As the industry chain construction matures, the market share of Chinese players is expected to increase.

Ranking of global GNSS chips and modules providers

In 2025, in terms of shipment volume, the global dedicated GNSS chips and modules market contains around 23.7% of the total Global GNSS chips and modules market size. In 2025, our Company was the fifth-largest global GNSS chips and modules provider and the second-largest global GNSS chips and modules provider among all Chinese Mainland companies in terms of shipment volume of dedicated GNSS chips and modules, with a global market share of 7.4%.

Ranking of Top Ten Global GNSS Chips and Modules Providers, in terms of Shipment Volume of Dedicated GNSS Chips and Modules, 2025

Rank	Company	Overview	Country/region	Listing status	Shipment volume of GNSS chips and modules[2] (million)	Market share (%)
1	Company A	• Founded in 1985, its primary business focuses on the research, development, and sale of integrated circuit products and system software based on cellular communication, connectivity, multimedia technology, and patent licensing services.	United States of America	Listed on the NASDAQ Stock Exchange	80.0	18.3%
2	Company B	• Established in 2000, its main business involves the research, development, production, and sale of GNSS chips and related products and services, 5G ceramic components, and intelligent connected vehicle solutions.	Chinese Mainland	Listed on the Shenzhen Stock Exchange	75.0	17.2%
3	Company C	• Established in 1997, this company specializes in system-on-chip solutions for wireless communication, smart TVs, the Internet of Things, and automotive electronics.	Taiwan, China	Listed on the Taiwan Stock Exchange	50.0	11.5%
4	Company D	• Established in 1997, this company provides positioning solutions and technologies for cellular and short-range communication, serving the automotive, industrial, and consumer markets.	Switzerland	Listed on the Swiss Stock Exchange	48.0	11.0%
5	**Our Company**	• **Founded in 2016, this company offers a wide range of products and solutions throughout the satellite navigation and positioning industry value chain, with a strategic focus on the design and sale of GNSS chips, modules, and solutions.**	**Chinese Mainland**	**[Applied for [REDACTED] on HKEX]**	**32.1**	**7.4%**
6	Company E	• Founded in 1991, its main business involves the design, development, and application of semiconductors, enterprise software, and security solutions.	United States of America	Listed on the NASDAQ Stock Exchange	25.0	5.7%
7	Company F	• Established in 2004, the company designs core chips for satellite navigation, motor drive chips, and RF components.	Chinese Mainland	Not Listed	20.0	4.6%
8	Company G	• Established in 1987, it focuses on manufacturing microcontrollers (MCUs), analog ICs, power semiconductors, sensors, and application-specific integrated circuits (ASICs).	Switzerland	Listed on the Milan Stock Exchange	15.0	3.4%
9	Company H	• Founded in 2008, it engages in the design and development of GNSS chips for time and space information.	Chinese Mainland	Not Listed	11.0	2.5%
10	Company I	• Established in 2008, it specializes in the design of semiconductor chips for storage controllers, video surveillance, digital TV, edge AI, and information security applications.	Chinese Mainland	Listed on the Shenzhen Stock Exchange	5.0	1.1%
	Sub-total				**361.1**	**82.8%**
	Total				**436.1**	**100.0%**

Source: Annual Reports, CIC

In 2025, the global Dedicated GNSS chips and modules market accounted for approximately 0.6% of the overall global GNSS spatial positioning service market in terms of sales value and approximately 27.1% of the overall global GNSS chips and modules market in terms of sales value. In 2025, our Company was the seventh-largest global GNSS chips and modules provider and the second-largest global GNSS chips and modules provider among all Chinese Mainland companies in terms of global sales value of dedicated GNSS chips and modules, with a global market share of 1.8%.

Ranking of Top Ten Global GNSS Chips and Modules Providers, in terms of Global Sales Value of Dedicated GNSS Chips and Modules, 2025

Rank	Company	Overview	Country/region	Listing status	Global sales value of GNSS chips and modules[2] (billion)	Market share (%)
1	Company A	• Founded in 1985, its primary business focuses on the research, development, and sale of integrated circuit products and system software based on cellular communication, connectivity, multimedia technology, and patent licensing services.	United States of America	Listed on the NASDAQ Stock Exchange	6.27	46.5%
2	Company D	• Established in 1997, this company provides positioning solutions and technologies for cellular and short-range communication, serving the automotive, industrial, and consumer markets.	Switzerland	Listed on the Swiss Stock Exchange	1.30	9.6%
3	Company C	• Established in 1997, this company specializes in system-on-chip solutions for wireless communication, smart TVs, the Internet of Things, and automotive electronics.	Taiwan, China	Listed on the Taiwan Stock Exchange	1.20	8.9%
4	Company B	• Established in 2000, its main business involves the research, development, production, and sale of GNSS chips and related products and services, 5G ceramic components, and intelligent connected vehicle solutions.	Chinese Mainland	Listed on the Shenzhen Stock Exchange	0.99	7.3%
5	Company E	• Founded in 1991, its main business involves the design, development, and application of semiconductors, enterprise software, and security solutions.	United States of America	Listed on the NASDAQ Stock Exchange	0.50	3.7%
6	Company G	• Established in 1987, it focuses on manufacturing microcontrollers (MCUs), analog ICs, power semiconductors, sensors, and application-specific integrated circuits (ASICs).	Switzerland	Listed on the Milan Stock Exchange	0.25	1.9%
7	**Our Company**	• **Founded in 2016, this company offers a wide range of products and solutions throughout the satellite navigation and positioning industry value chain, with a strategic focus on the design and sale of GNSS chips, modules, and solutions.**	**Chinese Mainland**	**[Applied for [REDACTED] on HKEX]**	**0.24**	**1.8%**
8	Company H	• Founded in 2008, it engages in the design and development of GNSS chips for time and space information.	Chinese Mainland	Not Listed	0.20	1.5%
9	Company F	• Established in 2004, the company designs core chips for satellite navigation, motor drive chips, and RF components.	Chinese Mainland	Not Listed	0.10	0.7%
10	Company I	• Established in 2008, it specializes in the design of semiconductor chips for storage controllers, video surveillance, digital TV, edge AI, and information security applications.	Chinese Mainland	Listed on the Shenzhen Stock Exchange	0.04	0.3%
	Sub-total				**11.1**	**82.2%**
	Total				**13.5**	**100.0%**

Source: Annual Reports, CIC

Key entry barriers of the global GNSS chips and modules industry

- **Technology barriers.** This industry requires long-term R&D investment and deep technical accumulation, spanning multiple domains such as satellite signal processing, RF and baseband design and high-precision positioning algorithms, thus creating significant entry barriers in technology. Additionally, leading industry players deeply participate in the formulation of domestic and international technical standards, holding dominance in standard-setting. Existing companies have accumulated a large number of core patents through years of R&D investment and technical expertise, forming a solid patent barrier.
- **Talent barriers.** The GNSS chips and modules industry relies heavily on technology and involves a diverse range of fields, including satellite positioning, wireless communication, software, chip designing, and algorithms. There is a particular shortage of interdisciplinary talent who are adept at both chip design and GNSS positioning technologies. Cultivating high-end talent is a long-term endeavor, making it difficult for new entrants to quickly build a professional team capable of supporting R&D and market expansion.
- **Business model barriers.** Leading enterprises have secured significant market share through first-mover advantages and established strong partnerships with core clients, forming stable business loops and high customer stickiness. To pursue differentiated competition, new entrants must build unique business models, with key challenges including: collaborating with diverse premium resources, introducing advanced technologies, deeply understanding the characteristics of downstream application industries, providing targeted integrated solutions for industrial chain collaboration, and enhancing the integration capability across multiple satellite navigation systems. Additionally, leading enterprises leverage technological and brand strengths to command higher product pricing power, further intensifying competitive barriers for new entrants.

- **Supply chain barriers.** The supply chain for GNSS chips and modules is highly specialized, involving multiple participants. Close collaboration among these participants is critical, as stable and efficient supply chain coordination plays a key role in ensuring product delivery and quality control. For companies operating under the fabless model, which do not directly engage in wafer manufacturing, establishing strong partnerships with wafer foundries that have stable production capacity and high utilization rates is essential. Due to the scarcity of wafer foundry resources and limited supply capacity, new entrants often struggle to secure stable supply chain support and are unable to compete with existing large-scale customers in bargaining power, further weakening their cost control and delivery assurance capabilities.

Sources and reliability of information

We commissioned CIC, a market research and consulting company founded in Hong Kong and engaged in the provision of professional consulting services across multiple industries, to conduct an analysis and report of the global GNSS spatial positioning services market and China's BeiDou spatial positioning services market. We have agreed to pay a fee of RMB0.45 million to CIC in connection with the preparation of the CIC Report. In this section, as well as in the sections titled "Summary," "Risk Factors," "Business," "Financial Information," and elsewhere in this Document to provide our potential **[REDACTED]** with a more comprehensive understanding of the industry in which we operate. Except as otherwise stated, all data and forecasts in this section come from the CIC Report.

The information and data collected by CIC have been analyzed, assessed, and validated using CIC's in-house analysis models and techniques. Primary research was conducted via interviews with key industry experts and leading industry participants. Secondary research involved analyzing data from various publicly available data sources.

The market forecasts in the CIC Report are based on the following key assumptions: (1) the overall social, economic and political environment in China is expected to remain stable during the forecast period; (2) related key industry-driving factors are likely to continue to drive the growth of global GNSS spatial positioning services market and China's BeiDou spatial positioning services market, such as technological advancements, supporting policies and increasing downstream demand, during the forecast period and (3) there will be no extreme force majeure or unforeseen industry regulations during the forecast period, which may have a drastic or fundamental impact on the market.