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NTN convergence

How satellite and mobile convergences are powering the 6G era

The key piece of the 6G era puzzle: NTN leads the new future of mobile communications

In 2024, the global satellite market revenue surpassed US$290 billion, with ground equipment and satellite services as the main drivers. Looking ahead, as 3GPP standards mature and multiple countries accelerate their deployment, NTN will fully expand across LEO satellites, ground terminals, and system services. The US leads with SpaceX and chip design edge; China is rapidly catching up with large-scale constellations and policy support, while Europe is steadily advancing through technological independence and international cooperation. Amid competition among many countries and explosive demand, the NTN market is set to drive synchronized growth in satellite manufacturing, chip modules, launch services, and ground gateways supply chains, unlocking long-term and substantial investment opportunities for the global telecommunications and technology industries.

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SPECIAL REPORT

Executive summary

As the mobile communications industry advances into the 6G era, non-terrestrial networks (NTN) are becoming a pivotal area for market and technological development. Guided by standardization initiatives and roadmaps from the 3rd Generation Partnership Project (3GPP), NTN seeks to transcend traditional terrestrial boundaries. This endeavor involves creating a complex, multi-layered network architecture that includes low-altitude and high-altitude platform stations (LAPS/HAPS), alongside low Earth orbit (LEO) and medium/high Earth orbit (MEO/GEO) satellites. The objective is to establish integrated communication capabilities that connect satellite, aerial, and terrestrial networks, in line with the 6G vision of achieving ubiquitous global coverage and seamless connectivity.

This report analyzes current trends in the NTN industry, concentrating on technological advancements, standards, application scenarios, and dynamic developments worldwide, including specific insights into Taiwanese and global supply chains. It assesses and predicts growth prospects in the global satellite equipment markets, providing an in-depth analysis of the operational dynamics among prominent international and Taiwanese suppliers. Furthermore, it offers the DIGITIMES research team valuable perspectives on future opportunities and challenges within NTN development.

The 3GPP has embraced NTN in its Release 17 and future iterations, marking a pivotal move towards integrating mobile and satellite communications. In upcoming 6G application scenarios, user terminals will be capable of simultaneously accessing multiple platforms, achieving optimal connectivity through the synergy of multi-network collaboration and AI-driven dynamic resource allocation. For telecom operators grappling with the underwhelming monetization of 5G, the introduction of 6G NTN is poised to be the critical step in advancing the fixed-mobile-satellite convergence (FMSC) operational model.

Major economies vary in their NTN development strategies. The US leverages private sector entities such as SpaceX and Amazon's Project Kuiper, supported by NASA and the Department of Defense, to spearhead the establishment of leading LEO constellations and innovative business models. Europe, on the other hand, prioritizes strategic autonomy and technological security through policy-driven funding while maintaining a cautious stance. China adopts a top-down, policy-driven approach, advancing the Guowang and Spacesail constellations. This development is intertwined with the Belt and Road Initiative to bolster geopolitical influence via satellite communications. Meanwhile, Japan and South Korea address market size constraints by concentrating on HAPS and specialized vertical applications. These varied strategies highlight the distinctive policy orientations and industrial strengths of each region.

As to industrial competitiveness, the US leads in rocket launches, LEO satellite constellations, and chip design. Europe emphasizes system integration and international collaboration. China is swiftly advancing with a comprehensive localized supply chain backed by robust policy support. Taiwan, while still developing, shows promise in component manufacturing, communication chips, and testing. Establishing regional testing centers and drawing private investment could position Taiwan strategically in the Asia-Pacific market.

In 2024, the global satellite market revenue reached US$293 billion, with ground equipment contributing the most at 53%, followed by satellite service revenue at 37%. The NTN supply chain will span various segments, such as satellite manufacturing, rocket launches, communication modules, baseband chips, antenna design, ground gateways, and operational services, all of which offer promising growth prospects.

The satellite and communication industry faces a dynamic future characterized by both opportunities and challenges. High operating costs, slow international spectrum coordination, increased geopolitical competition, and a shortage of successful, replicable business models are significant hurdles. Despite these challenges, NTN are poised to achieve cross-domain integration, elevating communication services. Taiwan can become a key player in the global space communication supply chain by leveraging its expertise in satellite components, communication chips, and system integration, supported by strong policies and international cooperation.

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From the trend perspective, the three models each have their own technical advantages and disadvantages but are gradually converging without replacing each other. In terms of mobile terminals, by 2025, major smartphone manufacturers will still choose to use private communication protocols to provide satellite services for their brand users. Companies such as Apple and Huawei International, besides maintaining their dominance in satellite communication partnerships, also try to find multiple satellite communication partners to reduce reliance on a single satellite operator. From the viewpoint of smartphone processor manufacturers, they are gradually aligning with the PP R17 standard specifications to offer more universal solutions to downstream smartphone manufacturers, benefiting from standardization and economies of scale, while allowing smartphone manufacturers to independently lead satellite communication partnerships.

In the telecom operators sector, many telecom operators are still seeking cooperation with satellite operators to quickly expand telecom signal coverage in remote areas by installing base station functions on satellites. In later stages, a new cooperative model integrating the ecosystem has even emerged among telecom operators, satellite companies, and mobile phone manufacturers. For example, the three-way cooperation between Apple, Starlink, and T-Mobile allows iPhone users on the T-Mobile network who lose signal to automatically connect to the satellite networks of Starlink or Globalstar as needed, minimizing situations without network signals.

Figure Comparison of D2C mobile technologies and cooperation models

D2C technologies	Satellite-end	Mobile device-end		
		Private communication protocol	3GPP develops NB-IoT standards	
			Mobile chip provider model	Satellite operator model
Overview	Satellite communication using mobile network frequencies.	Integrate satellite module in mobile devices via private protocol	Mobile processors connect via NTN IoT per 3GPP. Ssatellites provide basic base station functions.	Mobile processors connect via NTN IoT per 3GPP. Satellites relay signals directly to ground stations.
Advantage	• No upgrade needed for mobile devices • Can quickly expand signal coverage	• No concerns regarding band interference. Coordination schedule is brief, enabling rapid implementation.	• Compliant with standards and highly versatile, the frequency band experiences minimal interference.	• Compliant with standards and offers high versatility with no concerns regarding band interference.
Disadvantage	• Complex spectrum acquisition regulatory process • Risk of ground frequency band interference	• Closed ecosystem • Only supports specific brand smartphones • May increase mobile phone costs	• Development stage is relatively late, not yet widespread.	• Only supports specific phone models
Participants	Telecom operators + satellite operators	Mobile phone brands + satellite operators Chip providers + satellite companies (canceled)	Chip providers develop according to standard specifications and cooperate with satellite companies for testing	Satellite service providers + satellite operators + chip providers
Representative case	T-Mobile + Starlink	Apple + Globalstar	MediaTek, Qualcomm	Skylo + Qualcomm Inc. + Verizon

Source: DIGITIMES, 2025/9

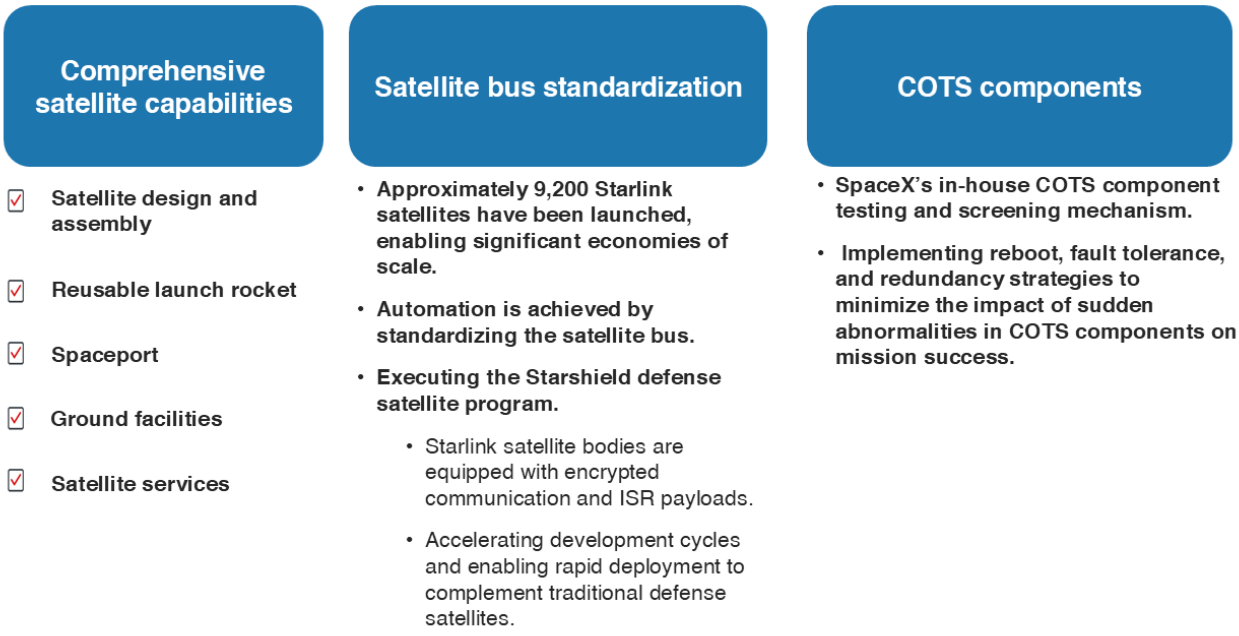
Today, SpaceX has become the leader in low Earth orbit (LEO) satellites, thanks to three core capabilities. First, SpaceX is currently the only company that simultaneously controls satellite launch, satellite manufacturing, and satellite broadband services. It was the first to adopt reusable rockets to reduce launch costs and built Starlink to provide satellite broadband services, breaking the market dominance long held by GEO satellite operators such as Viasat and Hughes.

SpaceX's second key capability is reducing satellite manufacturing costs by standardizing and modularizing the previously highly customized satellite platform (bus). For example, the satellite platform is categorized into six major subsystems: structure, power, thermal control, attitude and orbit control, communication, and data processing and control. This facilitates the introduction of automated production processes to achieve mass production while meeting both commercial and defense needs.

Taking SpaceX's defense project Starshield as an example, in the past, satellites required by the Department of Defense were mostly custom-built by companies like Boeing or Lockheed Martin according to mission requirements, resulting in long development cycles and high costs. In contrast, SpaceX uses a standardized satellite platform that can be equipped with encrypted communications, optical lenses, or synthetic aperture radar (SAR)

payloads based on mission needs, enabling communication, monitoring, or ground observation tasks without redesigning the satellite for each specific purpose. The Department of Defense deploys low Earth orbit satellites not to replace traditional defense satellites but to leverage their rapid deployment and real-time communication capabilities, complementing traditional defense satellites' wide coverage, anti-jamming features, and continuous observation without frequent handovers.

Figure Three key capabilities of SpaceX leading the space industry



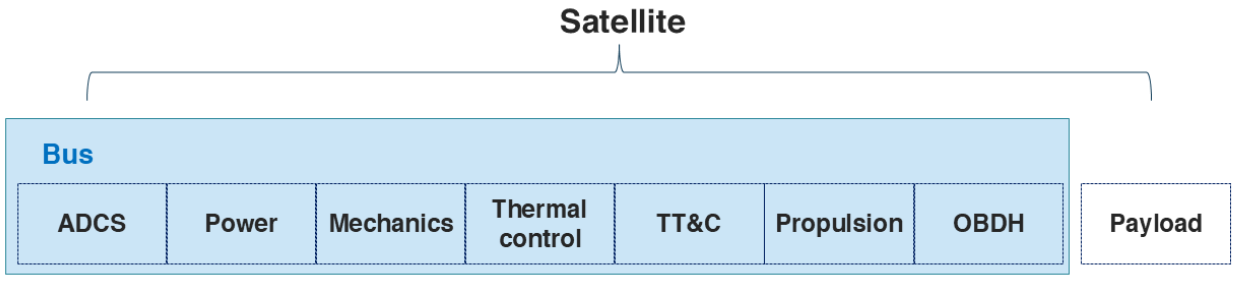
Note: ISR stands for Intelligence, Surveillance, Reconnaissance; COTS stands for commercial off-the-shelf.
Source: DIGITIMES, 2025/9

In the early stages of Starlink and OneWeb, many Taiwanese manufacturers actively entered the supply chain focusing on UT's huge demand. However, since SpaceX controls key components, Taiwanese manufacturers could only provide parts, such as Compeq Manufacturing supplying PCB boards and Auden Techno Corp. supplying filters, or undertake some manufacturing processes. As for OneWeb, although some Taiwanese manufacturers had entered the supply chain, cooperation was suspended due to OneWeb slowing down the launch schedule of its second-generation satellites. At the same time, several companies

from South Korea and Southeast Asia have also invested in UT layout, and the market will face intense price competition in the future.

With the support of TASA's "Startup Star Chasing" program, some Taiwanese manufacturers have begun attempting to send products into space. In 2Q24, Rapidtek and Fangxing each launched a 3U cube satellite performing communication and telemetry missions respectively. The initial mission used a standard cube satellite platform paired with payloads made by Taiwanese manufacturers, connecting with ground stations for basic testing. The mission aimed to verify feasibility, such as whether the ground station could receive beacon signals transmitted from the satellite in orbit and whether the satellite could receive and execute commands from the ground. Subsequent cube satellites increased in size from 3U to 8U, with testing items gradually increasing, helping companies accumulate practical experience in on-orbit verification and ground station operations.

Figure Layout of Taiwan's supply chain from satellite subsystems



Project	Suppliers
Payload	**Communication satellite** • Ku-band: Rapidtek, YTTEK • Ka-band: Tron Future, Rapidtek, YTTEK **Remote sensing satellite** • X-band: Pyras • OCI: Pyras, YTTEK • SAR*: Tron Future

Product	Suppliers
ADCS	Tensor Tech: Sensor, spherical motor actuator Aegiverse: Fiber optic gyroscope
Power	LiveStrong Optoelectronics, ET Space Power
TT&C	Patch antenna array: Rapidtek
OBDH	• OBC: Elitegroup Computer Systems • SSD: Phison Electronics.
Platform	Satoro Taiwan

Note: TT&C is the tracking, telemetry & command system; ADCS is the Attitude Determination and Control Subsystem; SAR is Synthetic Aperture Radar; * indicates under development; OBDH is On Board Data Handling.
Source: DIGITIMES, 2025/9

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