工業技術研究院
Industrial Technology
Research Institute

Path Toward Satcom's New Era
Proprietary and Open Standard Convergence

Part I Non-3GPP SatComs and User Terminals

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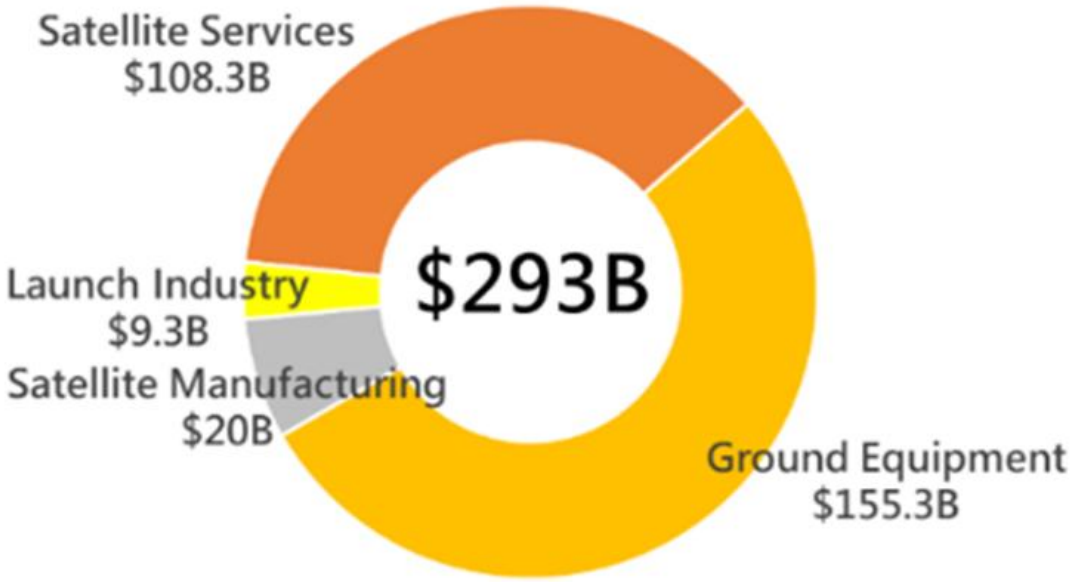
March 31, 2026

2026 R&S SatCom Forum

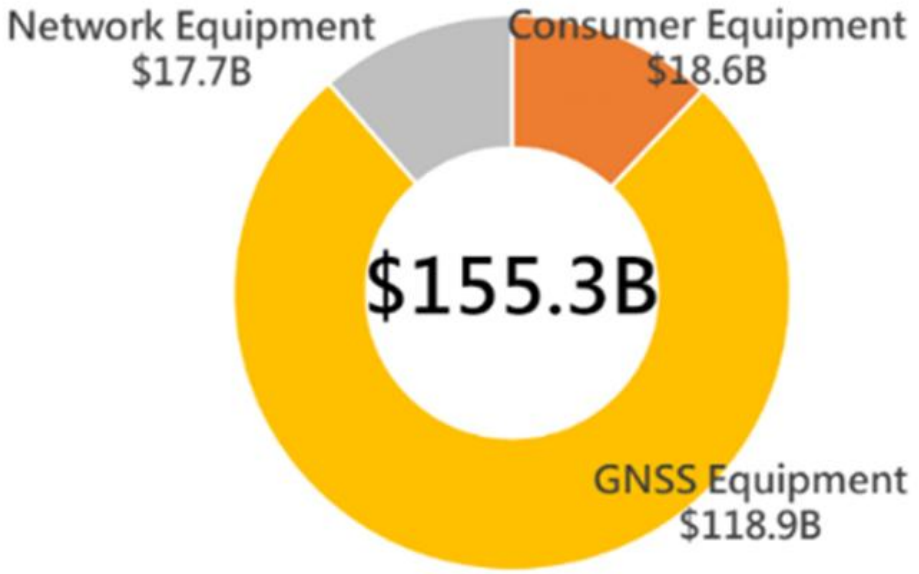
Market Forecast

Global Satellite Industry Revenues

- According to the Satellite Industry Association (SIA), the global satellite industry generated USD 293 billion in revenue in 2024.
- Ground equipment accounted for the largest share at USD 155.3 billion, followed by satellite services.
- Ground equipment revenue grew 3% year-over-year, remaining the key driver of industry growth.



Global Satellite Industry Revenues



Ground equipment Revenues

Source: SIA; compiled by III, January 2026.

Market Forecast

Cross-Band Integration Is In Full Swing

GEO : 36

LEO : 648

Eutelsat and OneWeb

- Merged to provide integrated GEO-LEO services.
- Integrated antenna/modem solutions.

GEO : 6

GEO : 15

Viasat and Inmarsat
Merged to deliver L-band D2D connectivity services.

GEO : 44 / MEO : 27

GEO : 49

SES and Intelsat
Merged to strengthen multi-orbit (GEO/MEO) satellite services and expand global capacity.

GEO : 93 / MEO : 27

LEO : 648

The new SES +OneWeb
Provides land, maritime, and aviation applications.

GEO : 14

LEO (lightspeed) (+198)

TELESAT is building 198 satellites for Lightspeed constellation to deliver global broadband services.

GEO : 3

LEO : 648

GEO : 10

Hughes Network Systems + OneWeb + EchoStar Lyra
Support government and defense communications.

Source:

Eutelsat procures a further 340 OneWeb low earth orbit satellites from Airbus | Eutelsat

SES Closes Intelsat Deal, Creating Satellite Giant with 120-satellite Fleet | WashingtonExec

Inmarsat Maritime to deliver NexusWave connectivity across Auerbach fleet of newbuild heavy lift vessels | Viasat

Hughes bonds drop following addition of EchoStar entity as secured party to existing security agreement

Hughes bonds drop following addition of EchoStar entity as secured party to existing security agreement

Flexible Transponder Applications

Can easily form private or public networks

Transponder-based
GEO / MEO / LEO

41%

Single Carrier Per Channel (SCPC)
Private Network (Bandwidth leasing)

Military Communication **75.8%**

Sensitive GOV / Enterprise Network **24.2%**

59%

VSAT Network
(Capacity leasing)

Airline Entertainment **44%**

Maritime Communication **19%**

GOV/Enterprise Resilience **12%**

Rural Area Communication **25%**

Remote Antenna

Hub Antenna

Remote Antennas

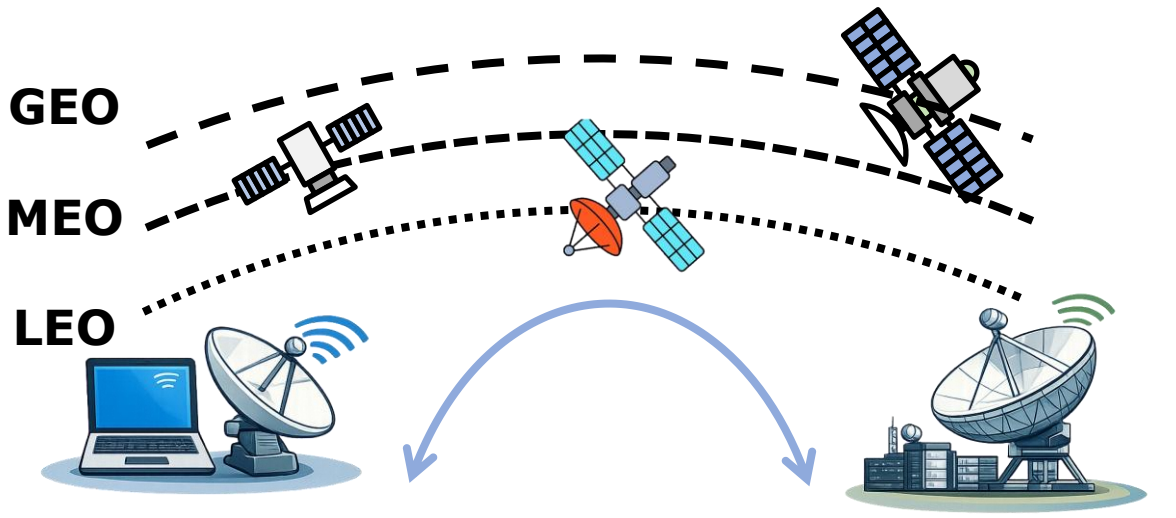
Hub Antenna

Internet Services

Source:
Market&Markets
SatCom Equipment Market
2028

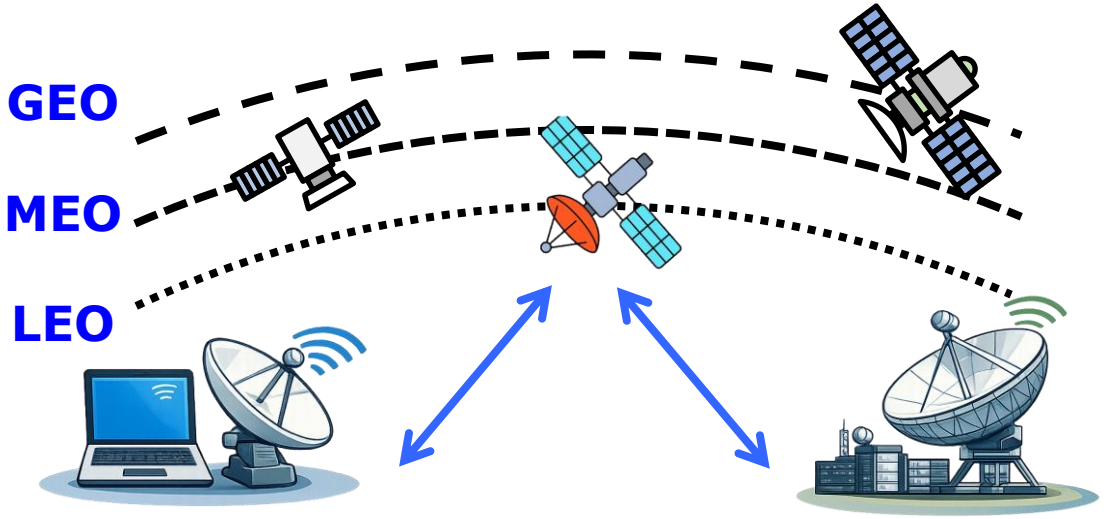
Network Architecture

Transparent



Dynamic BW Allocation	Beam Hopping / Digital BF	Flexible Beam Interconnect
Digital Transparent Satellite		
LEO/MEO/GEO Overlay		
End-to-End Traffic Steering		
Control & Management Policy		

Regenerative



Resource Allocation	Path Control	Burst Scheduling	SYNC & Recovery	Beamforming Sophistication
Onboard Control				
SAT Overlay	Link Control	GW/ISL Forwarding		
Routing	Link Policy	Traffic Prioritization		
Network Intelligence	**SWaaP**			

SWaaP: Software as a Platform

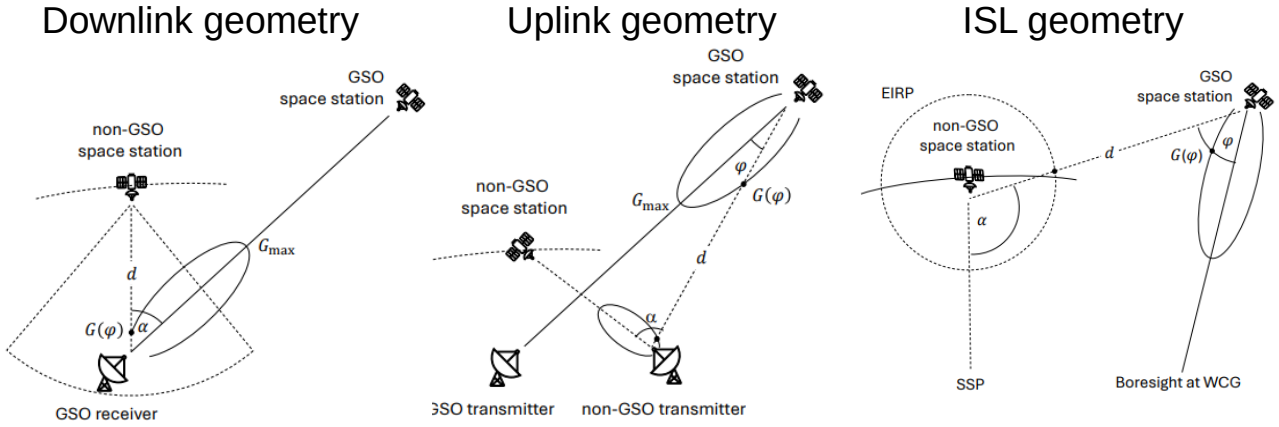
Performance Requirement
Regulator Perspective

Antenna Radiation Envelope
- Side-lobes must comply with regulatory envelope
- Prevent power leakage toward adjacent GSO satellites
- Strict off-axis EIRP density limits for VSAT

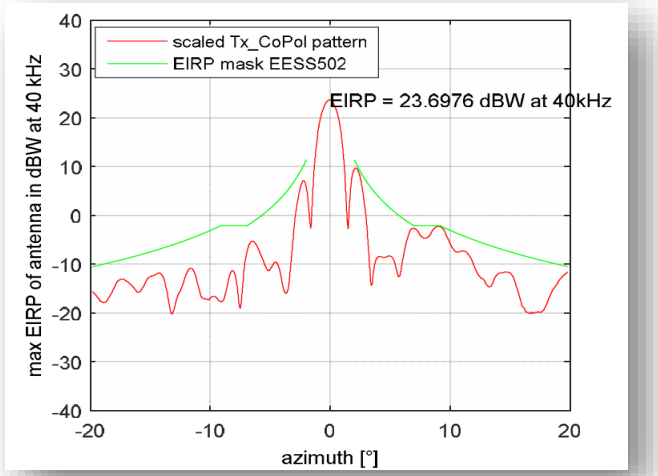
Ref: ITU-R S.580; FCC §25.209; EESS502

Pointing Errors & Interference
- Mobile ESIM platforms introduce off-axis emissions
- ITU recommends statistical modeling (SαS distribution)
- Automatic transmission shutdown required if mispointed (>0.5°)

Ref: ITU-R S.1857; FCC §25.139



ITU RR Article 22 EPFD



EIRP Mask

Power Flux Density (PFD & epfd)
- **PFD**: Protect terrestrial services (angle-dependent limits)
- **EPFD**: Aggregate NGSO interference to GSO systems
- Calculated using ITU-R S.1503 methodology

Ref: ITU RR Article 21, 22; ITU-R S.1503

Verification & Monitoring
- On-site antenna pattern measurement required
- Co-pol / Cross-pol compliance verification
- Remote shutdown capability under network control

Ref: FCC §25.132

Performance Requirement
Operator Perspective

Operator	Orbit	Frequency Band			In-Orbit Satellites (approx.)	Design Life	Planned Constellation	Roadmap
SES	GEO	C	Ku	Ka	~70 GEO + 20 O3b + 13 mPOWER	GEO 10–15 yrs; MEO 10–12 yrs	mPOWER expansion (~20 total); IRIS² participation	mPOWER phase-2 ongoing; EU IRIS² sovereign constellation by ~2030
ASTRANIS	GEO (microGEO)		Ku	Ka	5 GEO	7–9 yrs	Block 3 + Omega (>100 long term)	Small GEO satellites for regional operators
OneWeb	LEO		Ku	Ka	34 GEO + 648 LEO	GEO 10–15 yrs; LEO 5–7 yrs	OneWeb Gen2 >6000 LEO	Dual-orbit strategy; Gen2 deployment ~2027–2028
EUTELSAT	GEO	C	Ku	Ka	17 GEO	12–15 yrs	JSAT-32 + LEO constellation	GEO core in APAC; LEO augmentation strategy
JSAT International	GEO		Ku	Ka	~200 LEO (initial deployment)	5–7 yrs	3236 LEO	Commercial service ramp 2026–2027; FCC milestone deployment
amazon leo	LEO			Ka	~8–9 GEO	10–15 yrs	ViaSat-3 global coverage + next-gen GEO	Aviation & gov focus; post-Inmarsat integration
Viasat	GEO	C	Ku	Ka	~70 GEO + 20 O3b + 13 mPOWER	GEO 10–15 yrs; MEO 10–12 yrs	mPOWER expansion (~20 total); IRIS² participation	mPOWER phase-2 ongoing; EU IRIS² sovereign constellation by ~2030

Performance Requirement

Case Study of Flat Panel Terminal

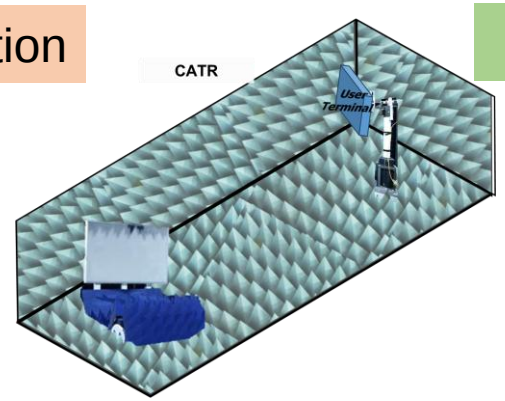
Product Name	ThinAir Ka2517	ThinAir Ku3030	RESA M Multi Orbit	OrBeam MIL 5[illegible]	OrBeam MIL 55[illegible]	
Product Appearance						
Antenna type	Phase array	Phase array	Phase array	Phase array	Phase array	Phase array
Frequency band	Ka band	Ku band	Ku band	Ku band	Ka band	Ka band Ku band
Transmit Frequency (GHz)	27.5 to 30.0	13.75 to 14.5	GEO: 13.75 to 14.5 LEO: 14.0 to 14.5	13.75 to 14.5	27.5 to 31.0	GEO: 13.75 to 14.5 LEO: 27.5 to 30.0
Receive Frequency (GHz)	17.3 to 20.2	10.7 to 12.75	GEO: 10.7 to 12.75 LEO: 10.7 to 12.75	10.7 to 12.75	17.7 to 21.2	GEO: 10.7 to 12.75 LEO: 17.7 to 20.2
EIRP (dBW)	40.5	57	GEO: 49 LEO: 36.6	35	42 EL 45°)	GEO: > 47.5 LEO: > 43.5
G/T (dB/K)	18.5	18.5	GEO: 11 LEO: 11	6	7.7 (EL 45°)	9~11
Scan Angles	EL. +7.5˚to +90˚	EL. +7.5˚to +90˚	EL. +10˚to +90˚	EL. +30˚to +90˚	NA	EL. +30˚to +90˚
Polarization	Circular	Linear	Circular & Linear	Circular & Linear	Circular & Linear	Circular & Linear
Pointing Accuracy	< 0.2°	< 0.2°	NA	NA	NA	GEO: < 0.2° LEO: 0.83°
Tracking Speed	NA	NA	NA	NA	NA	8°/s

R&D Progress

- **Facilitate a testbed to support Lab. testing and field testing**

RF and Antenna Testing and Verification

- RF and Spectrum Characterization Testing
- Antenna Radiation Pattern and Pointing Performance Testing
- EIRP Mask Measurement

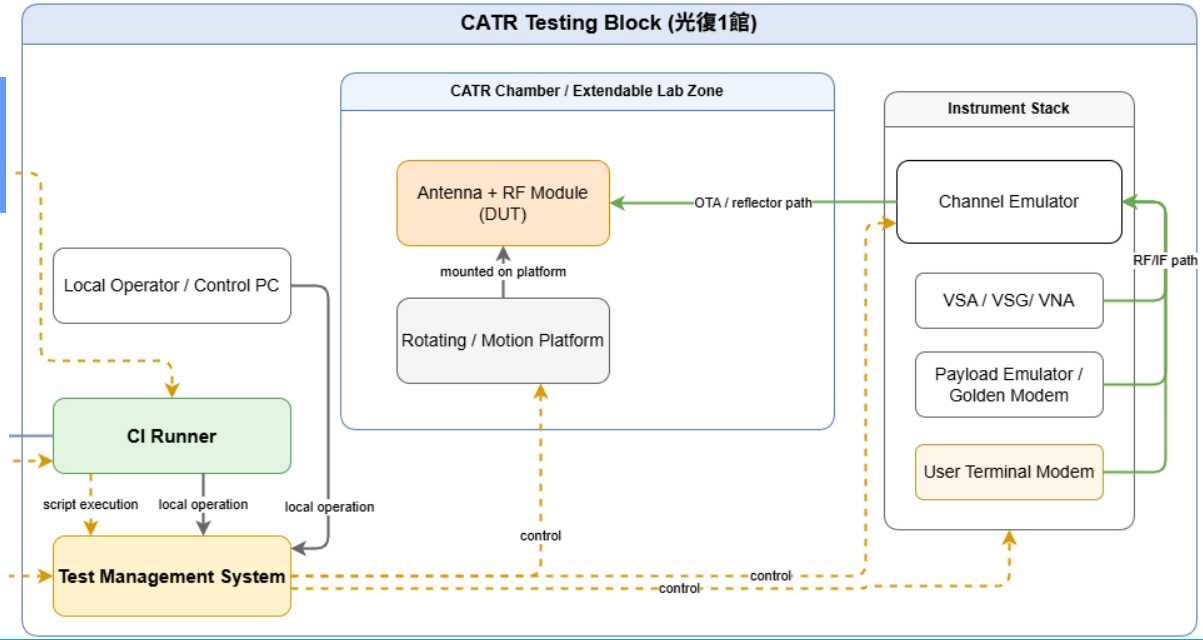


Signal and Network Testing and Verification

- OpenAMIP/DIFI Testing
- Satellite Channel Effects and Constellation Simulation
- SD-WAN Cross-Network Testing and Verification

Development of Automated Testing Technology

- Standardized Report Generation
- Automated Interface Definition



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Part II 3GPP NTN Trials and Case Studies

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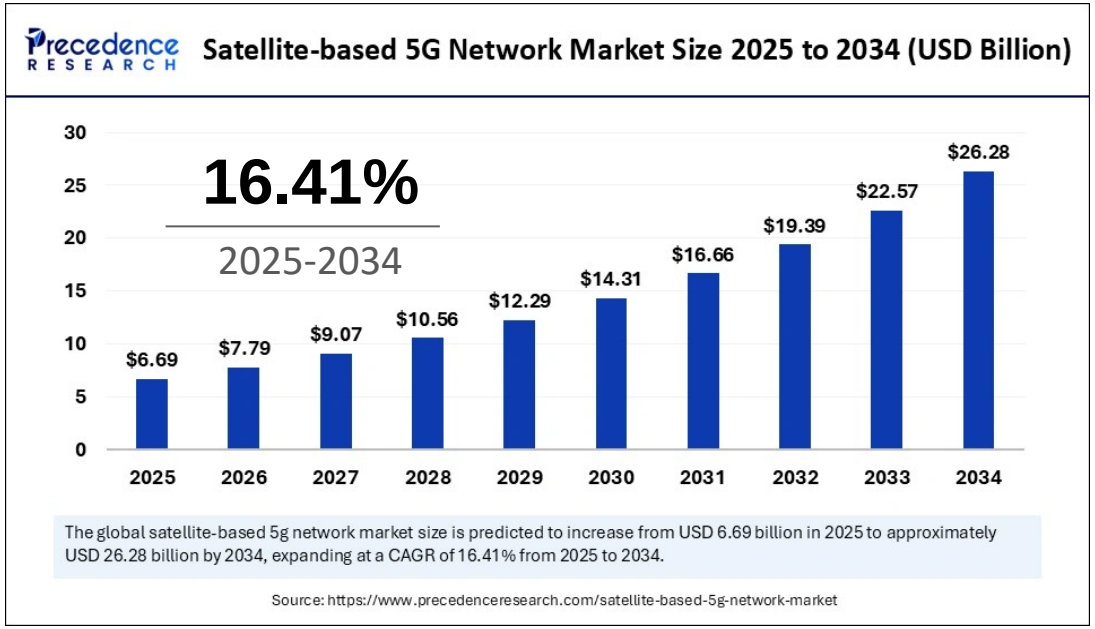
NTN Market Forecast

- Compared with 10.25% CAGR of global SATCOM market size, 5G NTN is predicted to have 16.41% CAGR in 10 years
- In 2034, 5G NTN will occupy 26.28B USD market size, which is about 10% of global satellite communication market



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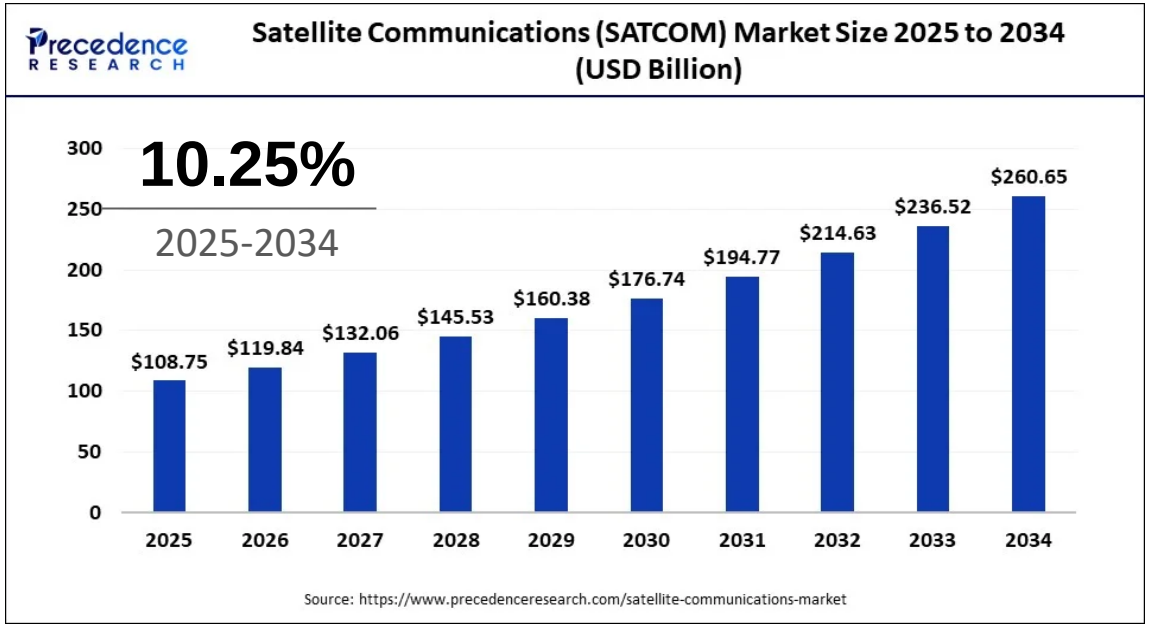

Source date: 2025/7

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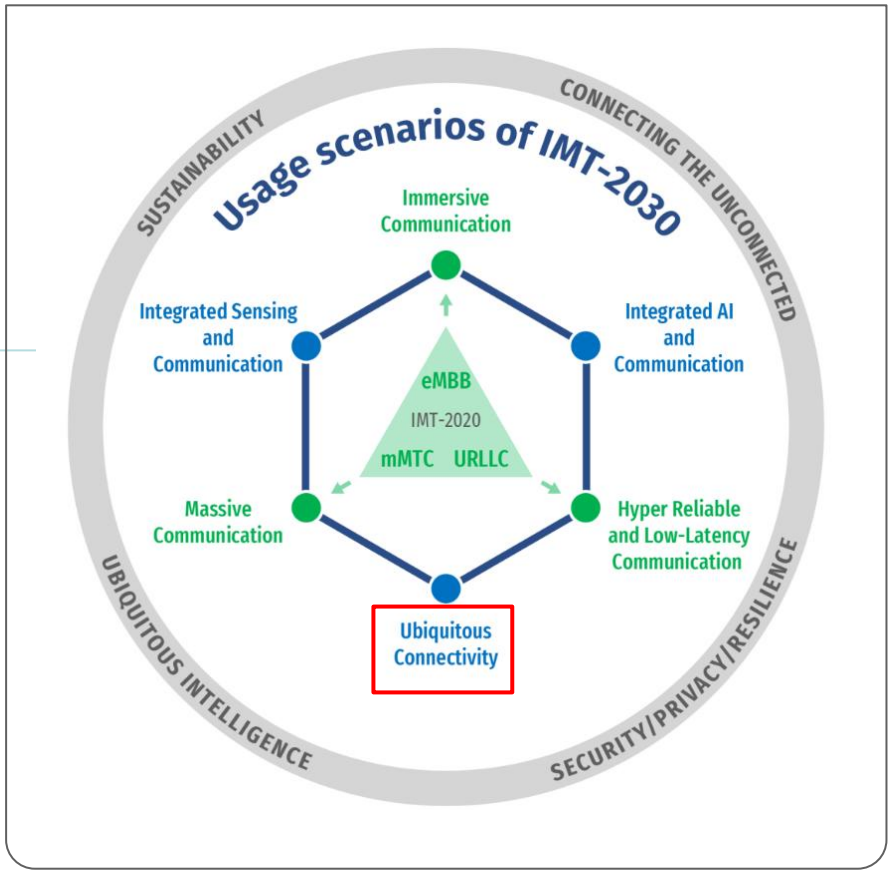
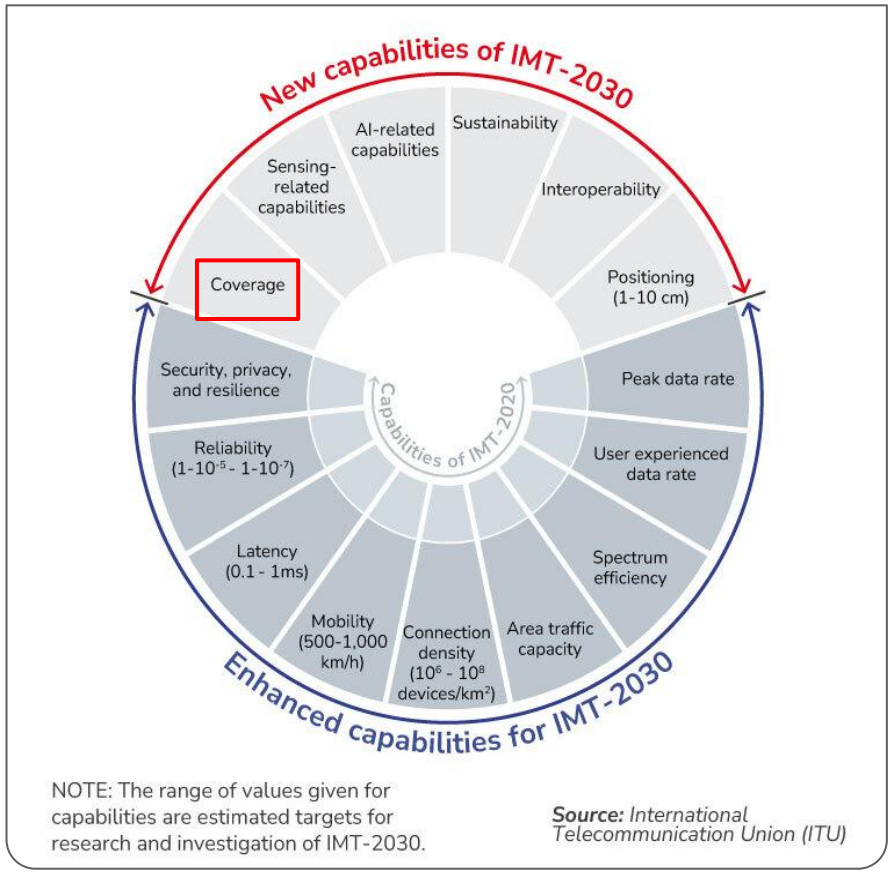
NTN Plays Crucial Role in Future 6G

NTN is a key enabler for IMT-2030 Usage Scenarios, and it also fulfills the new coverage capability to support 6G applications

Usage Scenarios : 3 extension + 3 new + 4 overarching



IMT-2030 Capabilities



NOTE: The range of values given for capabilities are estimated targets for research and investigation of IMT-2030.

Source: International Telecommunication Union (ITU)

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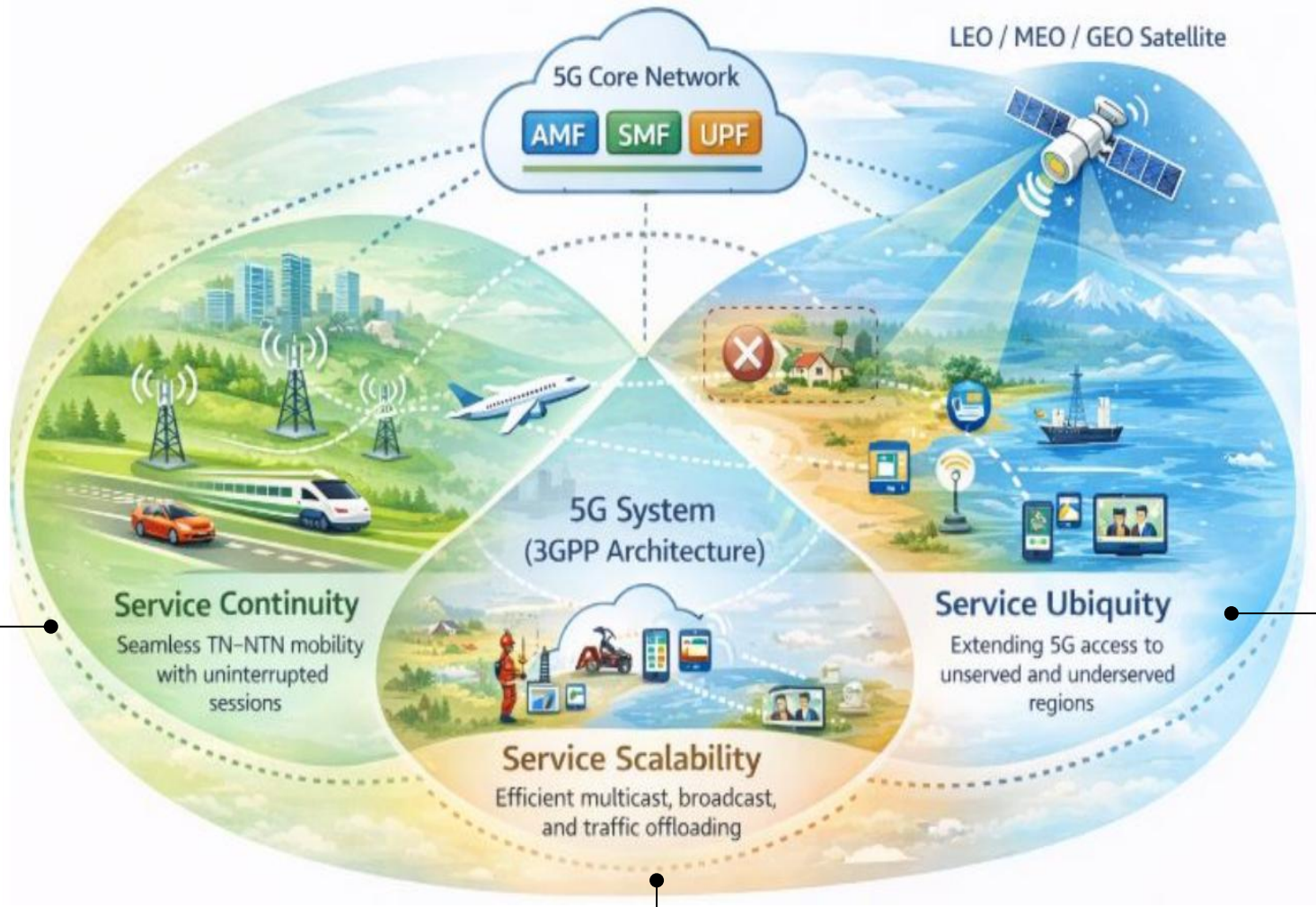
3GPP NTN Use Cases with 3GPP Architecture



Seamless Access Across Networks

Land-based, Airborne, and Maritime platforms

Service to Unserved and Underserved

Poor-/No- connectivity, Public safety & Disaster Relief

Efficient Distribution of Content

Multicast & Broadcast, Traffic Offloading

Source: https://www.techplayon.com

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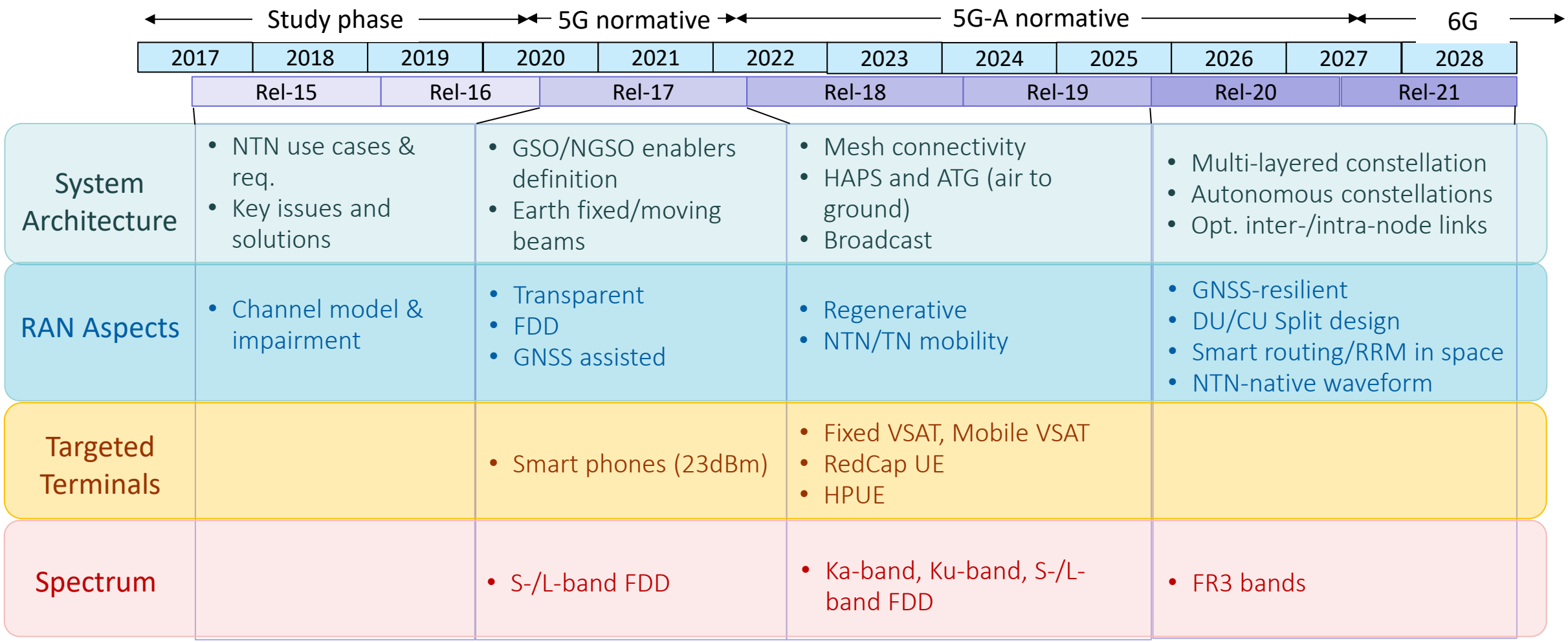
3GPP NTN Roadmap



Source: cnit, 3GPP

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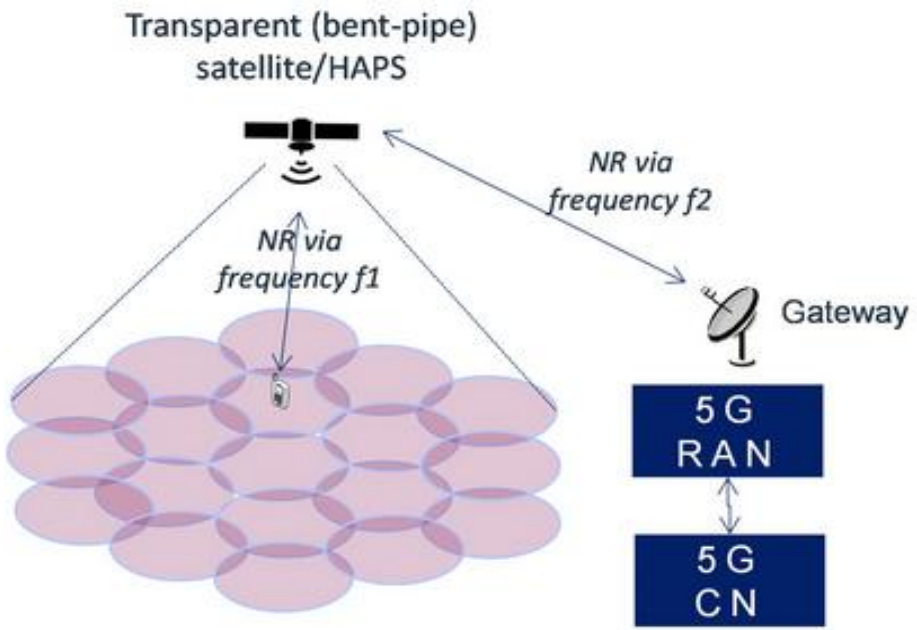
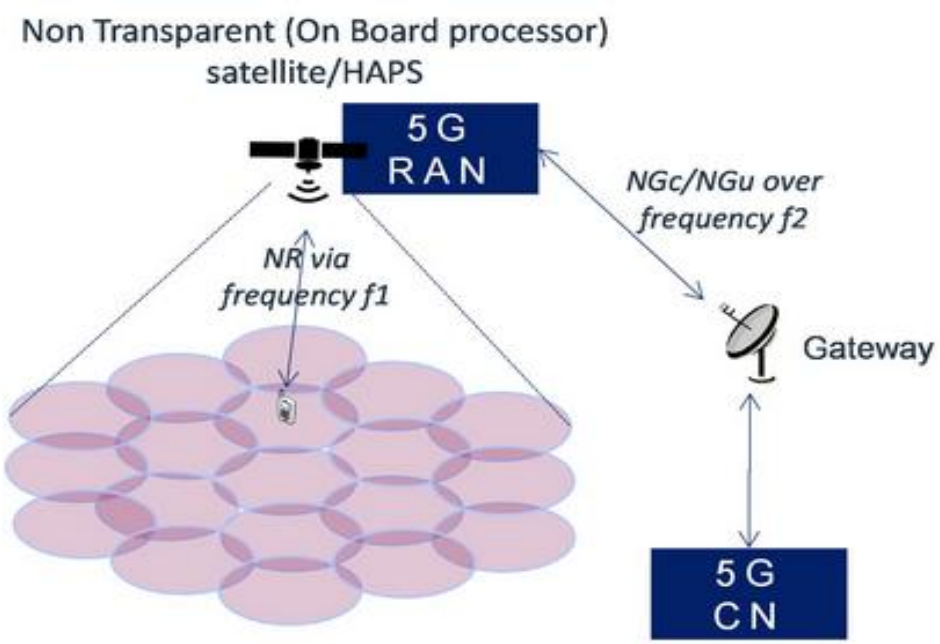
3GPP NTN Architecture Options



Transparent Mode

- Bent-pipe
- Support multi-beam operation
- Traffic centralization at local gateway

✚	-
• Proven technology • Conventional gNB	• Does not scale well • Multiple D/A conversions



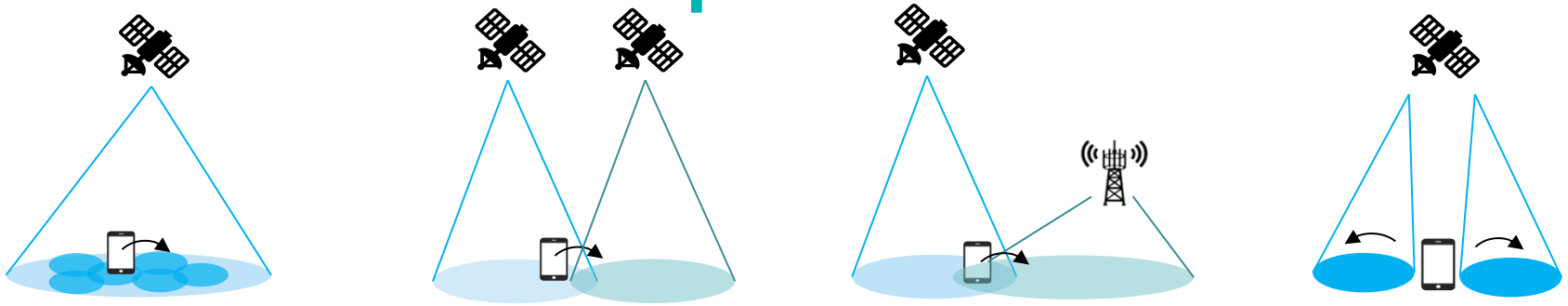
Regenerative Mode

- Real time beam control for lower latency
- Flexible spectrum utilization
- Enable sat. constellation via ISL

✚	-
• Improved performance • Better resilience • Inter-satellite links • Unlock new services	• More complex satellite • More power hungry • More expensive

3GPP NTN PoC Validation Priority

ITRI's Perspectives



inter-beam handover | Inter-satellite handover | NTN – terrestrial handover | cell reselection (Idle mode)

Priority High → Priority Low

Priority High ↓ Priority Low

stationary	High	High	Low	Median
Vehicular	High	High	High	Low
Public Safety	High	Median	Median	Low
Airplanes	Median	Median	Median	Low
Pedestrian	Median	Median	Low	High

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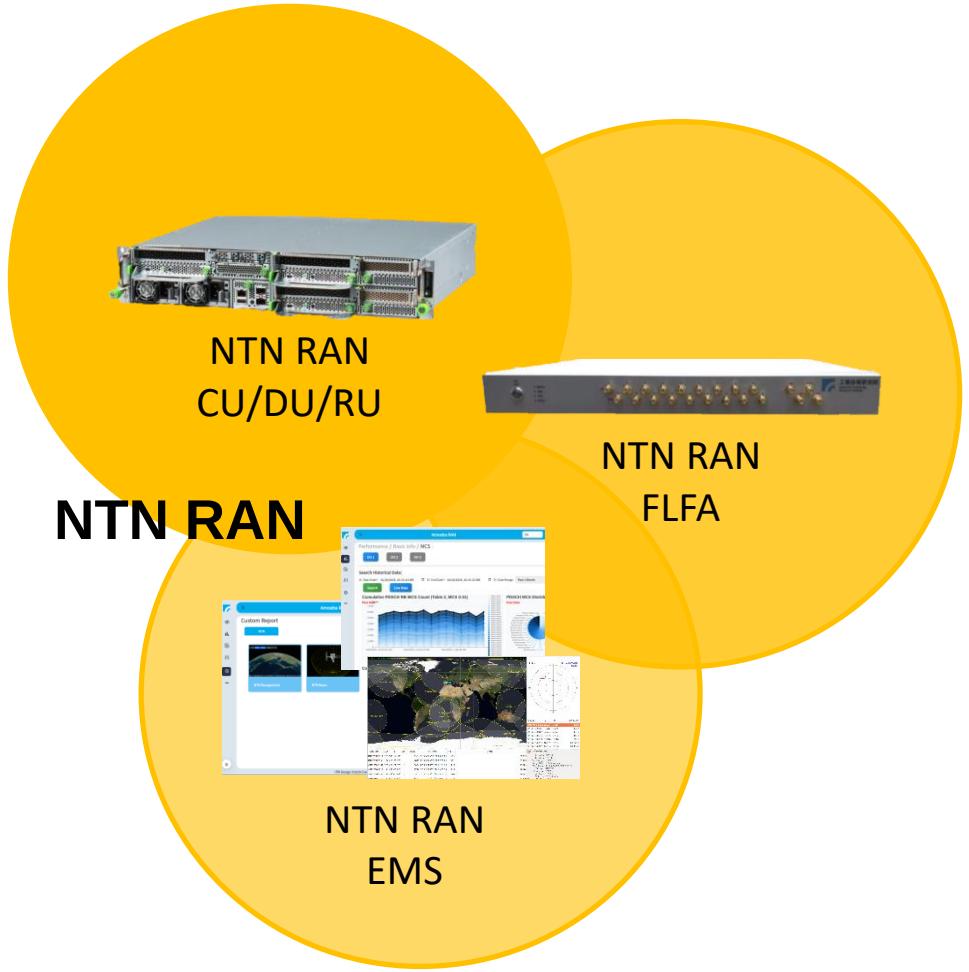
ITRI's Emulator for Transparent NTN RAN

- **Multiple Orbits support:**
  - GEO/MEO/LEO (field trial in different orbits)
- **Seamless Mobility Support:**
  - Conditional Handover/ Traditional Handover/ TN-NTN Handover/ NTN-NTN Handover
- **Multiple Bands Support:**
  - S band/L band/Ku band/Ka band
- **Futures:**
  - 3GPP NR NTN R17~R19 standard support.
  - Transparent mode & adaptive to different satellite gateways.
  - Post-analysis tools & EMS Network Control System.
  - From POC to customization, testing, and commercial deployment for an NTN RAN system.
  - Support TN(FR1/FR2) & NTN system (FDD & TDD).
  - Patented –" Beam/Frequency Switching technology"
  - Patented –" delay torrent communication technique"



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Case Study: GEO Field Trial @ 2024

- GEO Broadband OTA Validation On NTN Video Call

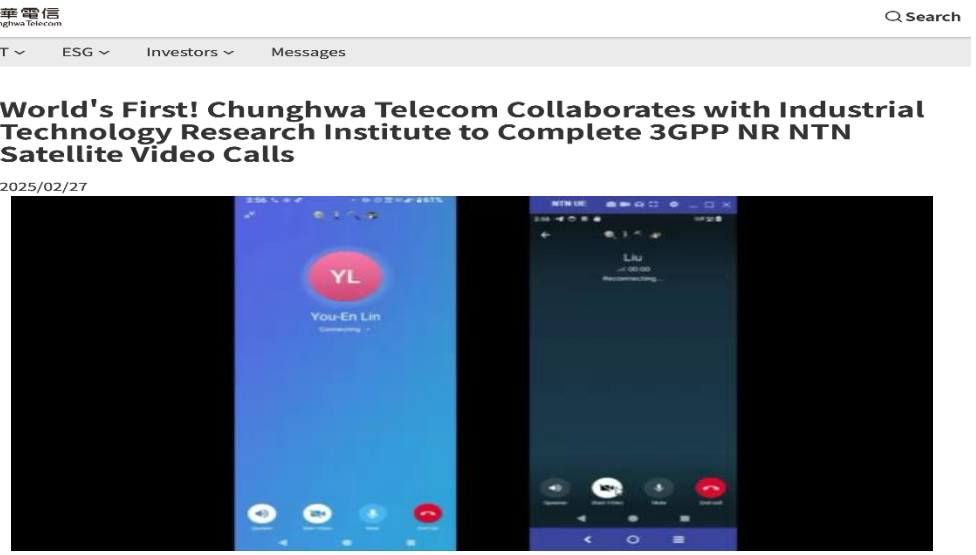
中華電信 Chunghwa Telecom

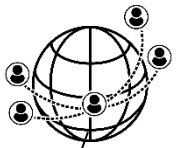
GEO
ST-2

Commercial UT/
UT emulator

VIAVI

NTN
Gateway





Third party
Core

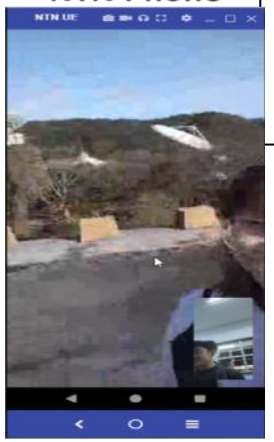
TN Phone

Downlink: ~10 Mbps
at 5 MHz BW (2 bits/Hz)

Uplink: ~1.4 Mbps
at 5 MHz BW (0.28 bits/Hz)

RTT: ~0.5 sec

NTN Phone



ITRI NTN control system

ITRI FLFA | ITRI RU | ITRI DU | ITRI CU

ITRI NTN RAN

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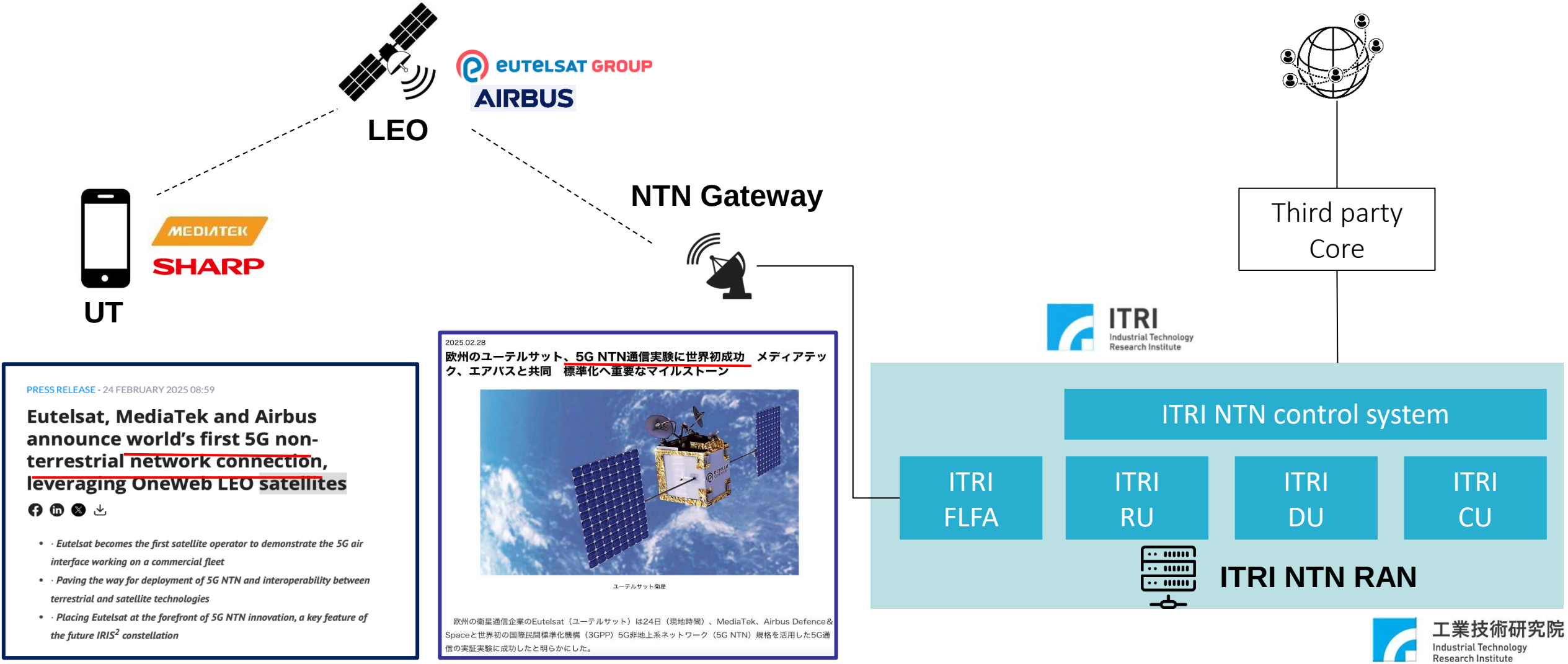
Case Study: LEO Field Trial @ 2025/Feb

- Rel-19 NR-NTN connection validation over Oneweb LEO Satellites

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