

Recent Trends in Satellite Communication

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Abstract: *This paper reviews major developments in satellite communication between 2024 and 2025. Topics include LEO mega-constellations, D2D and 5G NTN integration, optical links, AI/Cybersecurity, small satellites & IoT, sovereign networks, and orbital sustainability. Implications for market dynamics, policy, and future research are discussed.*

Keywords: *satellite communication.*

I. INTRODUCTION

Satellite communication continues to transform global connectivity, driven by burgeoning Low Earth Orbit (LEO) constellations, integration with terrestrial 5G/6G, AI-enabled networks, laser communication, and critical issues such as cybersecurity and orbital debris.

II. LEO MEGA-CONSTELLATIONS

LEO deployments have surged, e.g., Starlink (~7 k satellites), Amazon Kuiper upcoming launches via Ariane 64 in Q4 2025 en.wikipedia.org. The global LEO satcom market is expected to grow from USD 197 b (2025) to USD 305 b by 2030, at ~9 % CAGR mordorintelligence.com+1fortunebusinessinsights.com+1.

III. DIRECT-TO-DEVICE (D2D) & 5G NTN INTEGRATION

Satellite-to-smartphone is advancing: Eutelsat + OneWeb successfully trialed 5G NTN on standard phones. AST SpaceMobile connects cell towers globally, partnering with 45 operators for 5G-like service Asia-Pacific LEO broadband is projected to grow at CAGR ~50 % through 2030, driven by 5G NTN

IV. OPTICAL (LASER) COMMUNICATIONS

Programs like NASA's Laser Communications Relay Demonstration (LCRD) are testing GEO laser links for Tbps-class throughput .ESA contracts, e.g., Kepler-led optical LEO relay, support high-capacity intra-LEO networks .

V. AI-ENABLED NETWORKS & CYBERSECURITY

AI/ML is increasingly adopted for beam hopping, traffic management, anti-jamming, and onboard processing . Integrated sensing and communications (ISAC) using massive MIMO in LEO constellations are emerging as part of 6G NTN strategies . Sovereign networks like EU's IRIS² (€10.5 b, ~290 satellites) aim for secure, autonomous communications .

VI. SMALL SATELLITES & IOT

Smallsats/nanosats continue rapid deployment with modular designs, lowering costs and increasing flexibility Satellite IoT is expanding fast in logistics, agriculture, and defense, enabled by LEO constellations .

VII. ORBITAL SUSTAINABILITY & GEOPOLITICAL CONTEXT

LEO overcrowding risk is rising: ~2 500 objects launched in 2024; analysts warn of "Kessler syndrome" . Space is increasingly militarized. The U.S. Space Command is preparing for "orbital dogfights," and ESA seeks €1 b for military-grade constellation .



VIII. MARKET IMPACT & OUTLOOK

Satellite comms revenue reached ~\$108 b in 2024, with shift toward broadband and connectivity services; global satcom market may exceed .

Key challenges include spectrum allocation, regulatory alignment, cybersecurity, and cost of deployment .

IX. CONCLUSION

The 2024–2025 period underscores a transformation in satellite communication: LEO mega-constellations, device-level access, optical links, AI-enabled network autonomy, and sovereign resilience amid growing congestion and militarization. Going forward, interdisciplinary R&D across AI, 6G NTN, cybersecurity, space traffic management, and sustainable deployment will be essential.

REFERENCES

- [1] O. Ledesma, P. Lamo, J. A. Fraire, “Trends in LPWAN Technologies for LEO Satellite Constellations in the NewSpace Context,” *Electronics*, vol. 13, no. 3, p. 579, 2024. mdpi.com
- [2] J. Liu, “Overview of Low Earth Orbit Satellite Communication Systems,” *Appl. Comput. Eng.*, vol. 145, pp. 1–6, Apr. 2025. ewadirect.com
- [3] “Topology: LEO Satellite Market Size...,” Mordor Intelligence, May 19, 2025. ts2.tech+2fortunebusinessinsights.com+2mordorintelligence.com+2
- [4] “Asia-Pacific Satellite Internet Market...,” *GlobeNewswire*, Mar. 31, 2025. globenewswire.com
- [5] “10 Tech Trends That Will Impact the Satellite Industry in 2025,” *Satellite Today*, Dec. 2024. interactive.satellitetoday.com
- [6] “Global Satellite & Space Industry Report 2025...,” Tech Report, 2025. ts2.tech
- [7] “Laser Communications Relay Demonstration,” NASA, 2023. en.wikipedia.org
- [8] F. Fourati, M.-S. Alouini, “Artificial Intelligence for Satellite Communication: A Review,” *arXiv*, Jan. 2021. arxiv.org
- [9] L. You et al., “ISAC for Massive MIMO LEO Satellite Systems,” *arXiv*, Jul. 2024. ewadirect.com+3arxiv.org+3arxiv.org+3
- [10] F. Wang et al., “Non-Terrestrial Networking for 6G,” *arXiv*, Dec. 2024. telecomreview.com+3arxiv.org+3reddit.com+3
- [11] “IRIS²,” *Wikipedia*, Jun. 2025. ft.com+3en.wikipedia.org+3wired.com+3
- [12] “Starlink... orbital overcrowding...,” *The Verge*, May 2025. theaustralian.com.au+6theverge.com+6wired.com+6
- [13] “Orbital dogfights... Taiwan’s worries...,” *Reuters*, Jun. 13, 2025. reuters.com
- [14] “ESA seeks €1 bn for satellite network...,” *Financial Times*, Jun. 2025. ft.com

