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Insights and Practices in Space-Ground Integrated Development

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China Telecom

2026年9月2日

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Trends in Space-Ground Integration

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China Telecom's Innovation Practices

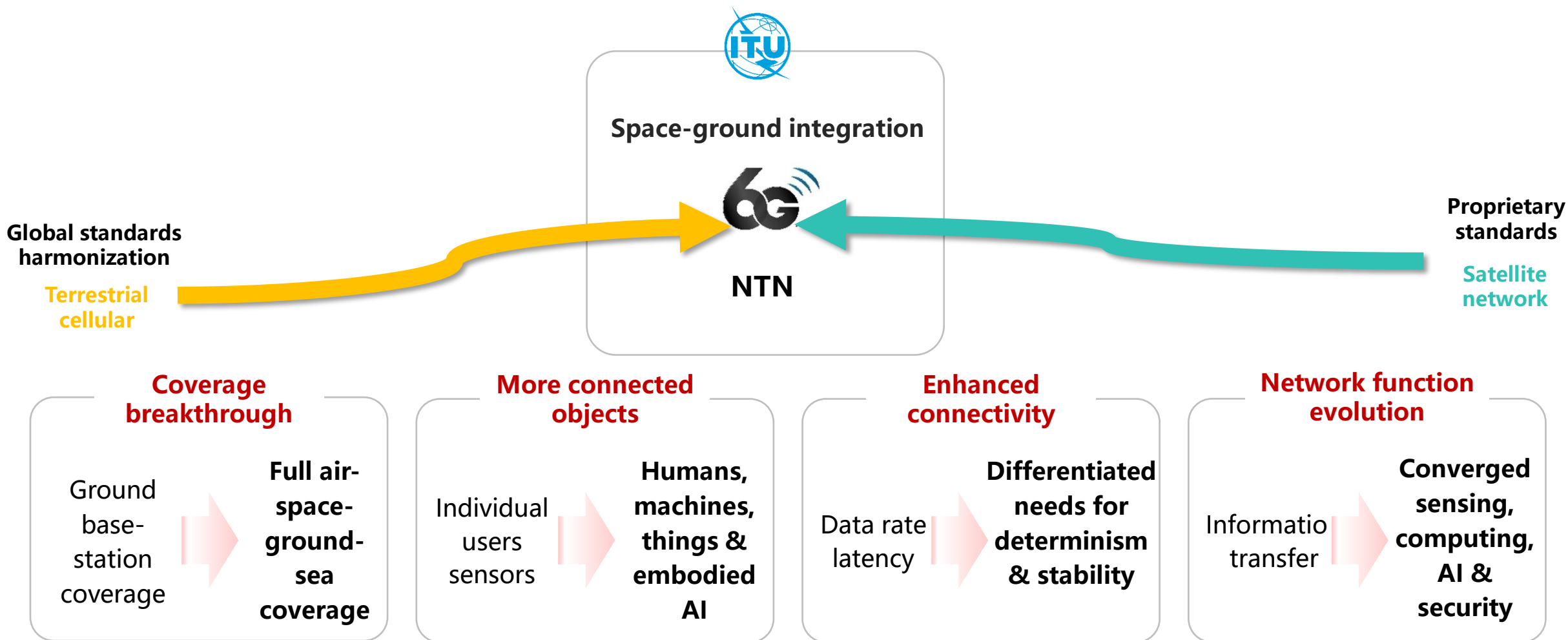
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Outlook for Space-Ground Integration

Space-Ground Integration: Direction of New-Generation Communication Networks



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The space-ground integrated network underpins ubiquitous air-space-ground-sea coverage and deep integration of communication, sensing, computing, intelligence and security.

Unified standards and spectrum coordination accelerate space-ground integration

Standards: 3GPP NTN as unified standard

- Rel-17 (transparent): 5G air interface to satellites
- Rel-18 (transparent): MEO/LEO coverage & capacity
- Rel-19 (regenerative): gNB on board, store-and-forward, UE-to-UE via satellite
- Rel-20 (integrated): 5G-A GEO voice, emergency call, 6G multi-orbit
- Over 30 satellite operators/vendors join 3GPP NTN

Spectrum: space-ground sharing in ITU-R and administration

- WRC-27 AI 1.12: NGSO MSS in L/S; AI 1.13: 694MHz-2.7GHz D2D; AI 1.14: 2GHz
- China: improving spectrum management & access, advancing space-ground sharing
- Europe: CEPT D2D conditions (ECC 373, Feb 2026); SE40/FM44 coexistence studies

Industry: global cooperation

- Operator cooperation: 275 operator-satellite NTN partnerships in 101 countries (Apr 2026)
- Converged networking: satellite wide coverage + terrestrial deep capacity

Market: Steady Growth of the Global Satellite Market



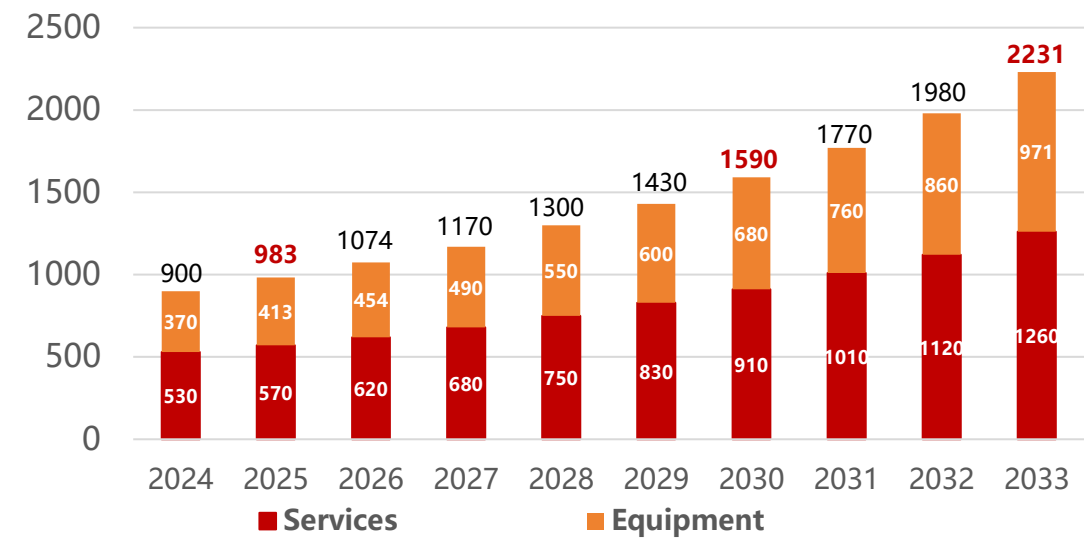
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China's global share to rise from 7.9% (2024) to 9.3% (2033)

Sustained global market growth

- Global: USD 98.28B (2025) to USD 223.06B (2033), CAGR 11%; services ~USD 126B
- North America leads with ~34.5% of revenue

Global Satellite Communications Market (USD 100M)

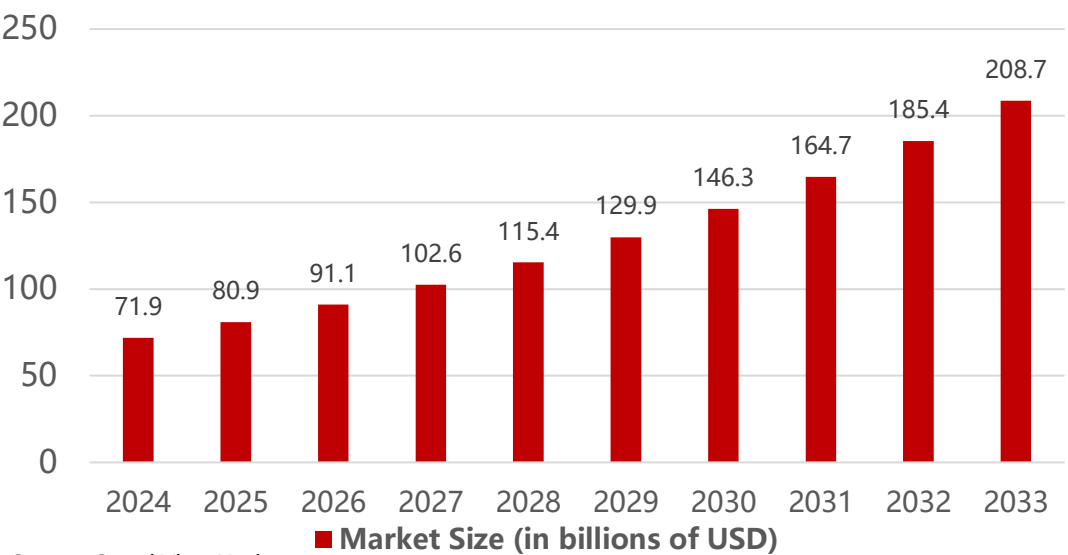


Source: Grand View Research

China's market to surge with LEO deployment

- China: USD 8.09B (2025) to USD 20.87B (2033), CAGR 12.27% — the fastest-growing market

China's Satellite Communications Market (USD 100M)



Source: Grand View Horizon

Demand: In-Flight and Maritime are the Largest Potential Markets



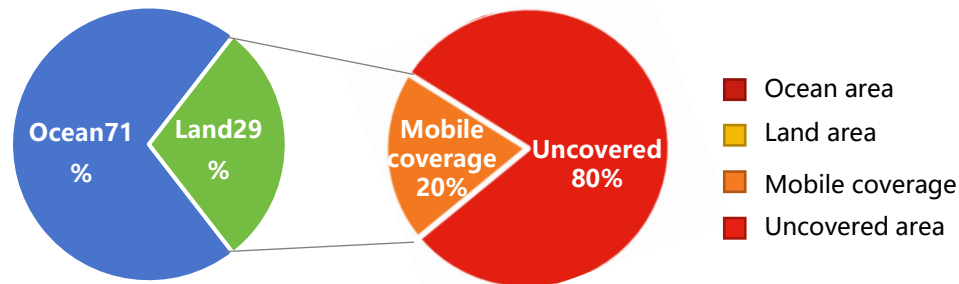
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Globally satellite fills coverage gaps; China focuses on in-flight, maritime, emergency

Global satellite: filling coverage gaps

- Terrestrial covers only 20% of land / 6% of Earth; mountains and deserts remain gaps
- 2024 penetration: global 71%, Africa only 47% — a large gap
- Satellite reaches beyond terrestrial, bridging the digital divide

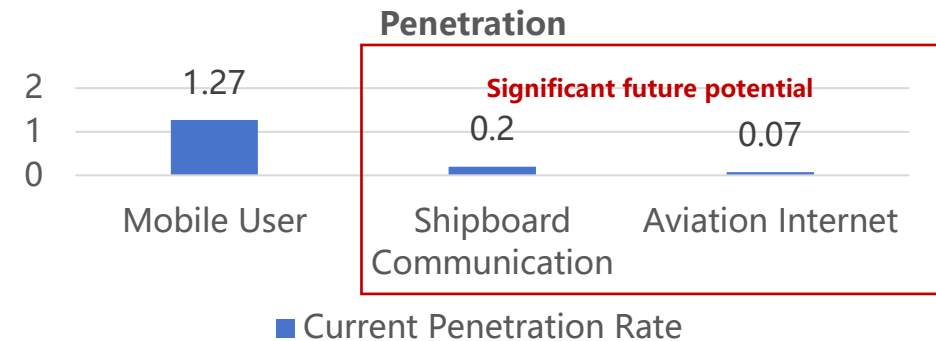
Global Mobile Coverage



China's satellite: mainly maritime, aviation, emergency

- Terrestrial networks: low cost, low latency, large capacity — constrain D2D
- China: 4.838M 5G base stations; mobile penetration over 127%
- Aviation, maritime and emergency scenarios still lack coverage and pricing models

Mobile, Maritime and In-flight Connectivity



D2D makes satellite communications lighter and more affordable

- Portability: D2D embeds the module into smartphones, cutting thickness and weight.
- Price: dedicated terminals cost thousands; D2D lowers price to ~RMB 2,000.

Type	Traditional satellite terminal		D2D smartphone terminal	
Model	Isatphone 2	Lesat P2 (Lezhong)	Mate60Pro	nova14ultra
Form factor				
Dimensions	169*75*36mm	168*78*21mm	164*79*8mm	163*75*8mm
Weight	318g	360g	225g	204g
Terminal price	RMB 8,159	RMB 12,795.7 (incl. 1-yr voice)	RMB 6,499	RMB 2,569

On-Board Intelligent Processing will be Mainstream for Next-Gen LEO Constellations

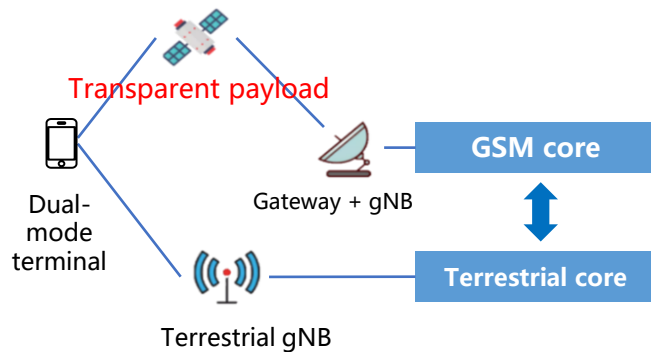


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Transparent-payload and on-board gNB coexist; space computing is a new hotspot

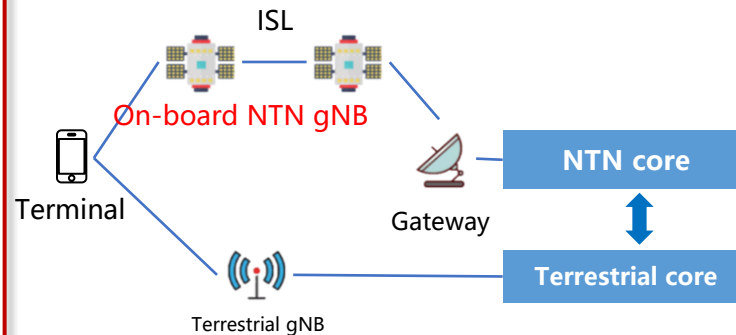
- 2025: >3,200 LEO launched; regenerative share 18%→41%
- SpaceX plans 1M-satellite data center; Blue Origin 52K space-computing satellites

Transparent payload



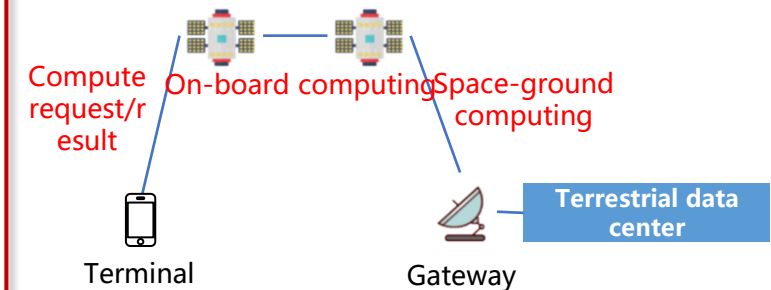
- ❑ Pros: no modulation/coding on board; low complexity
- ❑ Cons: relies on many gateways; cannot meet future regenerative needs

Regenerative Payload



- ❑ Pros: fewer gateways, low latency, signal/data/payload processing
- ❑ Cons: ISL adds complexity

On-board intelligent processing



- ❑ Pros: on-orbit processing avoids backhauling large data
- ❑ Cons: limited on-orbit power, constrained by power and heat

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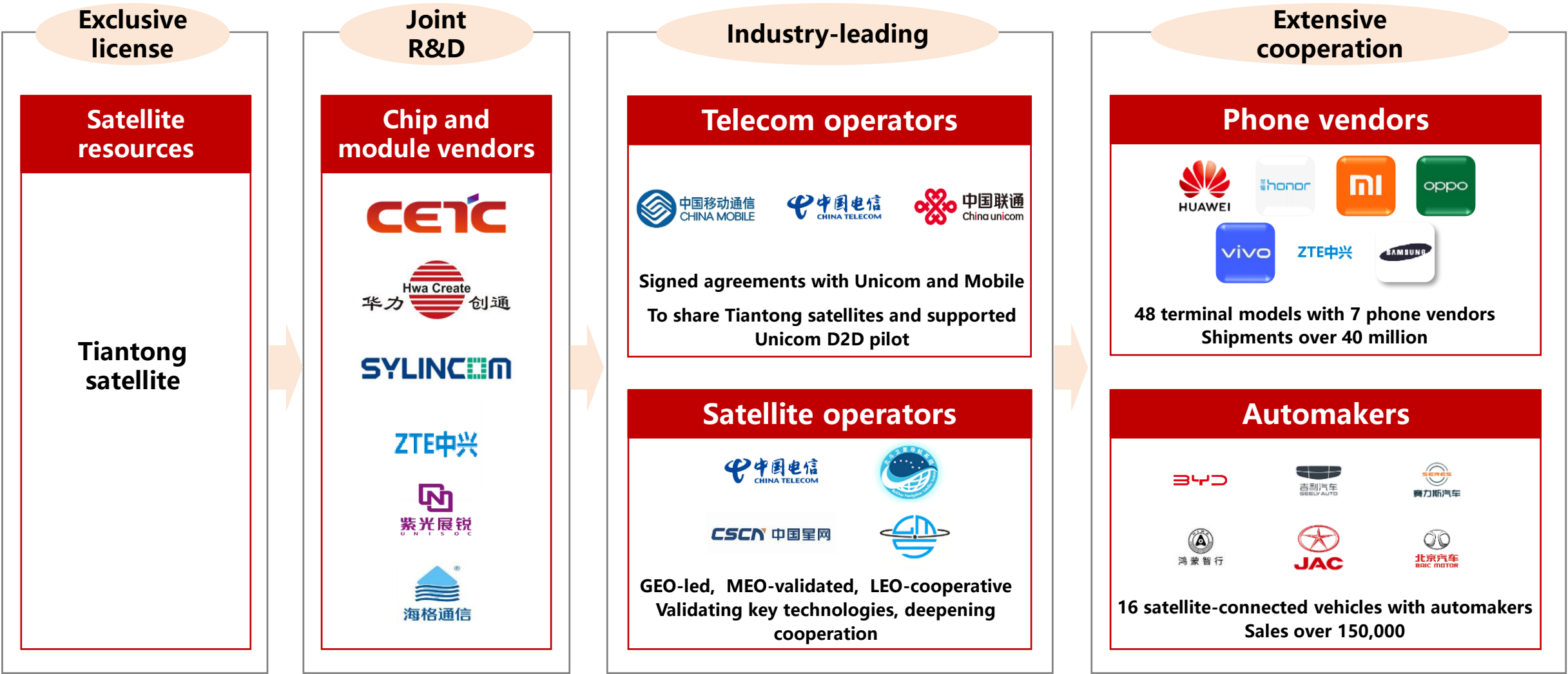
Outlook for Space-Ground Integration

China Telecom's Space-Ground Integration Ecosystem



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Full-chain Tiantong ecosystem: satellites, chips, modules, terminals, networks



By Jul 2026: 3M Tiantong D2D users; entered Laos etc.

The internationalization of the Tiantong satellite service



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China Telecom's Tiantong satellite business has already achieved operational deployment in the Hong Kong SAR and Laos, providing users with direct mobile satellite connectivity through cooperation with local MNOs. Applications and testing for landing permits in countries such as Indonesia are underway.

Hong Kong (China) (Launched)

- In May 2024, the Satellite Direct-to-Phone service was launched for users in Hong Kong
- From July to August 2024, HKT, Hutchison and SmarTone launched Satellite Direct-to-Phone services

Laos (Launched)

- In cooperation with ETL, the Lao operator, a launch event was held in Vientiane, Laos in May 2025, followed by the commencement of trial commercial operations

Thailand

- Discuss with the local operator for Tiantong satellite landing plan

Macao (China)

- Has the capability for official service launch
- Discuss with Macao Post and Telecommunications Bureau on policies for service deployment



Indonesia

- Applying for a deployment license from the Ministry of Communication and Informatics of Indonesia (KOMDIT).
- Conducting core network integration with Telkomsel

Philippine

- Core network integration with the local operator has been basically completed, enabling satellite phone calls using local operator numbers.

Singapore

- Together with partners, submitted an application for service deployment to the local government

Cambodia

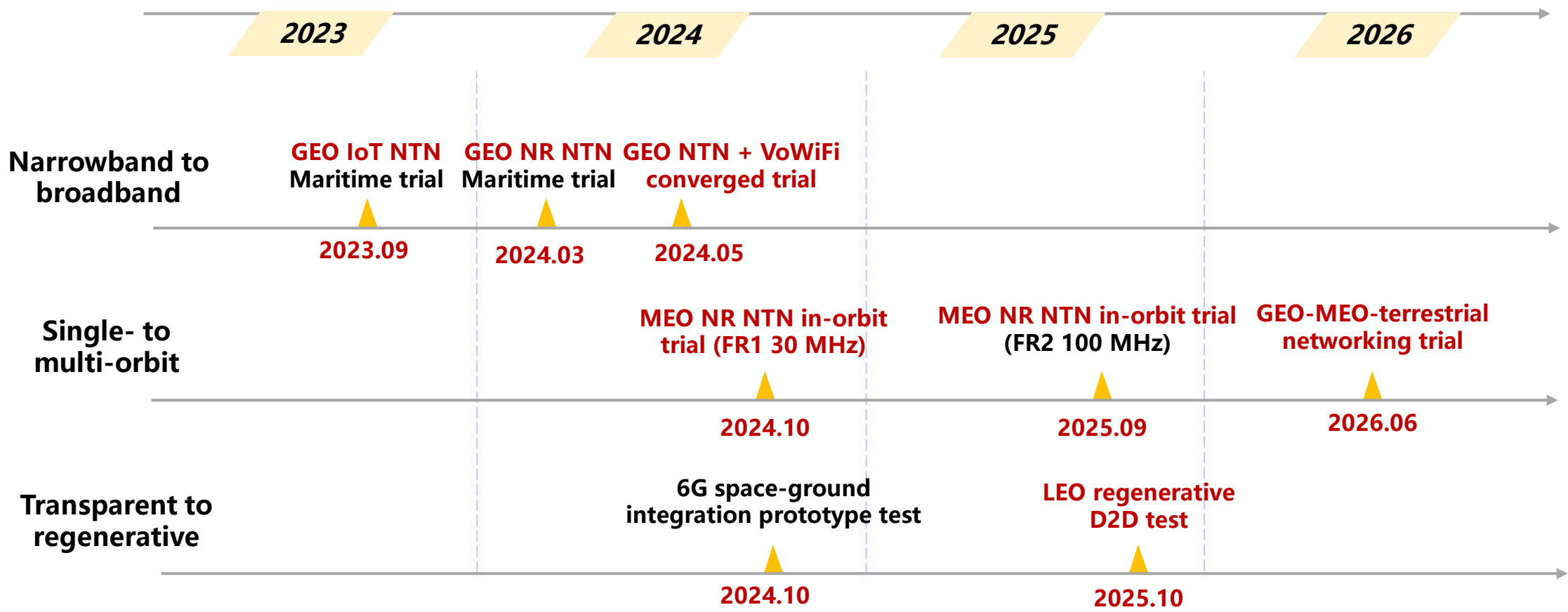
- MOU has been signed with Cambodian operators, and discussions are ongoing with the Cambodian government regarding policies for service deployment.

China Telecom's NTN Standardization and Trials



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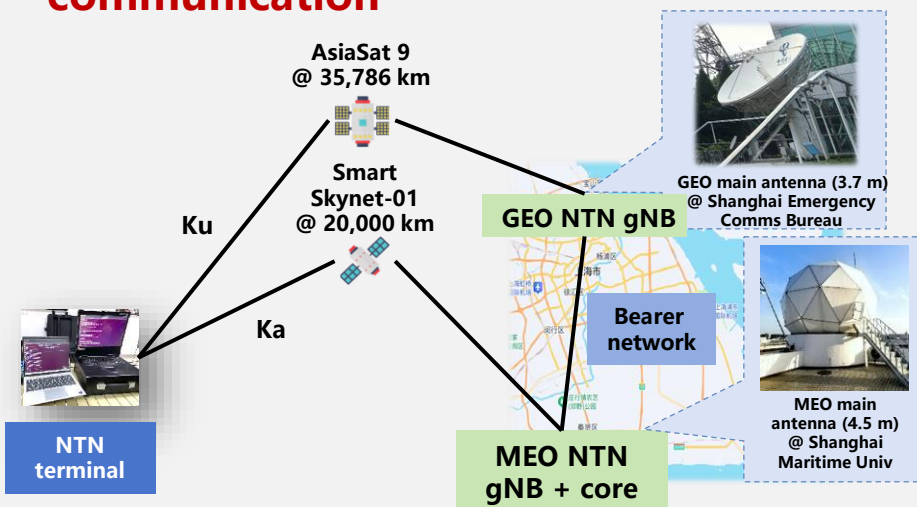
Targeting rate, coverage, reliability and latency, China Telecom advances 3GPP NTN standardization and trials



Targeting continuous coverage and large bandwidth: GEO/MEO-terrestrial networking and seamless cross-orbit handover

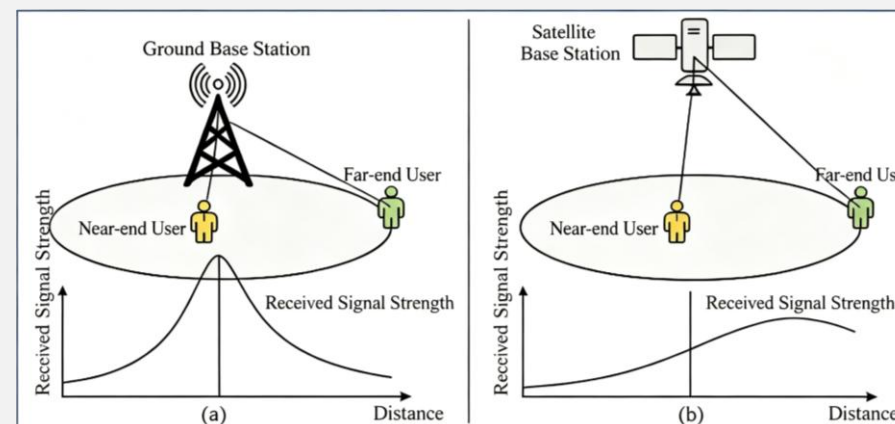
First NTN GEO-MEO collaborative architecture

- Breakthrough: multi-orbit scheme via terrestrial networks; dynamic time-frequency sync
- Result: "GEO all-time reliability + MEO large bandwidth" ubiquitous communication



Seamless cross-orbit handover

- Breakthrough: ephemeris-based conditional handover; pre-positioned switching
- Result: handover latency cut from 363 ms to 26 ms



Large center-edge signal difference (ground)

Small center-edge signal difference (satellite)

Narrowband to Broadband: Expanding NTN Services



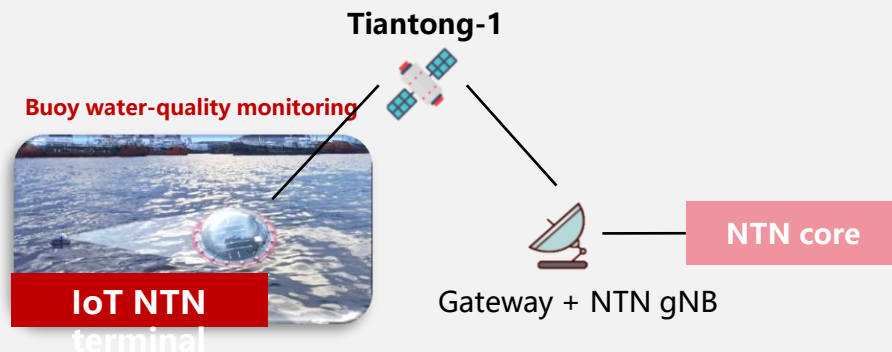
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Targeting short-message, data and voice: time/frequency sync and terminal miniaturization

GEO IoT NTN

*Sept 2023, Zhoushan:
first IoT NTN maritime trial*

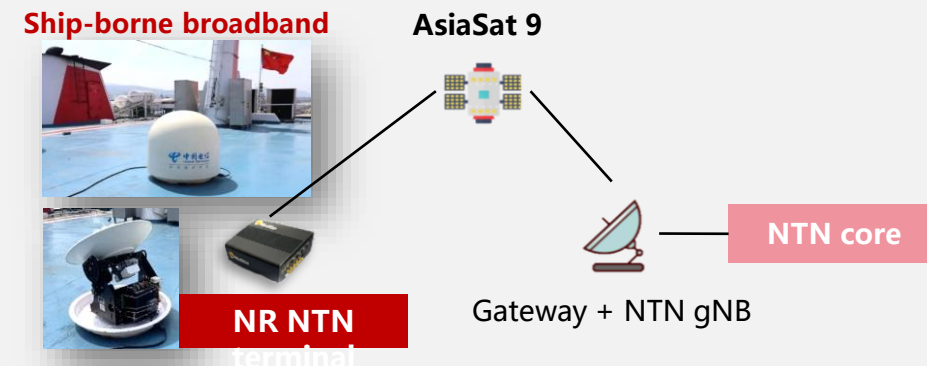
- First trial: marine monitoring and emergency SOS for uninhabited islands
- Breakthrough: time-frequency sync, timing adaptation
- Result: 200 kHz per terminal; IoT monitoring and SOS messaging



GEO NR NTN

*Mar 2024, Zhoushan:
first NR NTN maritime trial*

- First trial: 10-nautical-mile ferry route; on-the-move broadband in complex weather
- Breakthrough: time-frequency sync, terminal miniaturization
- Result: 5 MHz bandwidth, 7 Mbps downlink; broadband data and OTT voice



Transparent to Regenerative: On-Board Processing

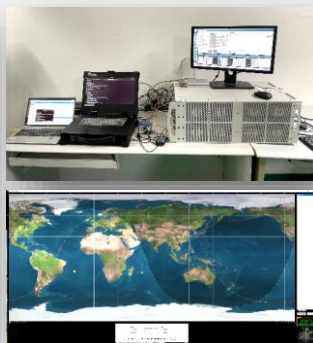


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Targeting low latency and inter-satellite networking: time-frequency offset compensation and on-orbit reconfigurability

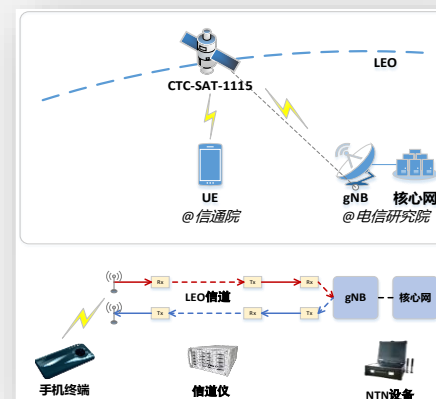
Regenerative mode — lab validation

- Breakthrough: HARQ optimization, UE-to-UE via satellite
- Result: 20 MHz bandwidth; 85 Mbps down, 65 Mbps up



Transparent mode— lab validation

- Breakthrough: time-frequency offset compensation; 5G TN access without GNSS
- Result: existing 5G UE accessed with continuous service



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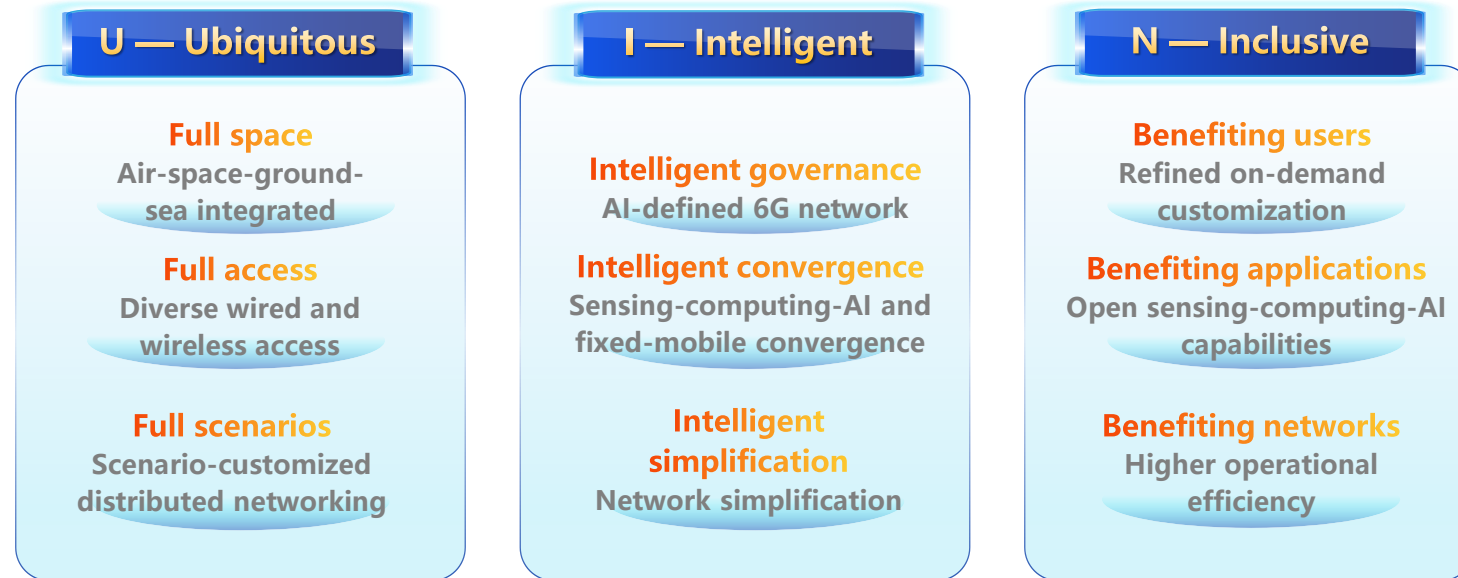
Outlook 1: Intelligent & Inclusive Services Across Air-Space-Ground-Sea



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China Telecom proposed 6G Ubiquitous Intelligent Network (UIN); initial progress in R&D, standards, trials

6G UIN: ubiquitous and intelligent-inclusive 6G vision
Ubiquitous Intelligent Network
Deep convergence of communication, sensing, intelligence and computing



Technology reserve

Industry focuses on 6G key technologies: ISAC, wireless AI, space-ground integration



System validation

Industry shifts to systematic 6G networking, integrating communication, sensing, AI and computing

Outlook 2: Converged Space-Ground Communication & Computing



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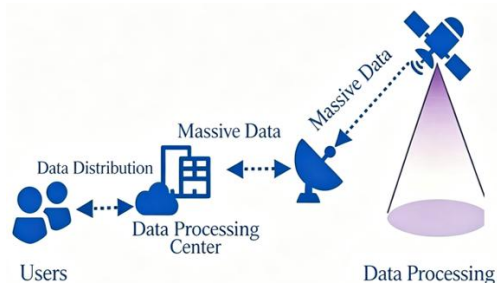
Enhanced on-board computing: satellite networks enter converged communication & computing

- **Computing extends to space:** collaborative computing and space data centers support autonomous sensing and decisions
- **Satellite networks evolve toward integrated "communication + intelligence + computing ":** evolving from simple communication forwarding to an integrated system of "communication + intelligence + computing", promoting unified planning, construction, and scheduling of network and computing resources.

From "space data, ground processing" to "space data, space processing"

Traditional ground backhaul

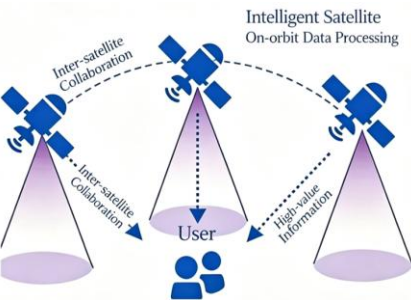
Downlink during overpass; hourly/daily processing



VS

On-board intelligent processing

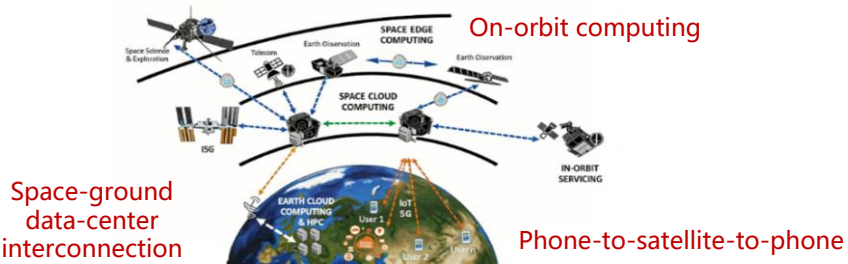
Real-time continuous processing (seconds)



Core change: orbit-level distributed AI architecture
Full process on orbit: acquire—process—store—output

Application scenarios

Scenario	Application
Disaster monitoring	On-orbit real-time identification of fires, floods and land changes
Ocean shipping	Real-time vessel positioning, track monitoring and anomaly detection
Low-altitude economy	Real-time identification, positioning and track tracking for low-altitude targets
Urban governance	Urban monitoring, traffic analysis and infrastructure safety



Note: schematic diagram

Outlook 3: Multi-Orbit Space-Ground Collaborative Networking



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Driving satellites toward unified access, cross-orbit collaboration and on-demand handover

Standards evolution

- ❑ Radio: multi-orbit access, cross-orbit mobility and multi-connectivity
- ❑ Core: multi-orbit selection, service continuity, policy control and traffic scheduling
- ❑ Terminal: promoting the incorporation of Tiantong terminal RF specifications into the ITU GMPCS (ITU-R Rec M.1480).

Space-ground coordination

- ❑ ITU-R WRC-27: establishing international rules for new satellite allocations (e.g. D2D)
- ❑ Regulators: D2D principles; satellite and terrestrial telecom converge

Trial priorities

- ❑ Multi-orbit handover: on-demand switching for maritime, aviation and power
- ❑ On-demand orbit selection: dynamic scheduling by latency, bandwidth and load



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Thank you!