10th Anniversary

GISC 2026

Global ICT Standards Conference 2026

(Session 3) 우주기반 초연결 시대를 향하여: 차세대 위성통신 비전과 표준화 전략

한국의 6G 저궤도 위성통신 기술개발 현황 및 표준화 추진 방향

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ICT Standards and Intellectual Property:
Shaping the Physical AI

주최 과학기술정보통신부 지식재산처 주관 국립전파연구원 TTA IITP KEA kista ETRI

AGENDA

From today's projects to tomorrow's standards

I Why these projects

Industry landscape, three technology gaps, and how they launched three projects

II Current projects

For each of A, B and C: overview, objectives and scope, execution plan

III Future projects

Next-phase R&D: K-LEO, next-generation satcom and space AI data centers

IV Standardization directions

3GPP and ITU-R roadmap, working-group mapping, and four priorities

SECTION

I

Why these projects

LEO constellations and 6G are converging, and three technology gaps follow

Landscape | Three technology gaps | Needs and projects | Portfolio

I · WHY THESE PROJECTS

LEO constellations and 6G are converging

8,000+

Starlink satellites launched (Apr 2025), with 42,000 planned; OneWeb and Kuiper follow

$42.1B

Global 5G NTN market by 2030, up from $7.5B in 2024 (CAGR 32.9%)

Rel-21

First 6G specifications expected around end-2028, with NTN built in from the Rel-20 study

WHAT CHANGES WITH 6G

Satellites become part of the mobile network, not an add-on. One standard, one device, seamless across ground, air, sea and space.

Sources: Global 5G NTN Market Size & Outlook 2023–2030

I · WHY THESE PROJECTS

Three gaps stand between today's networks and 6G NTN

GAP 1 · SATELLITE SYSTEM

Bent-pipe payloads

5G NTN relies on transparent satellites: limited interference control, no inter-satellite links, inefficient spectrum use.

Need: a 3GPP regenerative payload and ground segment

GAP 2 · CONNECTIVITY

Terrestrial limits

No coverage over sea, desert and airspace; backhaul demand soars; LEO motion causes bursty core signaling that can overload the NTN gateway.

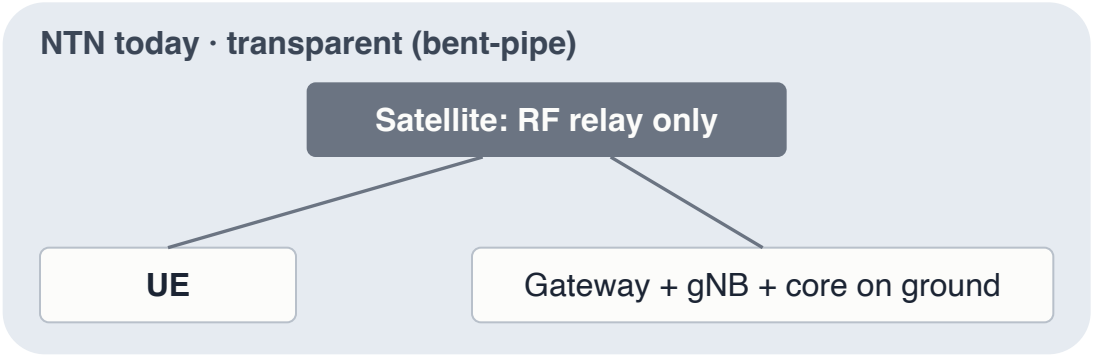
Need: IoT-NTN and NTN-native core

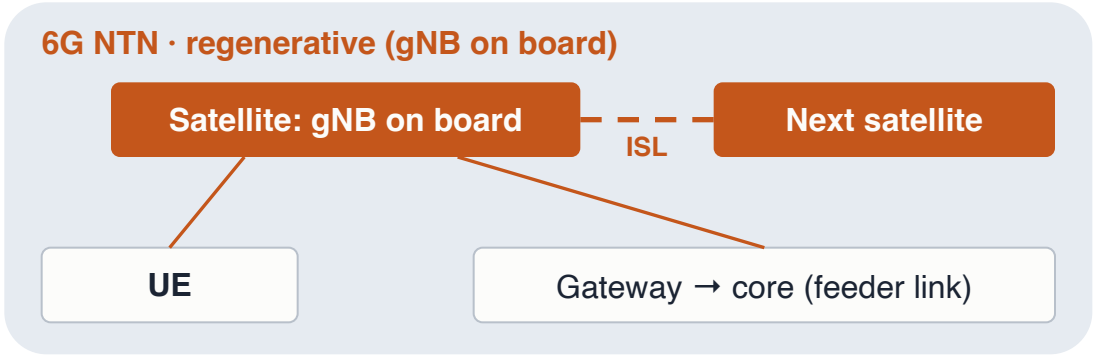
GAP 3 · POSITIONING

GNSS dependency

GNSS is vulnerable to jamming and spoofing, degrades in urban canyons and polar areas, and is not integrated with the network.

Need: network-native PNT over LEO satellite communication





PNT: Positioning, Navigation and Timing

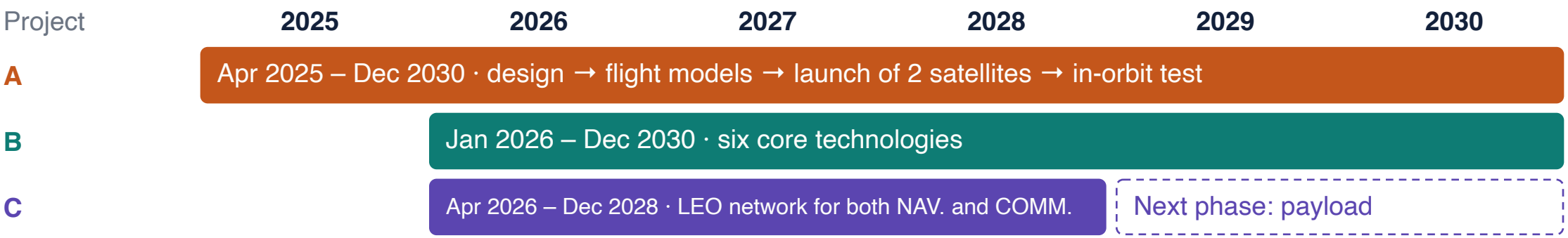
I · WHY THESE PROJECTS

Each need launched a dedicated project

Regenerative 6G satellite system	→	**A · 6G LEO Satellite Payload & Ground Station** System & infrastructure · 2025–2030
Connectivity beyond terrestrial limits	→	**B · 6G Hyper-Space 3D Communications** Enabling core technologies · 2026–2030
Network-native, GNSS-resilient PNT	→	**C · NTN Positioning for Integrated Navigation & Communication** New service layer · 2026–2028

One program, three layers: A builds the satellite system, B extends what it can connect, and C adds positioning on top of the same network.

The portfolio at a glance



Project	Funding program	Budget (KRW)	Target TRL	Partners
A	National LEO satcom R&D program	109.5 B (total)	7–8	17 organizations: operators, industry, academia
B	ETRI basic research program	13.9 B (direct)	5	Academia, industry, overseas institutes
C	NST strategic research program	11.3 B (gov.)	4–5	KT SAT, SK Telecom; 3 universities

Budget bases differ: A includes private matching funds, B is direct cost, C is government funding

NST: National Research Council of Science & Technology

SECTION

II

Current projects

Three projects: system, connectivity and service

A · LEO payload & ground station

B · Hyper-space 3D communications

C · NTN positioning

6G LEO Satellite Payload & Ground Station

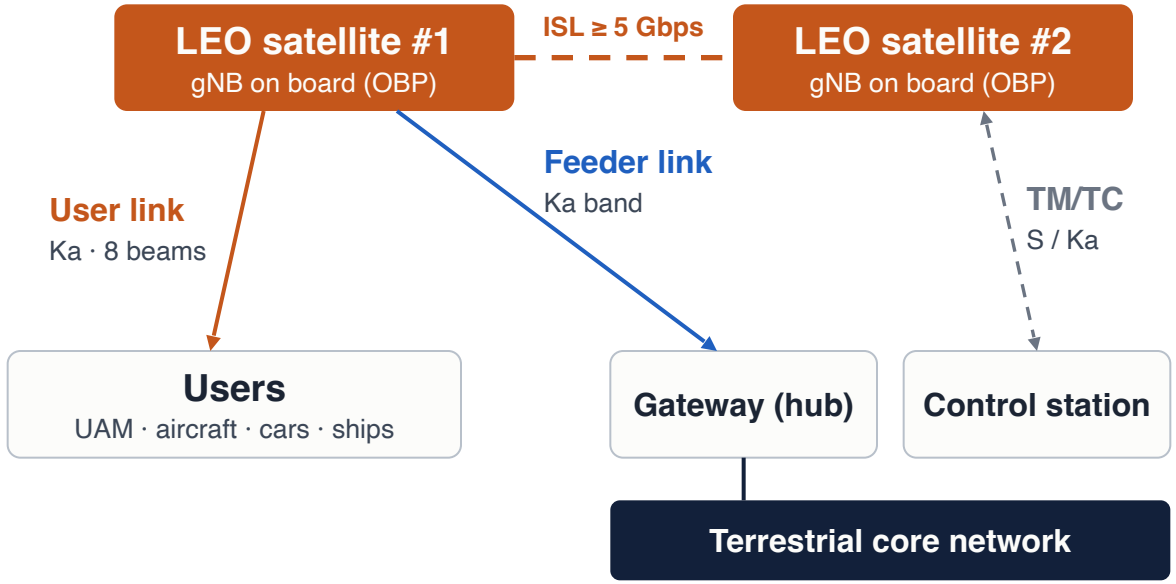
Item	Details
Full title	Development of Core Technologies for 6G-based LEO Satellite Payload and Ground Station
Period	Apr 2025 – Dec 2030 (5 years 9 months)
Lead	ETRI
Consortium	17 organizations: KT, KT SAT, SKT, LG U+, Hanwha Systems, LIG Nex1, universities and institutes
Team	235 researchers

Ambition

Launch and verify one of the world's first 3GPP 6G-based communication satellites

Seamless broadband anywhere in 3D space

Develop a 6G-based LEO system that serves UAM, aircraft, connected cars and ships with one standard.



System requirement	Value
Satellites / orbit	2 · 888 km SSO · 3-year life
Mass · power	530 kg · 2,300 W
Payload type	Digital regenerative (OBP)
Band · beams	Ka · 8 beams, Earth-fixed
Rate per 100 MHz	Feeder 400 · User DL 300 Mbps
Capacity · ISL	≥ 5 Gbps

OBP: On-Board Processor · ISL: Inter-Satellite Link · SSO: Sun-Synchronous Orbit · TM/TC: Telemetry/Telecommand

Payload and ground station development

Track 1 · Payload

- Ka-band active phased array antenna and beamformer ICs
- OBP HW (≤ 30 kg, ≤ 350 W, up to 64QAM)
- OBP SW: PHY, access, RRM, handover, Doppler and delay compensation, routing
- Feeder reflector antenna, RF units, optical ISL
- Payload integration

Track 2 · Ground station

- Hub modem: time/frequency sync, channel coding
- Hub SW: feeder protocol, multi-satellite RRM, ISL control, feeder switching
- Control station for 2 satellites (S/Ka), flight dynamics
- Terrestrial interworking testbed via KOREN

±51°
User beam scan range (SOTA ±48.2°)

300Mbps
Maximum service link capacity

Rel-21
OBP spec target, upgraded in orbit

RRM: Radio Resource Management · KOREN: Korea Advanced Research Network, SOTA: State of the Art

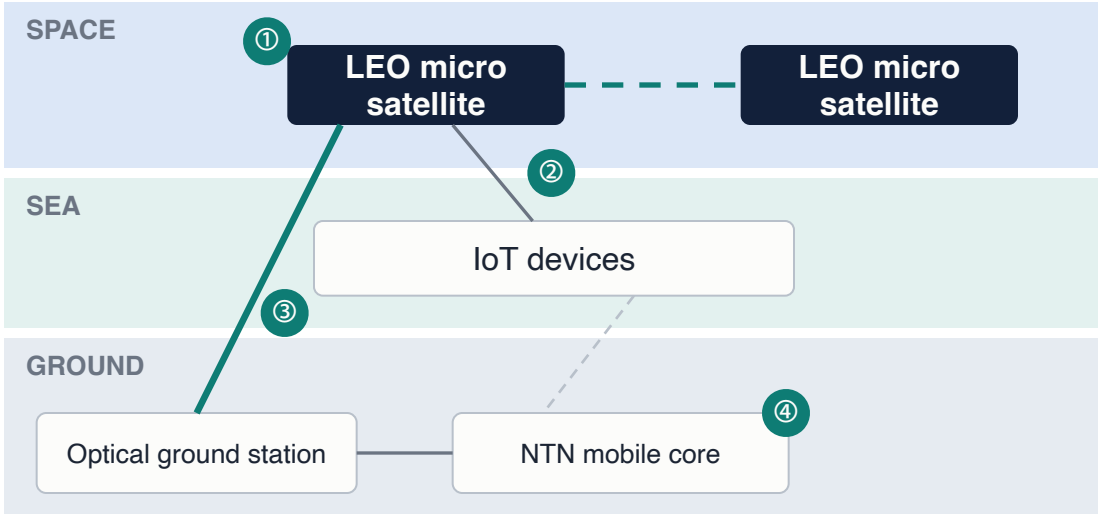
6G Hyper-Space 3D Communications

Item	Details
Full title	Development of 6G Hyper-Space 3D Communication Technologies
Period	Jan 2026 – Dec 2030 (5 years)
Lead	ETRI Satellite Communication Research Division
Program	ETRI basic research program
Maturity	TRL 5

Ambition

Overcome of coverage and capacity limits of terrestrial mobile networks

Four technical focus areas, from ground to space



① **6G IoT-NTN System**
10 kg-class 12U cubesat; maritime IoT

② **Satellite signal analysis**
Ground-based LEO RF emission analysis

③ **Ground-to-satellite optical**
Turbulence emulator; 400G transceiver

④ **6G NTN mobile core emulator**
TN-NTN switching; Low signaling overhead

1,000+ UEs/km²
IoT-NTN density (2× IMT-2020-SAT)

400G
Optical-wireless transceiver (vs 200G)

–30%
Core signaling

NTN Positioning for Integrated Navigation & Communication

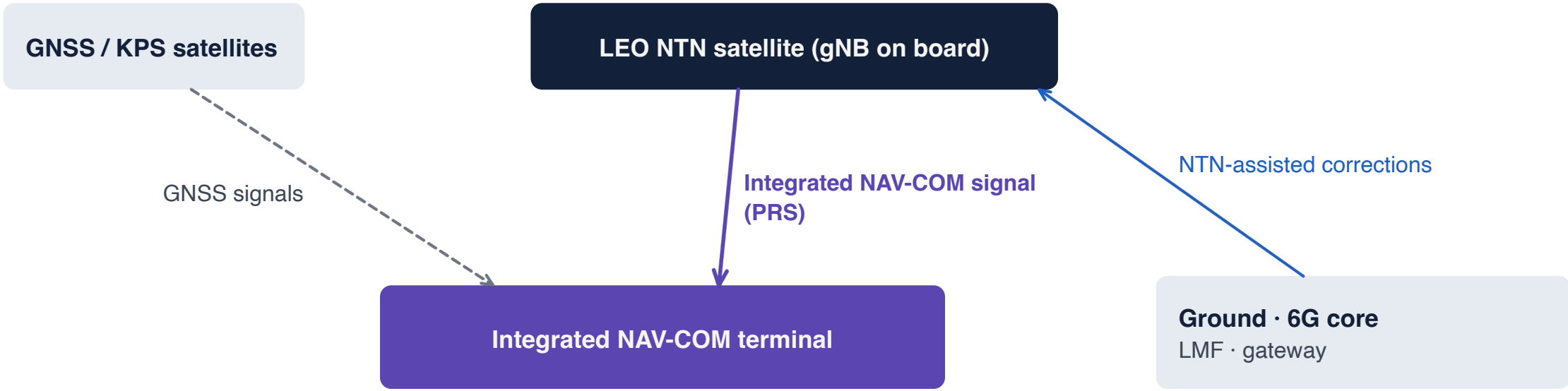
Item	Details
Full title	Development of Core Technologies for LEO Integrated Navigation and Communication based on 3GPP NTN Positioning
Period	Apr 2026 – Dec 2028 (2 years 9 months)
Partners	ETRI (lead) · KT SAT, SK Telecom · Hanyang, Ajou, Inha Univ.
Maturity	TRL 4–5 (simulation and PoC)

Staged Approach

Core technologies first; payload development starts once Rel-21 is complete and TRL 5–6 is reached

One LEO network for both navigation and communication

Develop core technologies based on 3GPP NTN Positioning so that LEO communication satellites also deliver PNT, standalone or alongside GNSS.



LMF: Location Management Function · PRS: Positioning Reference Signal · KPS: Korean Positioning System

Three tracks and three KPIs

TRACK 1

GNSS-free positioning

- NTN positioning reference signal
- NTN-based LMF

TRACK 2

NTN-assisted PNT

- GNSS corrections (RTK/PPP) delivered over NTN
- GNSS-resilient positioning

TRACK 3

PoC and standardization

- Satellite gNB and terminal PoC
- 3GPP 6G NTN Positioning

≤ 10 cm
Position accuracy (simulation)

≤ 5 s
Time to first fix (simulation)

≥ 50 Mbps
DL data rate with positioning on (PoC)

PoC: Ka-band, 100 MHz, 888 km orbit — aligned with Project A's system parameters

RTK: Real-Time Kinematic, PPP : Precise Point Positioning

SECTION

III

Future projects

Next-phase R&D toward 2030, from ETRI's satellite communication roadmap

K-LEO | Next-generation satcom | Space AI data centers

K-LEO: from two demo satellites to a constellation

Payload

- On-board DSP: DVB-S2X feeder and 3GPP NTN service-link ASICs
- 8-beam beamforming IC in one package, with a path to 16 beams
- Beam-steering feeder reflector and control electronics

Ground

- Network operation: multi-satellite ISL, mobility, simultaneous operation
- Large-constellation control: automated TT&C, flight dynamics, collision avoidance, mission planning

Terminal

- SWaP-C VSAT: flat-panel electronic beam steering, low-power NTN modem ASIC
- Tracking and handover verified with K-LEO satellites

Constellation control: today vs K-LEO

	Today (Korea)	K-LEO (512 sats)
Satellites controlled	1–5	**512**
Passes per day	Tens	**Thousands–10,000**
Maneuver planning	Few/month, manual	**Dozens/day, automated**
Conjunction screening	Few/year	**100s–1,000s/day**

BFIC: Beamforming IC · ISL: Inter-Satellite Link · TT&C: Telemetry, Tracking & Command · SWaP-C: Size, Weight, Power & Cost

Next-generation satcom: six project areas

6G direct-to-device

From 2027 · strategic

- AI-based regenerative OBP payload for handheld device
- Digital beamforming ASIC: 128 → 1,024 elements, 64 → 256 beams
- Hopping-beam phased array; ITU-R/WRC spectrum work

Regenerative IoT-NTN satellite

From 2026 · builds on Project B

- 6U cubesat, standards-based payload, store-and-forward
- 3GPP IoT-NTN modem and core network emulator
- Rel-21/22 PHY and protocol standardization

LEO-PNT

From 2029 · follows Project C

- Integrated navigation-communication payload
- Launch and in-orbit verification as a GNSS resilient solution

NTN-ISAC

From 2028 · in planning

- Joint waveform for NAV. and COMM. with Doppler and delay compensation
- TN/NTN cooperative sensing; 3GPP 6G ISAC

AI-native network management

From 2029

- Predictive spectrum and interference control across L/S, Ku/Ka, Q/V
- Topology prediction and TN–NTN mobility
- Multi-agent, federated and split learning

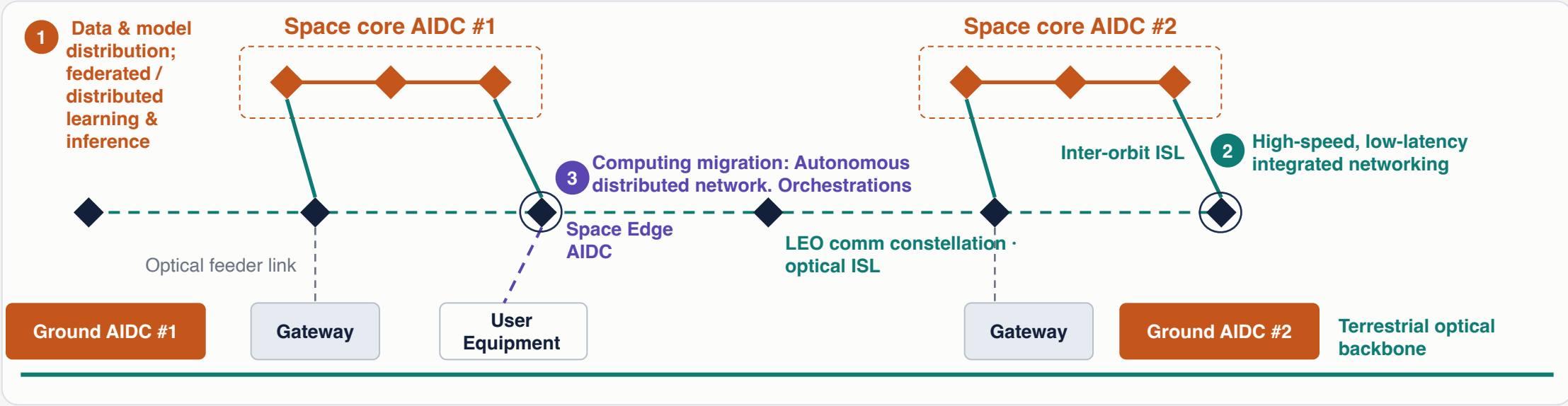
Multi-orbit and data relay

From 2028

- Integrated control, communication and relay across GEO and LEO
- Core technology of elay satellite(in planning)
- Cubesat SDR payload platform

OBP: On-Board Processor · ISAC: Integrated Sensing & Communication · SDR: Software-Defined Radio

Space–ground integrated AI data centers



CORE TECHNOLOGIES · FROM 2028 (IN PLANNING)

- Q/V-band wideband antenna and RF
- Data computing for the space environment
- Tbps-class optical ISL and constellation networking

INTEGRATION · FROM 2029 (IN PLANNING)

- LEO comm-satellite ↔ space AIDC interworking
- Space-ground hybrid Q/V + optical high-capacity links
- Space-ground AIDC network management and operations

AIDC: AI Data Center · ISL: Inter-Satellite Link ·

SECTION

IV

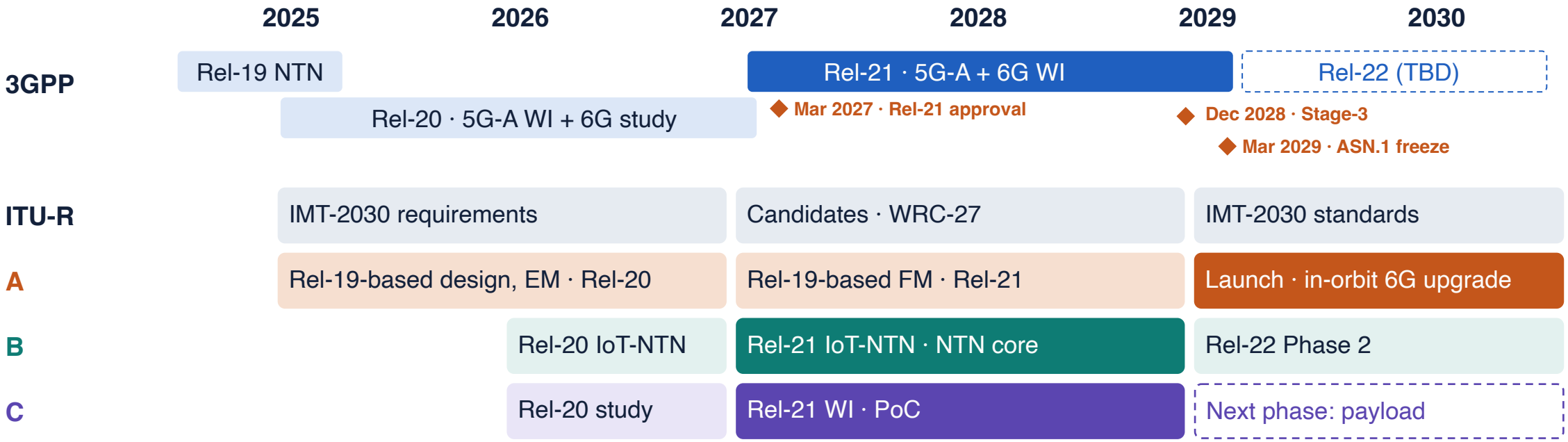
Standardization directions

How current and future projects reach 3GPP and ITU-R

3GPP & ITU-R roadmap | Working groups | Future topics | Four priorities

IV · STANDARDIZATION

All three projects converge on Rel-21



3GPP timeline, RP-260868 (TSG#112, June 2026)

Where each project contributes, by working group

Group	A · Payload & ground	B · 3D communications	C · NTN positioning
RAN1 physical layer	Regenerative PHY, multi-beam, Doppler and delay compensation	IoT-NTN waveform, massive access	NTN positioning reference signal and measurements
RAN2 radio protocols	LEO mobility and handover, feeder-link switching	IoT-NTN MAC/RRC for small satellites	LPP procedures, assistance data over NTN
RAN3 RAN architecture	Full vs Partial gNB split (DU on board, CU on ground)	n/a	NRPPa, satellite gNB timing
SA2 system architecture	Ground network interworking	TN-NTN inter-PLMN switching, on-board UPF, UE-satellite-UE	LMF for NTN, hybrid GNSS positioning
ITU-R WP 4B/5D	IMT-2030 candidate evaluation	IoT-NTN requirements input	PNT use cases

NRPPa: NG-RAN; NR Positioning Protocol A

Future projects extend the standards path

Topic	From	Rel-20 · to mid-2027	Rel-21 · first 6G, 2027–29	Rel-22+ · ITU-R
Regenerative payload, OBP	A · K-LEO	Rel-19 regenerative baseline; 6G study	Regenerative 6G NTN, ISL-aware mobility	K-LEO on-board processors
6G direct-to-device	DTC	6G study: NTN in one air interface	6G NR-NTN for handhelds	IMT-2030 · WRC-27 AI 1.13
IoT-NTN	B · IoT-NTN	IoT-NTN enhancements	—	—
Positioning, PNT	C · LEO-PNT	—	—	—
ISAC	NTN-ISAC	—	—	—
Multi-orbit management	Multi-orbit	Multi-orbit operation	—	—
Space AIDC, optical ISL	Space AIDC	—	—	—

Grayed items are future standardization candidates. Today's projects carry the first contributions; future projects extend them into Rel-21 and beyond.

Indicative; Rel-21/22 content still being defined · AI 1.13: WRC-27 item on satellite direct-to-device

Standardization directions: four priorities

① NTN native in 6G

Regenerative OBP, ISL and direct-to-device features so satellites are in the first 6G specifications (Rel-21), not added later.

② Lead where we validate

Focus on IoT-NTN, NTN positioning and ISAC, where in-orbit and PoC results give contributions and lead to essential IPR.

③ Spectrum and ITU-R

Satellite IMT-2030 in ITU-R WP 4B and direct-to-device spectrum for WRC-27; protect the bands K-LEO needs.

④ Collaboration

Align R&D and Release milestones with industry at home; co-develop and co-contribute with international partners.

2026–27
Rel-20 6G study inputs

→

Mar 2027
Rel-21 package approved

→

Dec 2028
Rel-21 Stage-3 freeze

→

2029 +
Rel-22 · K-LEO, LEO-PNT, ISAC

SUMMARY

From today's projects to tomorrow's standards

Now · 3 projects

Regenerative LEO system, extended connectivity and NTN positioning

Next · roadmap

K-LEO, 6G direct-to-device, IoT-NTN, LEO-PNT, NTN-ISAC, space AI data centers

Standards

Research results into 3GPP Rel-20/21/22 and ITU-R (WRC-27)

Together

Collaboration and abroad

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- Thank you -

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