The Convergence of TN-NTN & AI-Native 6G Architectures

Enabling seamless, hyperconverged service delivery across terrestrial, maritime, and aerospace domains.

Webinar Presentation | April 2026

Webinar Roadmap: The 6G Vision

3D Connectivity

Evolution from fragmented 2D grids to a unified Space-Air-Ground-Sea fabric.

AI-Native Edge

Embedding intelligence into the PHY/MAC layers for predictive network orchestration.

Hyperconvergence

Transitioning from bent-pipe satellites to regenerative O-RAN space nodes.

Standards Roadmap: Rel-17 to Rel-21

Rel-17/18

Foundations

Transparent NR-NTN & IoT payloads; initial D2D studies.

Rel-19

Refinement

Regenerative payloads; Mobility & Coverage enhancements.

Rel-20

6G Study

Integrated Sensing (ISAC); AI/ML Native framework.

Rel-21

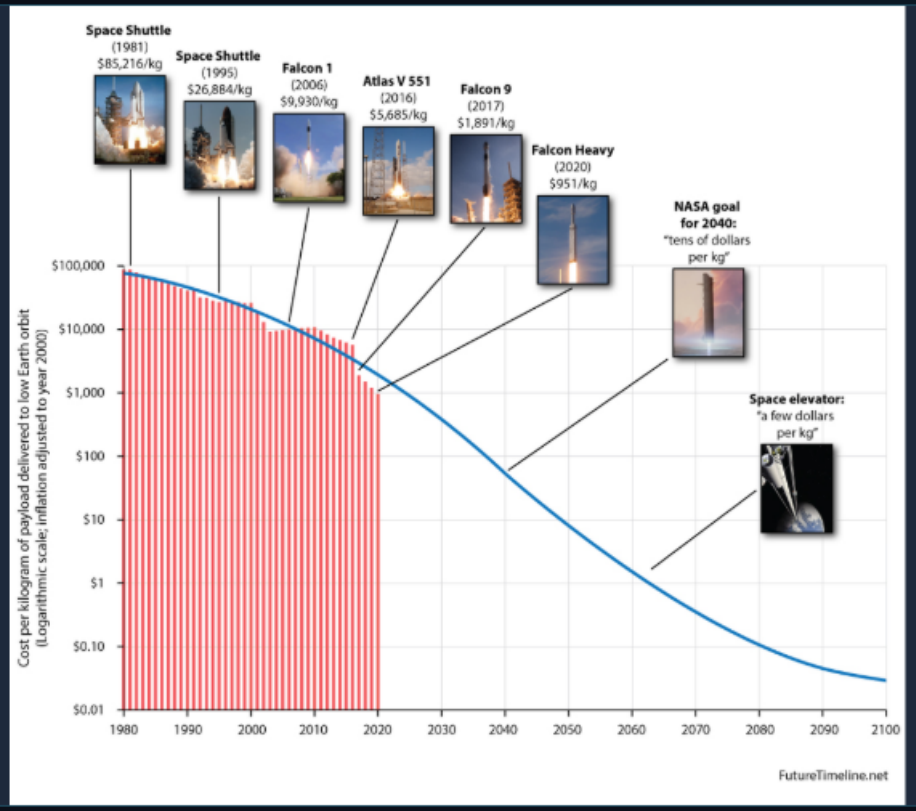
6G Normative

First set of 6G specifications; Full TN-NTN convergence.

Ref: 3GPP TR 38.821; ITU-R M.2160 (IMT-2030 Framework).

Physics at Orbital Speeds

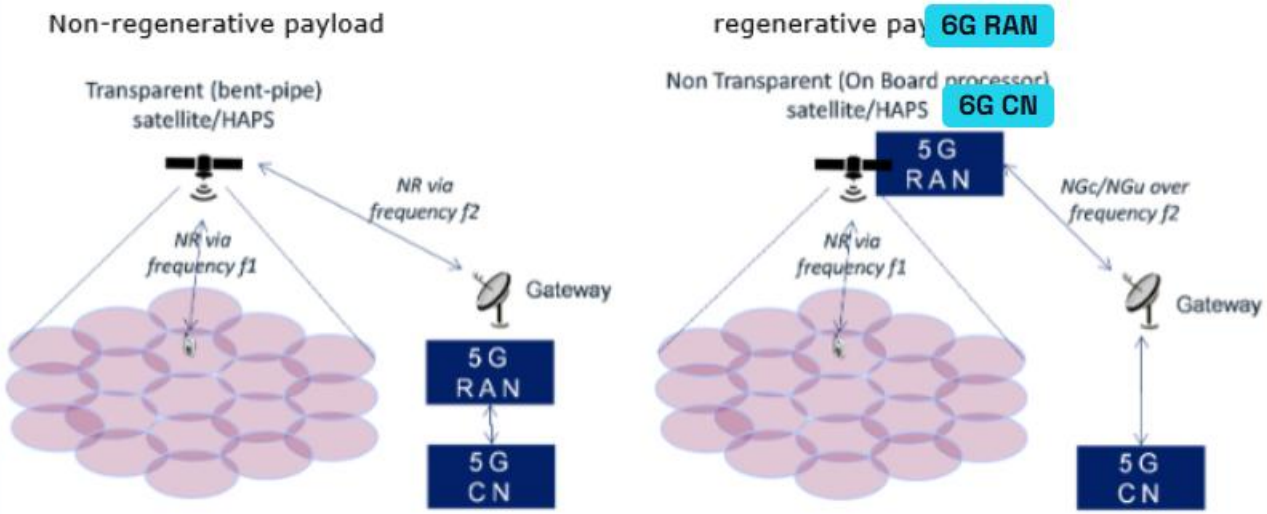
- **Extreme Doppler Shifts:** LEO velocity (~7.5 km/s) causes frequency shifts that exceed terrestrial compensations.
- **Propagation Delay:** Latency variations from 10ms (LEO) to 600ms (GEO) challenge HARQ and timing.
- **Link Budget:** Path loss at Ka/Ku and mmWave bands requires massive beamforming gain.



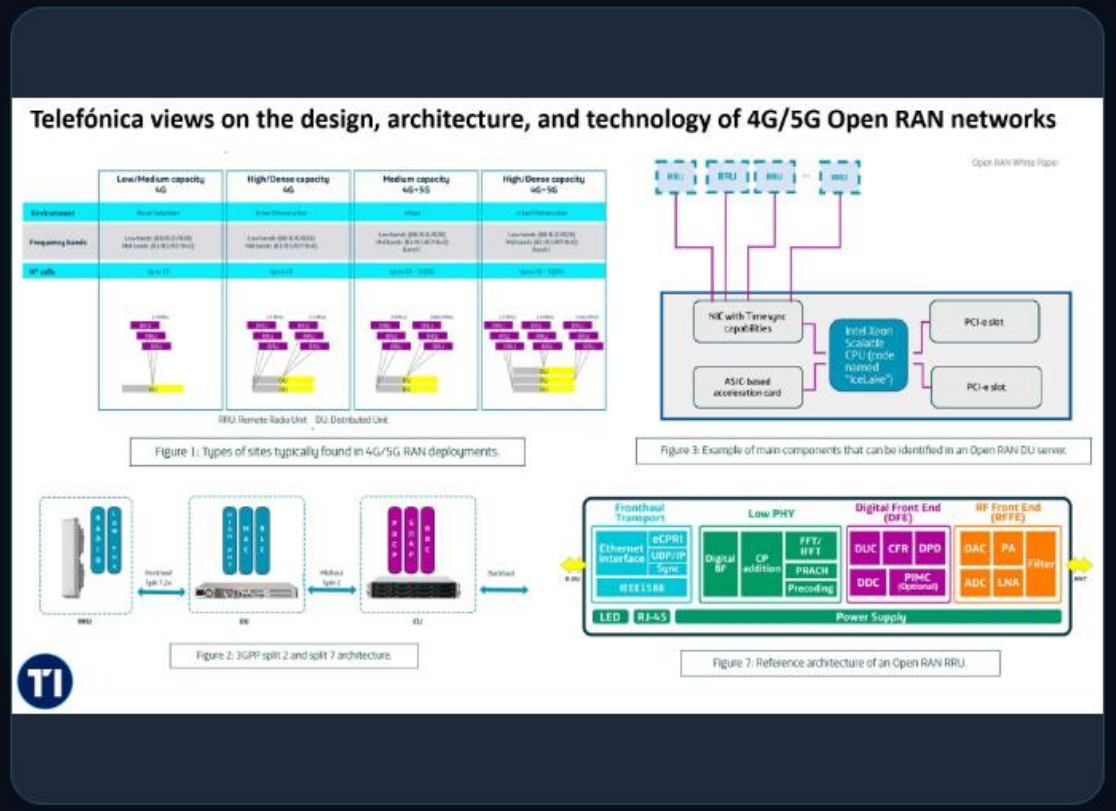
From 5G Bent-Pipe to 6G Regenerative

The industry is shifting from **Transparent (Bent-pipe)** payloads toward **6G Regenerative Payloads** where the gNB resides in orbit.

- **On-Board Processing:** Decouples feeder link from user link, reducing latency.
- **Mesh Networking:** Optical Inter-Satellite Links (ISL) enable dynamic routing in space.



The O-RAN Paradigm in Space



Flexible Functional Splits

Disaggregating the stack allows for strategic placement of compute nodes:

Split-2 (CU-DU): DU/RU in orbit, CU on ground. Ideal for regenerative payloads.

Split-7.2x (DU-RU): RU in orbit, DU/CU on ground. Optimized for low-complexity hardware.

RIC Integration: RAN Intelligent Controllers manage beam selection and handovers.

AI-Native 6G: Intelligence at the Edge

8%

Throughput Gain

via AI Channel Prediction

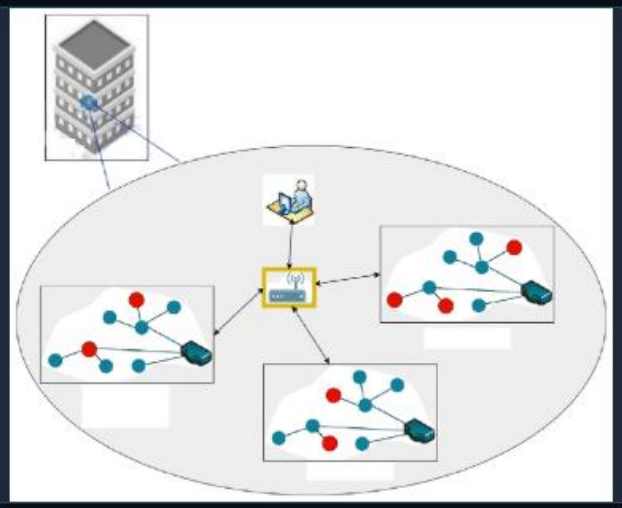
Neural Receivers

6G replaces standard DSP blocks with **Neural Receivers** trained for extreme conditions.

- Predictive beam-steering to counter LEO mobility.
- AI-managed interference cancellation for TN-NTN spectrum sharing.
- Lower compute overhead compared to traditional non-linear solvers.

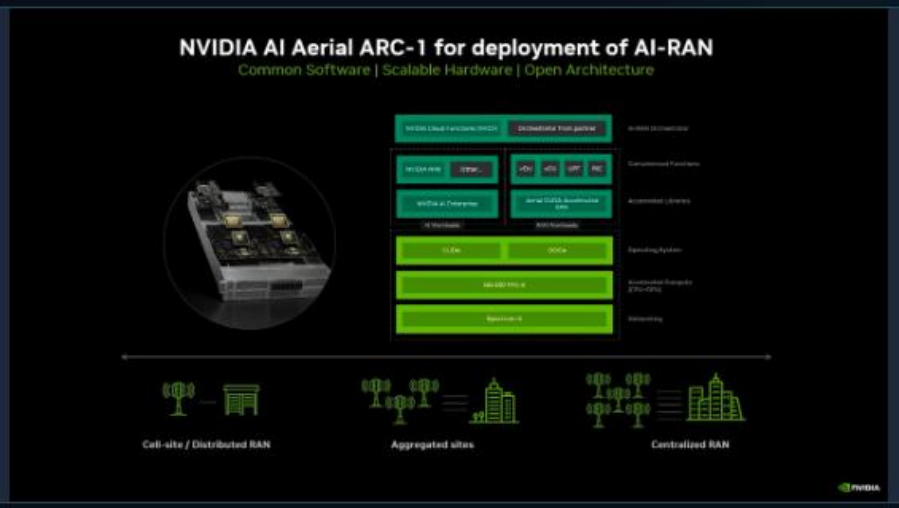
Ref: AI-RAN Alliance; Qualcomm 6G Research 2025.

Liquid Computing: Hardware Evolution



Unified Compute

Sharing GPU/Accelerator pools for both AI inference and baseband signal processing.



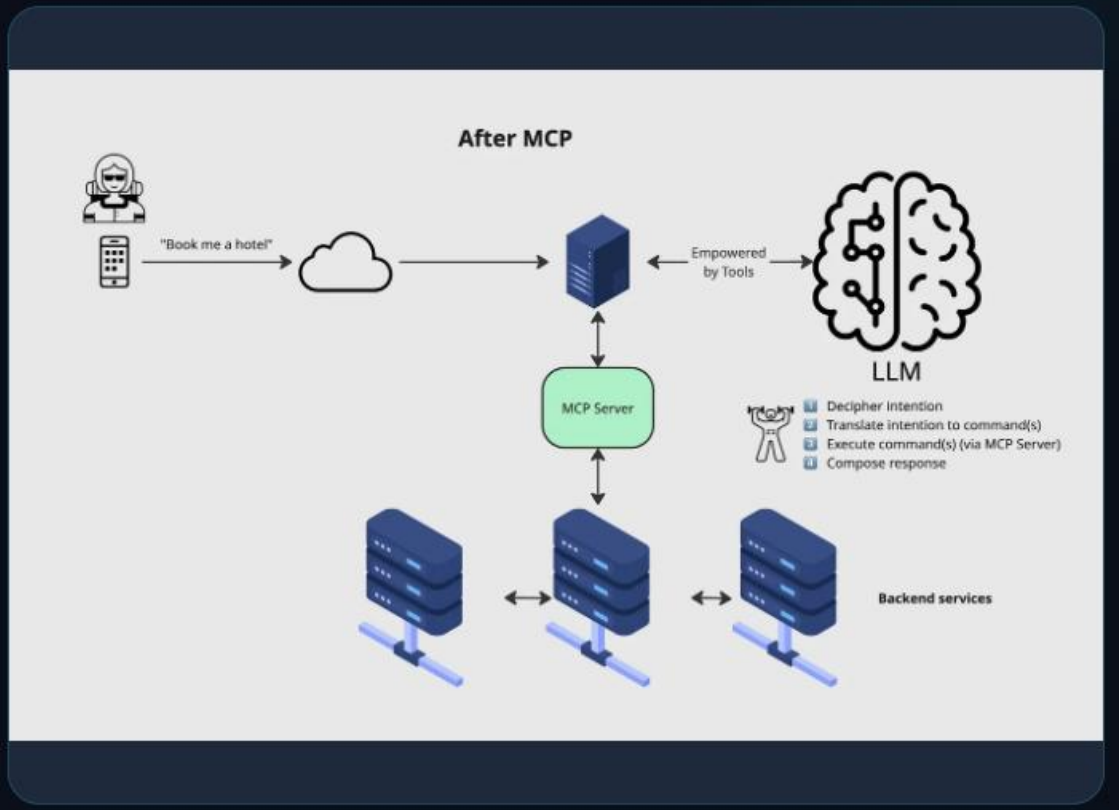
Software Defined Space

Cloud-native orbital payloads allowing for dynamic feature updates via CI/CD.

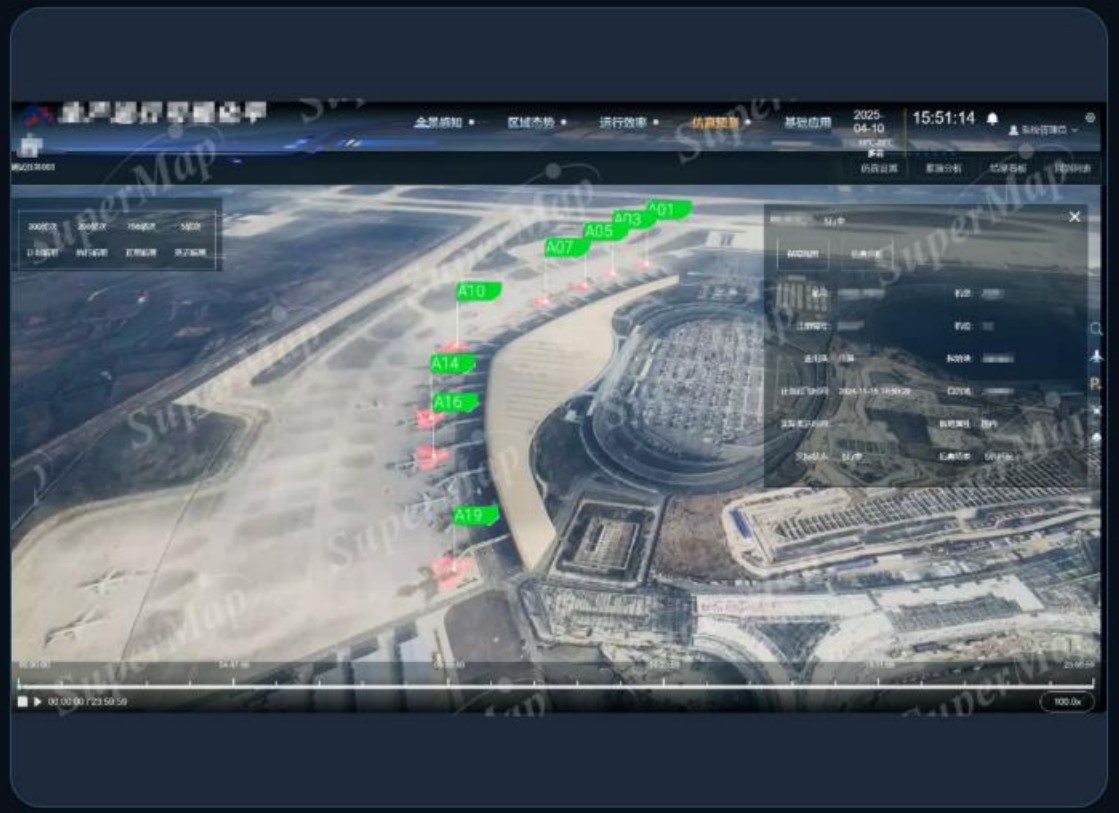
Zero-Touch Network Orchestration

Intent-Based Operations

- **Autonomous Healing:** AI agents diagnose and remediate orbital link failures in real-time.
- **Dynamic Slicing:** Cross-domain orchestration of SLAs (Low Latency/High Throughput) across satellites and towers.
- **Zero-Touch Management (ZSM):** Eliminating manual provisioning in complex 3D meshes.



Validation: Digital Twins & HIL



Testing the Untestable

Real-world testing in space is prohibitive. 6G relies on high-fidelity simulation:

Digital Twin Networks (DTN): Real-time replicas of satellite trajectories and atmospheric conditions.

Hardware-in-the-Loop (HIL): Validating terrestrial gNBs against simulated satellite Doppler shifts.

CI/CD Pipelines: Automated testing of multi-vendor interoperability before orbital deployment.

Roadmap to 2030: Throughput Targets

Anticipated ubiquitous throughput growth enabled by integrated AI-native NTN/TN architectures.

Questions?

"The future of connectivity is not limited by geography, but by our architectural imagination."

— Building the Hyperconverged Future

Thank you for attending.

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