

Toward a Unified 6G Network Architecture

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Principles, Layers & Key Enabling Technologies

Intelligent RAN

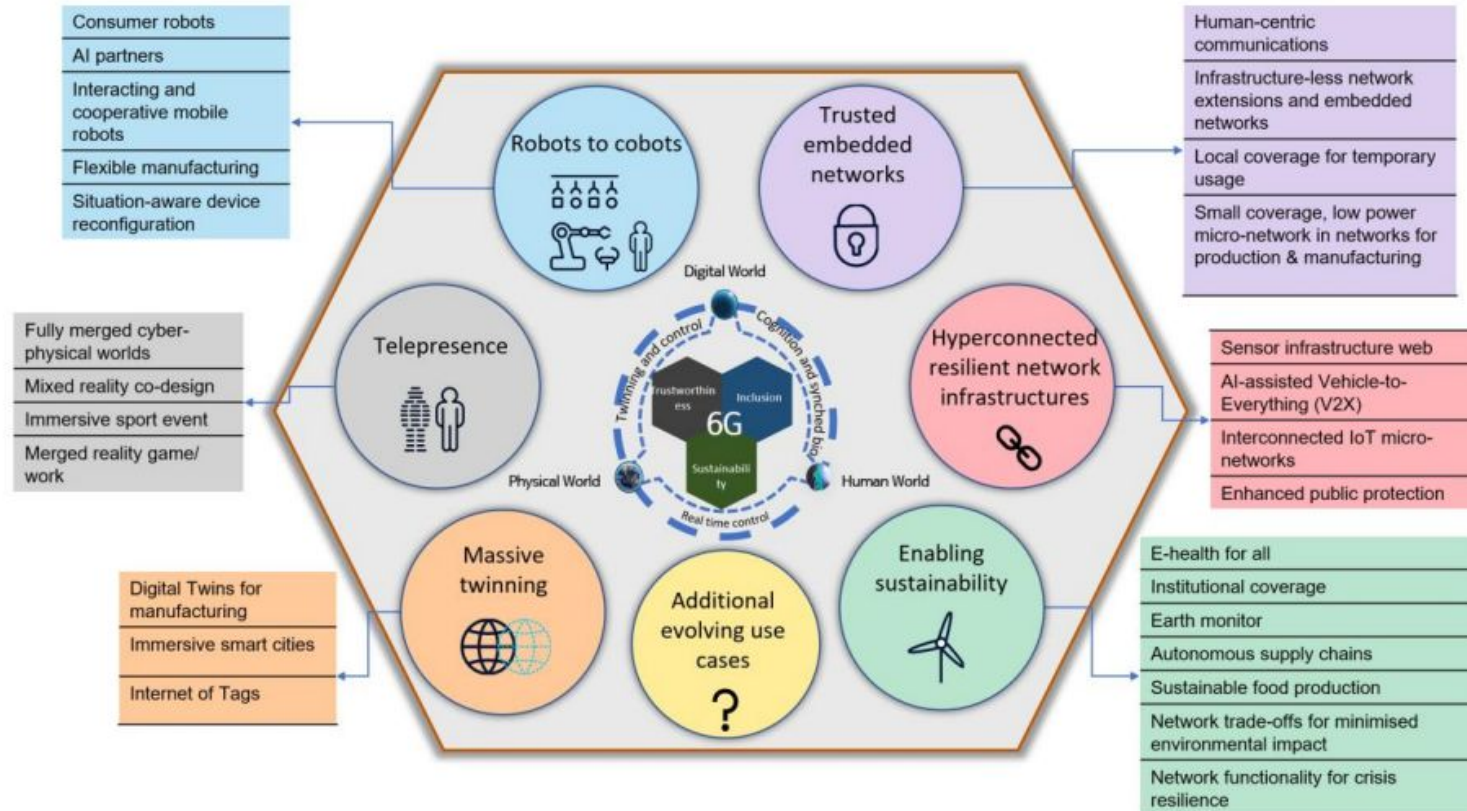
AI-Native Core

Semantic Comms

NTN Stratum

6G Position Paper – WWRF Huddle, Istanbul, 16th September, 2026

Potential 6G Use Cases



Source [HEX-D13]

Why 6G? The Case for Rearchitecting

> 1 Tbps

Peak Data Rate

< 100 μ s

Air Interface Latency

100×

Energy Efficiency Gain

2030

Target Deployment

Key Application Drivers

Holographic Telepresence

Multi-Gbps bidirectional video requiring sub-millisecond synchronisation across endpoints.

Tactile Internet

Haptic feedback loops demanding end-to-end round trips well below 1 ms.

Autonomous Multi-Robot Systems

Dense, low-latency coordination for factory and logistics automation at scale.

Global Digital Twins

Persistent, real-time mirroring of physical environments at planetary scale.

Gaps to be filled from 5G to 6G

- Enabling AI & Agentic AI
- Programmability
- Cloud native, softwarization and service-based architecture
- Continuum Orchestration
- Others: sustainability, reliability, trustworthiness, cybersecurity, standardization and regulation.

6G architecture principles from [HEX-D51], guiding the architecture design

1: Exposure of capabilities

2: AI for full automation

3: Flexibility to different topologies

4: Scalability

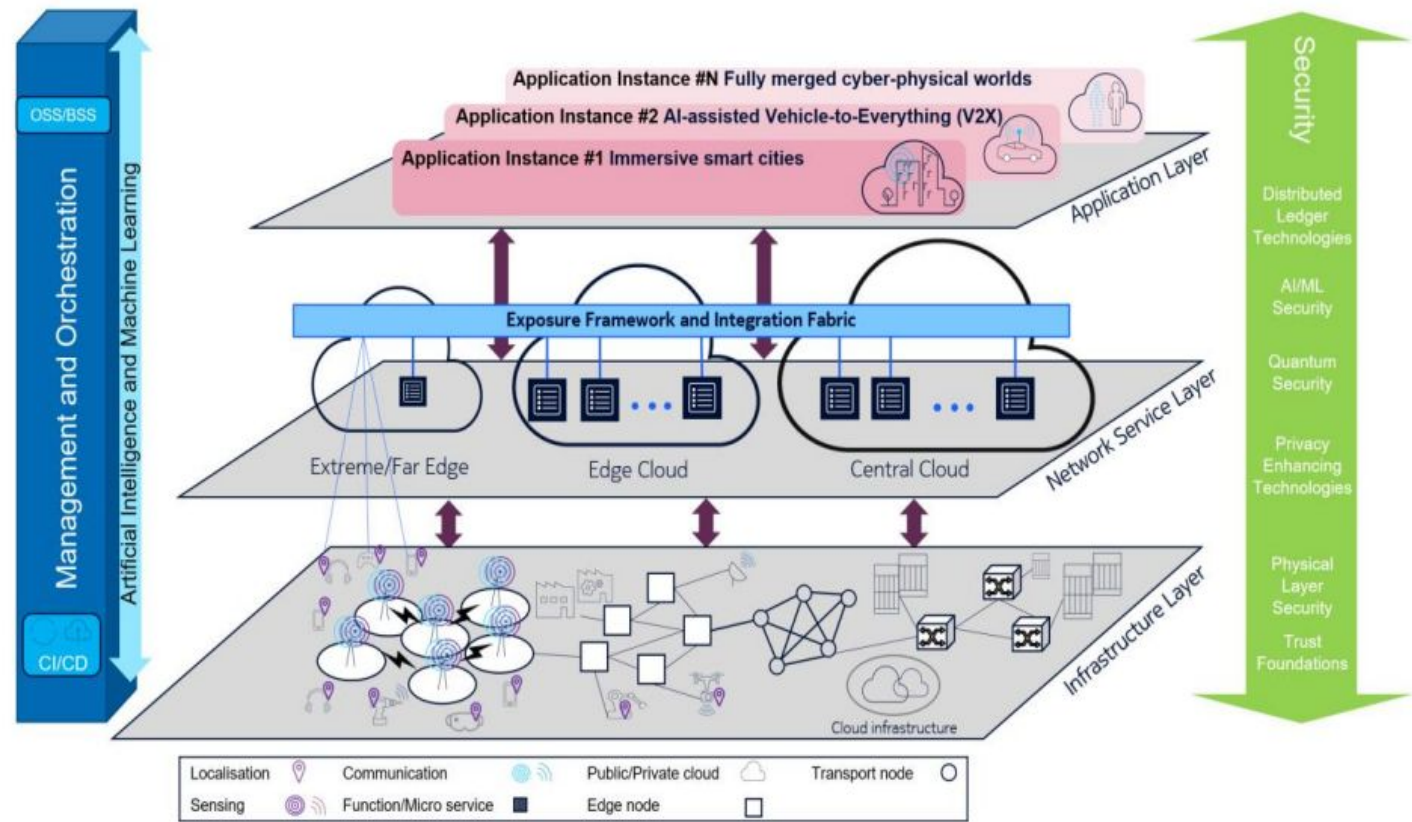
5: Resilience and availability

6: Exposed interfaces are service based

7: Separation of concerns of network functions

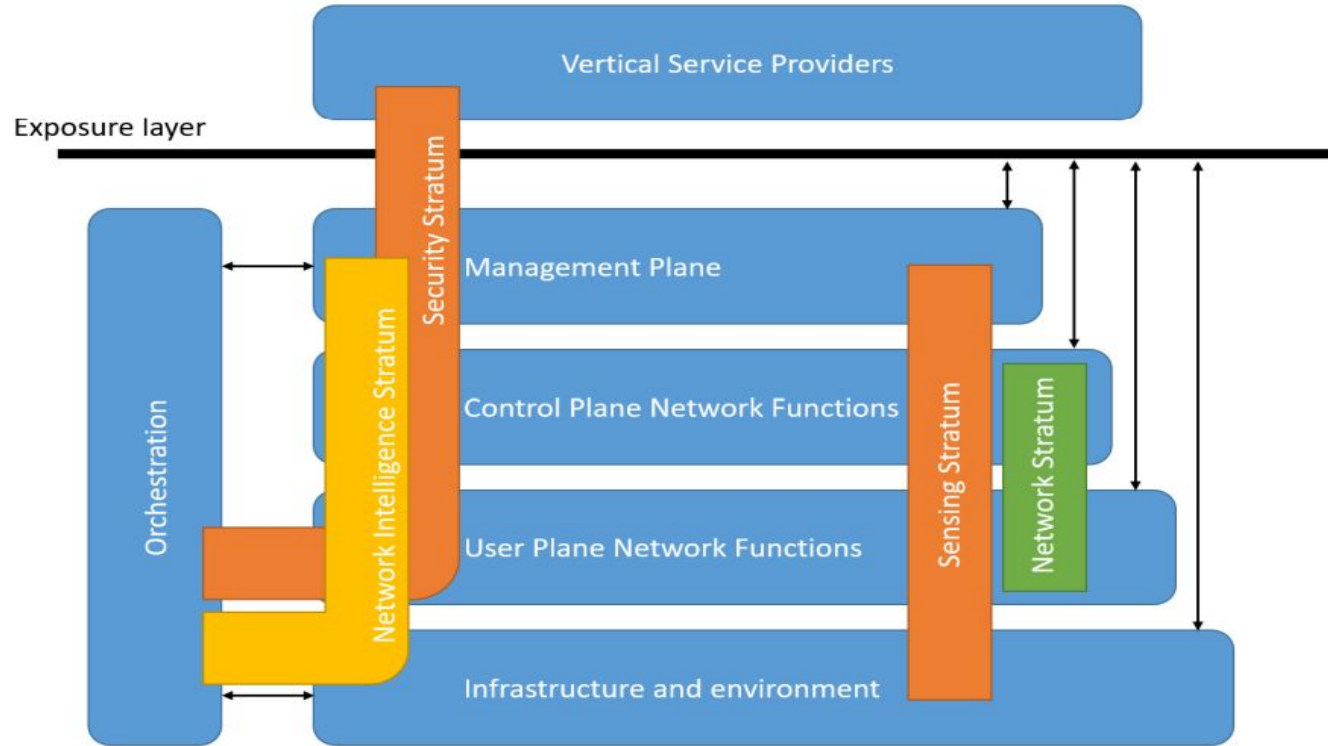
8: Network simplification in comparison to previous generations

High-level view of the 6G architecture



Source [HEX-D13]

Proposed 6G reference architecture (a functional view)



**From 5G PPP Architecture
Working Group**

Proposed 6G Architecture — Four-Layer Stack

AI / ML
ORCHESTRATION
PLANE

4

NTN Stratum

LEO satellites · HAPS · UAV base stations · Topology Prediction Engine · ISL optical backhaul

3

Semantic Communication Plane

Intent-based transmission · Shared semantic codecs · 40–60× bit reduction for rich media

2

AI-Native Core (ANC)

Semantic Context Function · Post-quantum auth (CRYSTALS-Kyber) · Intent-based networking

1

Intelligent RAN (I-RAN)

Dynamic CU/DU split · Federated learning RIC · RIS management · Sub-THz spectrum engine

Unified Data Fabric + Zero-Trust Security Framework (cross-cutting across all layers)

Challenges & Conclusion

Open Challenges

Semantic Codec Standardisation

Cross-industry consensus on ontologies & quality metrics beyond PSNR/SSIM

NTN Topology Prediction

High-fidelity prediction at orbital scale across thousands of LEO satellites

PQC Compute Overhead

Absorbing post-quantum auth latency at QSAF without degrading user experience

Federated RIC Convergence

Convergence guarantees in non-IID, heterogeneous data distributions across cells

Key Takeaways

- Four-layer architecture (I-RAN → ANC → SCP → NTN) covers RAN, core, semantic & space domains
- AI is native — embedded in every network function, not bolted on
- Semantic communication reduces rich-media transmitted data by 40–60×
- Post-quantum security and zero-trust are mandatory requirements
- 100× energy efficiency improvement per bit vs. 5G baseline

Future Work

Prototype Semantic Context Function · Federated RIC xApp validation at scale · NTN topology prediction trials

References

1. IMT-2030 Framework — ITU-R Recommendation M.2160 (2023)
2. "6G White Paper on Network Architecture" — 6G Flagship, University of Oulu (2020–2023)
3. Hexa-X Deliverable D2.1 / D2.2 / D13 / D51— Use Cases and Architecture Requirements" — Hexa-X Consortium (2021–2023)
4. Sudhir Dixit, "Towards a Unified 6G Network Architecture: *Principles, Layers, and Key Enabling Technology*, WWRT Magazine, July 2026.