



5G Non-Terrestrial Networks: Get Ready for Launch

WHITE PAPER / NOV 2024

MAVair™

Contents

| | | | |
|--|----|--|----|
| 1. Introduction | 3 | 9. Mavenir’s Cloud-Native Solution for Non-Terrestrial Networks | 12 |
| 2. Executive Summary | 3 | 3GPP Compliance and Features | 12 |
| 3. NTN NR Market | 5 | Connectivity and Protocols | 12 |
| 4. The Economic Drivers and Strategic Benefits of Adopting NTN | 5 | Centralized Management and Monitoring | 13 |
| 5. NTN Evolution | 6 | Observability and Performance Management | 13 |
| Baseline for NR Functionalities | 7 | eNB/gNB Application Container Processes | 13 |
| RAN (Radio Access Network) Enhancements | 7 | 10. Path toward regenerative NTN architecture | 14 |
| Core and Terminals Enhancements | 7 | Non-Standards based (Proprietary) Solution before Rel-19 (2025/26) | 15 |
| IoT NTN Enablement | 7 | Standards-based Solution (3GPP) in 2026/27 | 15 |
| 6. NTN in 3GPP Roadmap | 8 | 11. Core Network Considerations for Non-Terrestrial Networks | 16 |
| 7. Building Blocks of NTN | 9 | 12. NTN Use Cases | 17 |
| 8. Satellite-based NTN Architecture | 10 | 13. Conclusion | 18 |
| Transparent Satellite-based Architecture | 11 | Appendix | 19 |
| Operational Considerations | 11 | References | 19 |
| Regenerative Satellite-based Architecture | 11 | Acronyms | 19 |



Copyright © Mavenir 2024. All rights reserved. Mavenir, MAVair, MAVapps, MAVcore, MAVedge, MAVscale, and OpenBeam are trademarks of Mavenir. This document is protected by international copyright law and may not be reprinted, reproduced, copied, or utilized in whole or in part by any means without the prior written consent of Mavenir. All other marks and names mentioned herein may be trademarks of their respective companies.

Whilst reasonable care has been taken to ensure the accuracy of the information contained herein, Mavenir shall not be liable for any error, loss or damage of any kind suffered by any party as a result of the contents of this publication or the reliance of any party thereon. The information in this document is provided on an “as is” basis without warranty and is subject to change without notice and cannot be construed as a commitment by Mavenir. Nothing contained herein shall be construed to grant a license to any intellectual property.

1. Introduction

The advent of 5G marks a significant leap forward in telecommunication capabilities, delivering enhanced throughput, increased capacity, and improved latency. However, the potential of this fifth-generation wireless technology extends far beyond terrestrial confines, expanding into the realm of satellite-based Non-Terrestrial Networks (NTN). NTN open-up new applications and services by providing robust connectivity in remote and underserved areas and are the key to bridging the digital divide and ensuring comprehensive global connectivity.

With the introduction of 3GPP Rel-17, NTN capabilities have been significantly bolstered, enabling the seamless delivery of Internet of Things (IoT) and 5G New Radio (NR) applications.

Discover how NTN are revolutionizing connectivity, empowering communities with tailored solutions serving diverse needs – from agriculture to public safety – and successfully bridging the digital divide worldwide. Get ready for the launch of 5G NTN.

2. Executive Summary

The wireless telecommunications industry has evolved significantly over recent decades, progressing to 5G technology that is focused on connecting everyone and everything with higher throughput, increased capacity, and reduced latency. Open Radio Access Network (O-RAN)-powered 5G further enhances efficiency, facilitating access to new vertical markets and paving the way for the implementation of advanced automation and Artificial Intelligence (AI).

While these technological advancements are often confined to areas with terrestrial infrastructure, Non-Terrestrial Networks (NTN) can extend the reach of 5G to new industry sectors and geographical regions. The development of satellite-based communications technologies has continued to build momentum over the past few years, initially with NB-IoT networks, followed by proprietary broadband technology services launching, and now an increasing focus on 3GPP-based 5G. The introduction of 3GPP Rel-17 marks the true beginning of NTN, enabling the delivery of Internet of Things (IoT) and New Radio (NR) applications.

The mobile industry is increasingly embracing this shift, according to recent research from the GSA (the Global mobile Suppliers Association), a not-for-profit industry organization representing mobile suppliers, by the end of March 2024 77 publicly announced partnerships between operators and satellite vendors had been identified across 43 countries and territories. The GSA found that in total, 50 operators in 37 countries and territories have planned satellite services, with nine operators in nine countries and territories currently evaluating, testing or trialing these.¹

One significant advantage of satellite 5G NR technology is its ubiquitous geographical coverage, allowing IoT devices to function in remote and challenging areas. As diverse industries continue to embrace digital transformation and leverage IoT for increased efficiency and productivity, satellite-based 5G NR solutions are expected to play a crucial role in supporting and strengthening IoT ecosystems. The convergence of satellite and 5G technologies has acted as a powerful spur to innovation and investment in the space sector, with major stakeholders collaborating to develop enhanced satellite systems capable of delivering 5G NR connectivity.

¹[GSA: Non-Terrestrial 5G Networks and Satellite Connectivity \(April 2024\)](#)



Advancements in satellite technology have led to the deployment of high-throughput satellites (HTS) and non-geostationary orbit (NGSO) satellite constellations, significantly improving the capacity and performance of satellite 5G NR networks. These developments, combined with the growing demand for 5G and IoT applications, create promising opportunities for market growth in the satellite 5G NR sector. The satellite communication industry today is experiencing rapid growth, with the global NR NTN market projected to reach up to \$93.6 billion by 2032, at a compound global rate(CAGR) of 40.6% from 2023 to 2032.²

The economic viability of launching and maintaining satellite networks has improved due to reduced costs and better economies of scale. This makes it financially attractive for operators to explore NTN as a means to expand their service offerings without the high infrastructure costs associated with terrestrial networks. NTN present both a challenge and an opportunity for MNOs. While they introduce competition in areas where traditional networks struggle, they also offer a chance for MNOs to enhance their resilience and expand their market reach by partnering with satellite operators.

This white paper delves into the intricacies of NR NTN, exploring its market adaptability and future deployment scenarios. It examines the planned specifications and developments under 3GPP, alongside the coexistence and enhancement of non-proprietary solutions within the telecommunications industry. Through this exploration, Mavenir aims to deliver a comprehensive analysis of the transformative potential of NR NTN in the 5G landscape and provide the satellite industry and mobile operator communities a grounding in the key issues to get ready for the launch of the 5G NTN era.

² [5G NTN Market Size, Share | Industry Forecast - 2032 \(alliedmarketresearch.com\)](https://www.alliedmarketresearch.com/5g-ntn-market-size-share)

3. NTN NR Market

The exploration of Non-Terrestrial Networks (NTN) by Mobile Network Operators (MNOs) and satellite operators is driven by a combination of technological advancements and economic pressures. These factors are reshaping the telecommunications landscape, making NTN an attractive option for expanding connectivity and addressing unmet demands.

The market reported revenue generation of \$4.58 billion in 2022 and is predicted to grow at a CAGR of 11.92% and above during the forecast period 2023–2033 to reach \$14.47+ billion by 2033.³

Industry study of the technical implications of NTN started in 2017 through 3GPP Rel-17, which recognized that the proliferation of Non-Terrestrial Networks, including satellites in Low Earth Orbit (LEO) and Geostationary Earth Orbit (GEO), presents unique challenges and opportunities for the telecommunications industry. In response to this evolving landscape, 3GPP embarked on a journey to define the necessary enhancements to the 5G New Radio (NR) standard required to support these networks effectively.

4. The Economic Drivers and Strategic Benefits of Adopting NTN

As demand for widespread and reliable connectivity grows, CSPs encounter substantial costs associated with expanding terrestrial network infrastructure, particularly in remote and underserved regions. Building and maintaining ground-based infrastructure in these areas can be prohibitively expensive, making NTN — such as satellite and high-altitude platforms — a cost-effective alternative. By leveraging NTN solutions, CSPs can extend their network coverage and enhance service quality without the significant financial investment required for traditional infrastructure.

Traditional GEO services are experiencing a decline, with revenue reductions of approximately 15% due to competition from Low Earth Orbit (LEO) satellites. LEO satellites are capturing core markets such as maritime and remote communications, which has prompted GEO operators to seek innovative strategies to maintain their market presence. NTN provide a critical steppingstone for GEO operators, enabling them to integrate advanced satellite technologies and adapt to evolving market demands while remaining competitive in an increasingly challenging landscape.

³ Satellite 5G New Radio (NR) Market—A Global and Regional Analysis, BIS Research 2023

Moreover, an NTN solution is particularly valuable in addressing connectivity needs in economic fringe areas – regions that are neither fully rural nor urban and where traditional infrastructure investments are economically impractical. Extending Fiber-to-the-Premises (FTTP) or building out 5G networks in these regions often involves high costs with limited returns on investment. NTN offer a practical and cost-effective solution for delivering connectivity in such challenging environments, ensuring that underserved areas receive the benefits of modern telecommunications without the need for prohibitively expensive infrastructure projects.

In addition to these economic considerations, Non-Terrestrial Networks significantly enhance global coverage and connectivity. They provide a means to reach remote and isolated regions where terrestrial networks cannot extend, bridging digital divides and ensuring comprehensive service availability. This capability is especially important for supporting emerging applications, such as Internet of Things (IoT) devices and autonomous vehicles, which require widespread and reliable connectivity. By integrating NTN, operators can offer advanced services and applications that benefit from global connectivity, further driving the adoption and development of these innovative solutions.

5. NTN Evolution

The evolution of Non-Terrestrial Networks has already proven to be a significant factor in expanding global connectivity. Traditional NTN has now evolved into Narrowband Internet of Things (NB-IoT), which offers wide area connectivity for IoT devices. The progression to proprietary solutions and ultimately to 5G New Radio (NR) NTN represents a step change in integrating satellite communications within the 5G ecosystem of smartphones, making possible the provision of mobile broadband and fixed wireless access in remote areas.

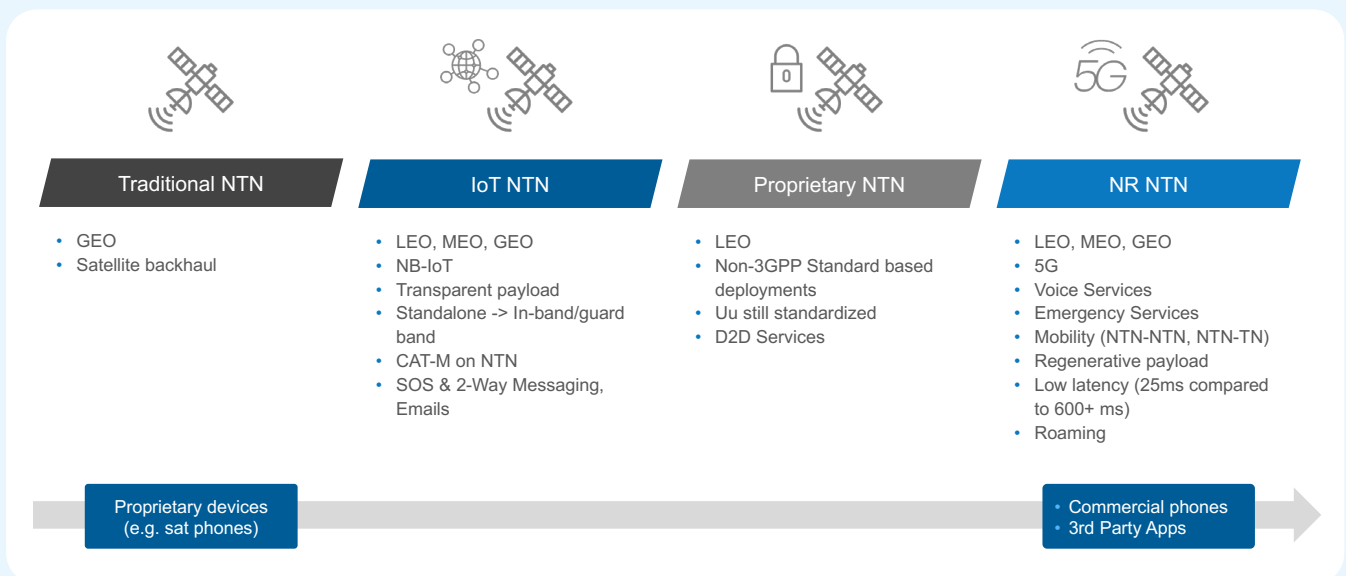


Figure 1: NTN Evolution

Baseline for NR Functionalities

3GPP Rel-17 laid the groundwork for NR functionalities required to support LEO and GEO satellites. Several assumptions were made to establish a baseline for further standardization efforts, including the utilization of Frequency Division Duplex (FDD), Earth-fixed tracking areas, Global Navigation Satellite Systems (GNSS) capabilities in User Equipment (UE), and the assumption of a transparent payload.

RAN (Radio Access Network) Enhancements

The work in 3GPP Rel-17 and subsequent releases focused on specifying feature enhancements across several working groups to address the challenges posed by satellite communication. These enhancements span multiple domains, including Radio Access Network (RAN), System Architecture (SA), Core, and Terminals. In RAN working groups (WG1, WG2, WG3, WG4), feature enhancements were specified to mitigate issues such as long propagation delays, large Doppler effects, and the mobility of cells associated with satellite communication. These enhancements encompassed improvements in timing relationships, Hybrid Automatic Repeat Request (HARQ), uplink synchronization, protocol stack functionalities, and architectural aspects such as feed link switchover and cell-related functionalities.

Core and Terminals Enhancements

Studies were conducted in the Core and Terminals working groups to address aspects of the 5G core network architecture for satellite networks. This included considerations for Public Land Mobile Network (PLMN) selection, mobility management, Quality of Service (QoS), and regulatory services.

IoT NTN Enablement

3GPP has made significant strides in enabling 5G support for NTN, particularly in 3GPP Rel-16 and ongoing efforts in subsequent releases. Crucially, a study item was approved to enable the Internet of Things (IoT) operation over NTN. This study leveraged existing Narrowband IoT (NB-IoT) features and enhanced Machine Type Communication (eMTC) or CAT-M over satellite communications, taking into consideration various scenarios and satellite orbits. The collaborative efforts across various working groups have resulted in the specification of essential feature enhancements to facilitate the seamless integration of satellite communication into the 5G ecosystem. As the telecommunications industry continues to evolve, these standards will play a pivotal role in realizing the full potential of Non-Terrestrial Networks in the 5G era.

6. NTN in 3GPP Roadmap

A notable area of exploration within 3GPP has been enabling 5G systems to support Non-Terrestrial Networks. NTN encompasses a broad spectrum of networks involving non-terrestrial flying objects, serving as an umbrella term for myriad technologies. These include satellite communication networks, high altitude platform systems (HAPS) and air-to-ground networks, each presenting unique challenges and opportunities within the telecommunications landscape.

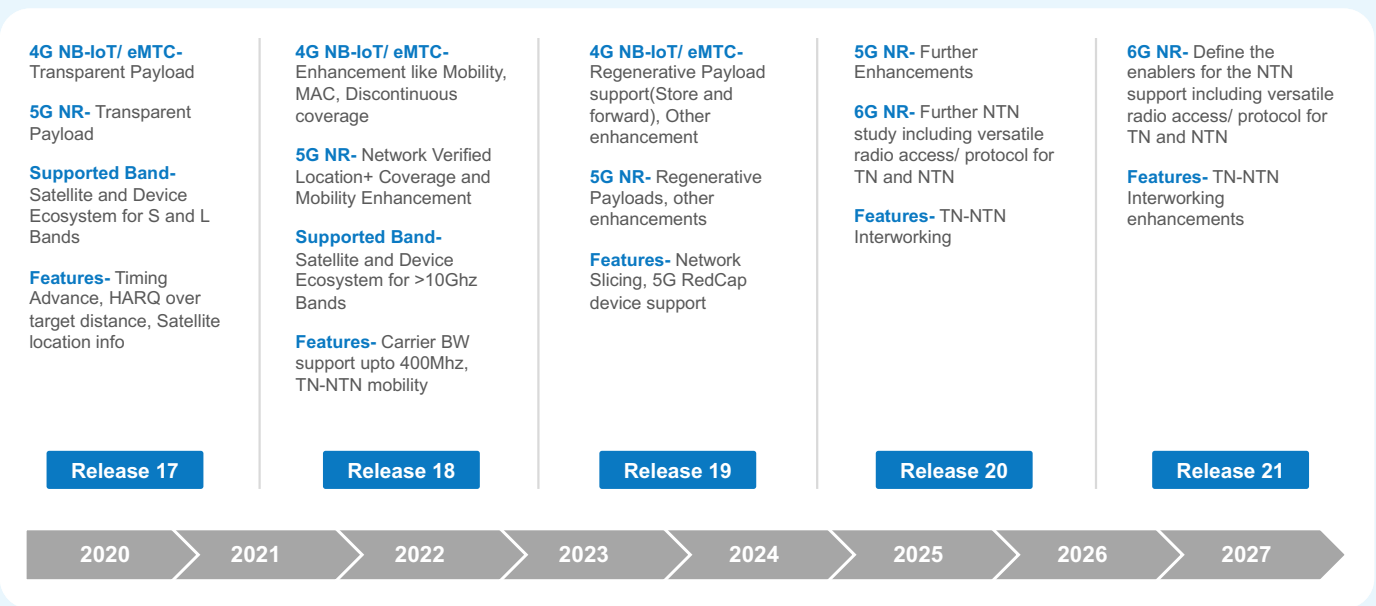


Figure 2: NTN in 3GPP Roadmap

With the completion of 3GPP Rel-17, the groundwork for New Radio-based satellite access was laid, promising enhanced 4G and 5G connectivity on the transparent payload for handheld devices and massive IoT use cases in sectors spanning industry and agriculture to logistics. The work in 3GPP Rel-18 and the ongoing progress for 3GPP Rel-19 seeks to push the boundaries still further, introducing regenerative payload with the aim of optimizing satellite access performance and supporting new capabilities to ensure reliable and extended reach for 5G services.

As the industry moves towards 3GPP Rel-20 and beyond, the focus will shift to greater optimization of satellite access performance and supporting new capabilities and services as part of the 5G roadmap. The culmination of these efforts in 3GPP Rel-21 and the anticipated developments in subsequent releases are set to define the future trajectory of 5G and beyond – paving the way for 6G technologies.

7. Building Blocks of NTN

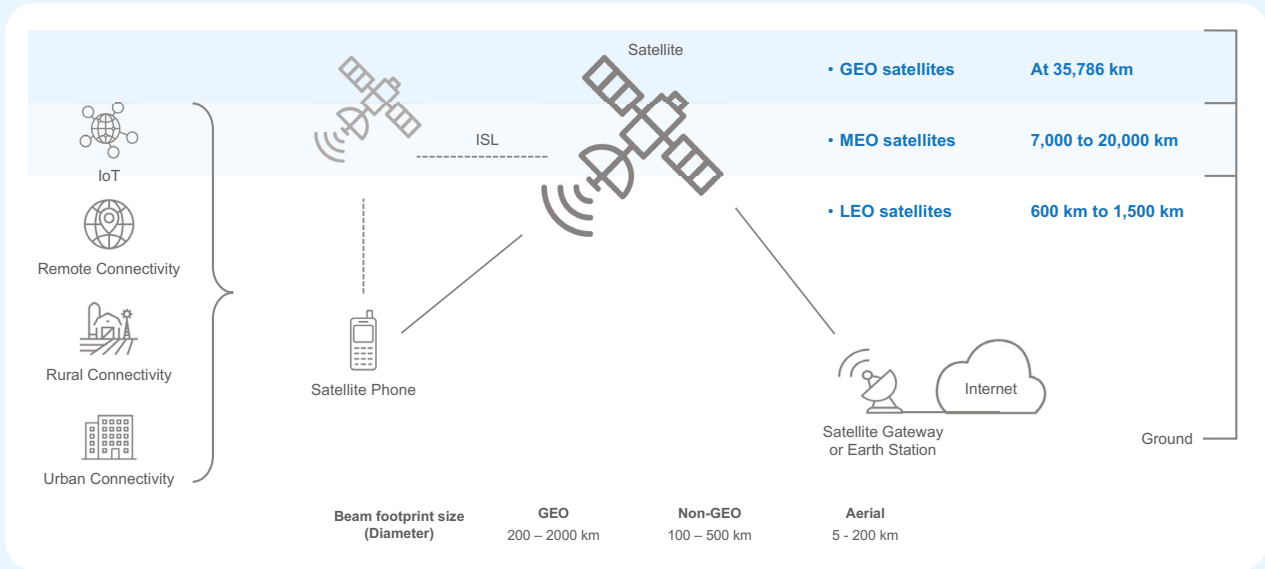


Figure 3 : Non-Terrestrial Network

In accordance with 3GPP TR 38.821, a satellite-based Non-Terrestrial Network typically comprises several essential components:

Geostationary Orbit (GEO) Satellites are approximately 35,786 kilometers above the equator, providing constant coverage to specific areas. Suitable for applications requiring stable, continuous connectivity, such as broadcasting and fixed communications.

Medium Earth Orbit (MEO) Satellites operate at altitudes between 2,000 and 35,786 kilometers, offering a balance between latency and coverage, ideal for regional services.

Low Earth Orbit (LEO) Satellites operate at altitudes between 160 and 2,000 kilometers, providing low latency and high bandwidth, suitable for real-time applications and dense IoT networks.

Satellite Gateways are the crucial link between the Non-Terrestrial Network and the public data network. In the case of a Geostationary Earth Orbit (GEO) satellite, one or multiple satellite gateways strategically positioned across the satellite’s coverage area (e.g., regional or continental) feed the satellite. Each cell of NTN is typically serviced by a single satellite gateway. In contrast, for Non-Geostationary (Non-GEO) satellites, one or more gateways serve the satellite successively. The

system ensures continuous service and feeder link connectivity between successive serving gateways, allowing for mobility anchoring and handover procedures.

Feeder Link refers to the radio link connecting the satellite gateway(s) to the satellite.

Service Link connects the user equipment directly to the satellite, facilitating communication between the end-users and the satellite.

Satellite Payload can be implemented as either a transparent or a regenerative payload. With a transparent payload, the satellite performs basic radio frequency operations such as filtering, frequency conversion, and amplification without altering the waveform signal. Conversely, a regenerative payload involves more advanced processing, including demodulation, decoding, switching, routing, and modulation/coding functions, akin to having base station functions (e.g. gNodeB or “gNB”) onboard the satellite. The satellite typically generates multiple beams over its service area, with beam footprints often assuming elliptical shapes.

Inter-Satellite Links (ISL) are optional in satellite constellations. ISLs (Inter Satellite Links) facilitate communication between satellites. For this to occur, regenerative payloads are required onboard the satellites. ISLs may operate in radio frequency (RF) or optical bands.

User Equipment (UE) is the devices served by the satellite within the targeted service area, enabling end-users to access the satellite-based network.

These components work in coordination to establish and maintain connectivity within a satellite-based Non-Terrestrial Network, facilitating communication between users and the broader network infrastructure.

8. Satellite-based NTN Architecture

In 3GPP Rel-16, various network architectures were examined, with the Transparent mode selected for further development in 3GPP Rel-17.

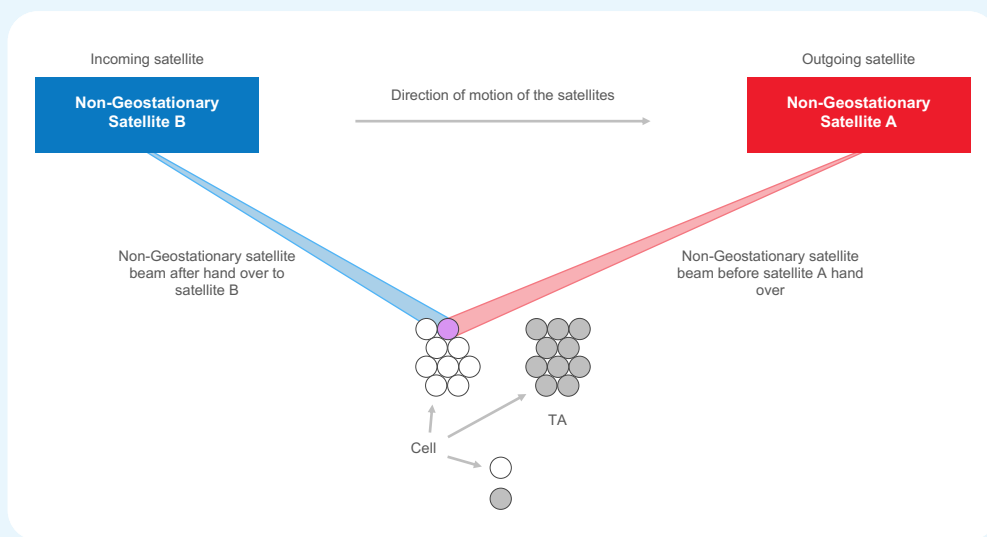


Figure 4: Non-Geostationary Satellite Beam Steering and Handover (source: 3GPP SA2 study report 23.737)

Key principles of satellite-based NTN architecture include fixed tracking areas, mobility procedures like terrestrial networks, and Core Network (CN) paging within allocated Registration Areas. Mobility management ensures continuity amid changes in mapping between gNBs and satellite beams for Non-Geostationary Orbit (NGSO) satellites, while Earth-fixed tracking areas accommodate moving beams/cells.

The 3GPP NTN architecture outlines two main approaches: transparent and regenerative. Transparent architecture relays signals between user equipment and ground stations without onboard processing, ensuring straightforward integration with terrestrial networks. Regenerative architecture, conversely, involves satellites performing complex processing tasks such as demodulation and routing, reducing dependency on ground stations, and enhancing network efficiency and flexibility.

Transparent Satellite-based Architecture

Outlined in 3GPP TR 38.821, the transparent satellite-based architecture involves the satellite payload performing frequency conversion and radio frequency amplification in both the uplink and downlink directions. The satellite repeats the NR-Uu radio interface from the feeder link (between the satellite-based NTN gateway and the satellite) to the service link (between the satellite and the UE), and vice versa. The Satellite Radio Interface (SRI) on the feeder link is maintained as the NR-Uu, implying that the satellite does not terminate the NR-Uu, while the satellite-based NTN Gateway (GW) supports all necessary functions to forward the NR-Uu interface signal. Notably, multiple transparent satellites may be linked to the same ground-based Node B (gNB), though the description here simplifies this to a single gNB accessing the satellite payload. Another factor is reliance on having strong feeder links to ground stations located throughout the coverage area. One of the challenges of Transparent payload is that the same waveform must be used for FR1 service link and FR2 feeder link.

Operational Considerations

For effective operation, NR-Uu timers may need extensions to accommodate the long delays associated with feeder and service links, particularly in scenarios involving Low Earth Orbit (LEO) satellites with Inter-Satellite Links (ISL). Control plane (CP) and user plane (UP) protocols are terminated on the ground, with adaptations required for longer round-trip times for UP packets. Moreover, satellite-based NTN will implement position-based and fixed tracking area satellite access, assuming UEs possess location determination capabilities.

In summary, the transparent satellite-based architecture presents a robust framework for integrating satellite communication into 5G networks, with considerations for efficient operation and seamless connectivity across different network segments.

Regenerative Satellite-based Architecture

Regenerative satellite-based architecture represents an advanced approach within Non-Terrestrial Networks, aiming to enhance the efficiency, capacity and flexibility of satellite communication systems. In accordance with 3GPP standards – particularly as outlined in TR 38.821 – regenerative satellite architecture involves satellites that perform more complex processing tasks onboard rather than relying solely on ground stations.

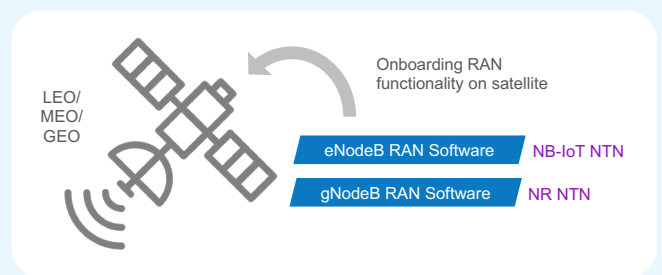


Figure 5: NB-IoT and NR NTN RAN Architecture

Regenerative payload requires network functions such as radio frequency filtering, frequency conversion, amplification, demodulation/decoding, switch and/or routing, and coding/modulation on the satellite. With the full specification still to be defined in 3GPP Rel-19, there has been some observation with non-3GPP adaptability now being considered until 2026 before networks evolve toward the 3GPP standards.

The 3GPP-based regenerative satellite architecture represents a significant advance in satellite communication, leveraging onboard processing to enhance network performance, efficiency and flexibility. By integrating advanced satellite technologies with terrestrial networks, this architecture supports a wide range of applications, driving innovation and ensuring ubiquitous connectivity. As the 5G ecosystem continues to evolve, regenerative satellite architectures will play a crucial role in expanding the reach and capabilities of global telecommunications networks.

9. Mavenir’s Cloud-Native Solution for Non-Terrestrial Networks

Mavenir’s solution, adhering to 3GPP standards for Non-Terrestrial Networks (NTN), is designed as a cloud-native, containerized platform. It features NTN RAN and Packet Core functions segmented into modular, containerized services for faster deployment and seamless upgrade.

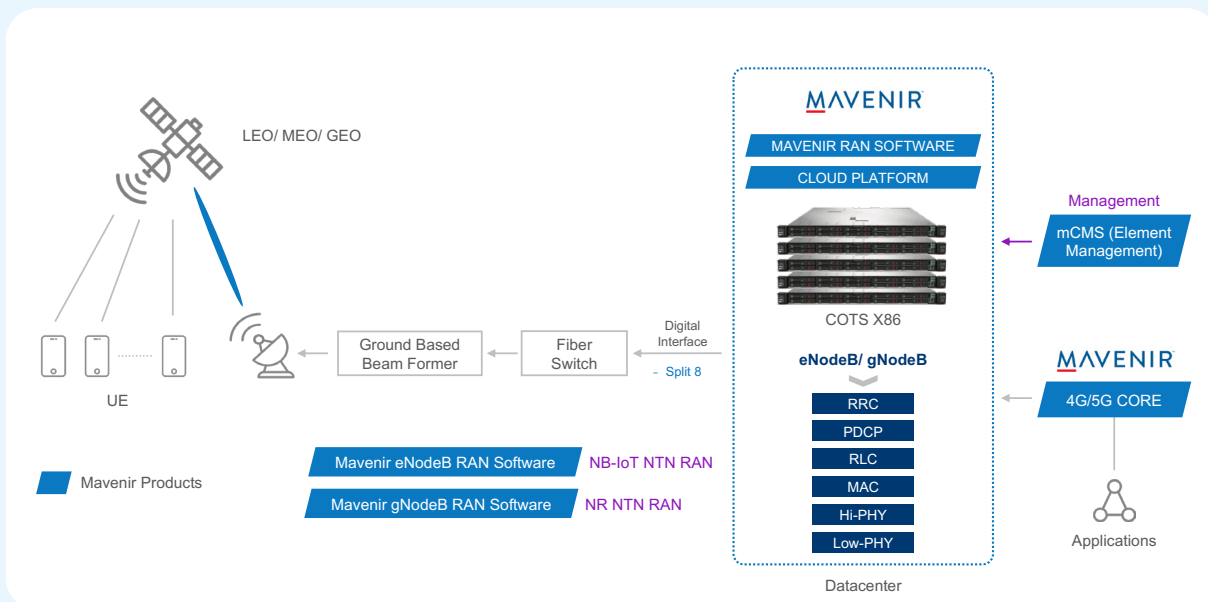


Figure 6: Mavenir Satellite NTN architecture based on transparent payload

3GPP Compliance and Features

Targeting 3GPP Rel-17, Mavenir’s solution supports Frequency Division Duplex (FDD) bands for NB-IoT and NR NTN, with fixed tracking areas and moving cells. Considerations regarding the number of cells per server are addressed through cloud-native and virtualized, containerized solutions. Mavenir’s cloud-native architecture decomposes NB-IoT RAN network functions (NF) into containerized services, facilitating easy deployment and upgrades. This service-based architecture ensures flexibility, agility to network changes and rapid roll-out capabilities. Containerized services can be deployed on physical infrastructure distributed across geographical regions.

Key functionalities include Mobile Originated and Terminated Data Transfer, Tracking Area Update, Idle Mode Selection and Reselection, Connected Mode Discontinuous Reception (C-DRX), and Multi-Frequency Band Indicators.

Connectivity and Protocols

The solution employs a 3GPP-compliant S1 interface to connect to the core network, with the radio interface towards User Equipment (UE) provided through a geosynchronous satellite. The gNB CNF (Containerized Network Function) supports SIAP (S1 Application Protocol), RRC (Radio Resource Control), RLC (Radio Link Control), MAC (Medium Access Control), and PHY protocol stacks compliant with 3GPP specifications. Additionally, the gNB CNF resamples and maps IQ samples from/to different cells to their respective beam ports.

Centralized Management and Monitoring

Mavenir's Centralized Management System (mCMS) CNF offers centralized FCAPS (Fault, Configuration, Accounting, Performance, and Security) functionality. A centrally deployed mCMS manages all gNB Pods in the cluster, allowing operators to use its GUI (Graphical User Interface) for comprehensive OAM (Operations, Administration, and Maintenance) functions. The mCMS also provides a REST-based Northbound Interface (NBI) for integration with the operator's OSS/BSS.

Observability and Performance Management

The XA observability platform collects performance management counters, alarm/event notifications, and logs from a range of network elements, presenting them as comprehensive KPI reports and dashboards. This ensures real-time monitoring and performance analysis across the network.



eNB/gNB Application Container Processes

The eNB or gNB Application Container runs three primary processes:

L2/L3 Process: Handles call processing functions in compliance with 3GPP specifications, including:

- > Radio Resource Control (RRC)
- > Radio Resource Management (RRM)
- > S1 Application Protocol (SIAP)
- > Radio Link Control (RLC)
- > Scheduler
- > Medium Access Control (MAC)

L1 Process: Manages the following call processing functions, compliant with 3GPP standards:

- > High-PHY (Hi-Phy)
- > Low-PHY (Low-Phy)

Digital Front End (DFE):

- > Sampling/ Resampling and support specific beam bandwidths.

Each eNB/gNB Pod can scale to support multiple cells within the eNB Application Container, with one pair of L1 and L2/L3 processes per cell. Each Pod contains a single DFE.

For more details, visit Mavenir's NTN RAN webpage: [Non-Terrestrial Networks \(NTNs\) - Mavenir](#)



10. Path toward regenerative NTN architecture

The regenerative payload option is planned for standardization in 3GPP Rel-19 with three potential design options:

- > Full gNB(RU-DU-CU) on board
- > gNodeB Centralized Unit (gNB-CU) is on the ground, Distributed Unit (gNB-DU) is on board.
- > gNodeB on the ground, RU (Radio Unit) on satellite

Two main approaches to implementing regenerative NTN architectures are proprietary solutions developed by private companies and standardized solutions based on 3GPP specifications.

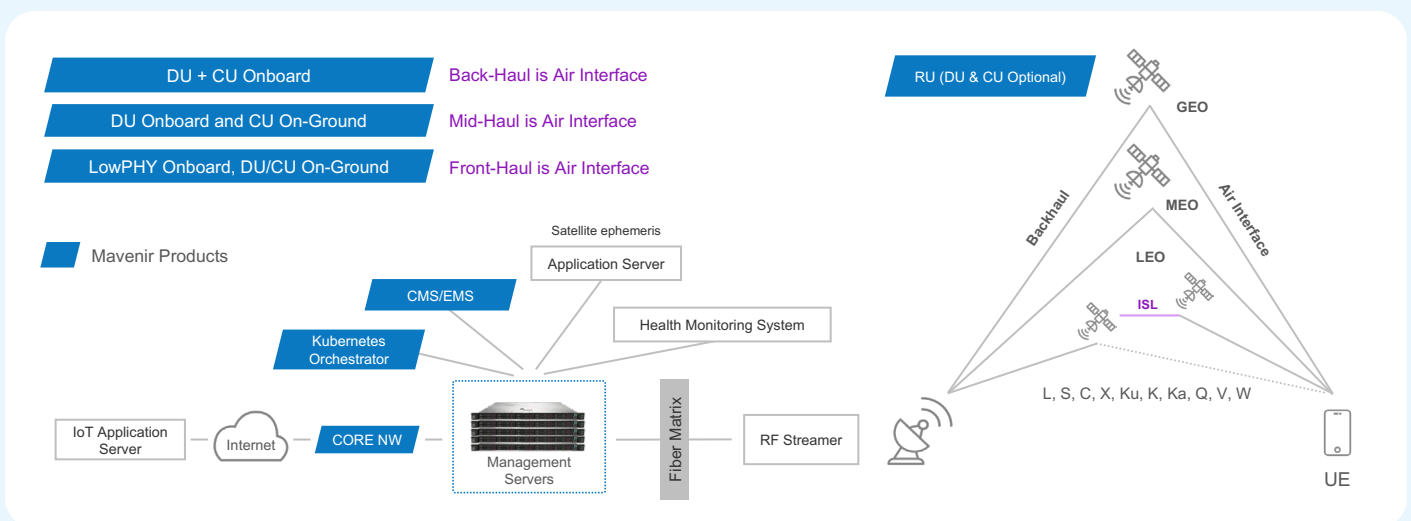


Figure 7: NB-IoT and NR NTN Regenerative RAN Architecture

Non-Standards based (Proprietary) Solution before Rel-19 (2025/26)

Proprietary regenerative NTN solutions are developed by private companies and are often tailored to specific applications and operational requirements. These solutions are typically characterized by unique technologies and architectures designed to meet the strategic goals of the providers.

A regenerative payload solution is possible within the timeframe of 2025/26 with the following implementation criteria:

> Approach 1

- Develop a regenerative RAN/Core solution: (onboard LLow Earth Orbit satellite support) that will work with L and S-band, followed by FR2 (a potential solution that industry professionals and stakeholders can actively shape today)
- Operators and RAN Vendors will need to define and implement the specs for this proprietary solution
- Chipset Dependency/Availability:
 - NB-IOT: NTN device Chipsets may qualify for L&S support by mid-2024
 - NR NTN: will be available 2026/27 as per chipset vendors aligning with the 3GPP specification
 - To meet 2025/26 timelines for NR NTN for operators, device chipset development to be aligned with chipset vendors

> Approach 2

- Develop a regenerative RAN/Core solution (onboard LEOs) that will work with current MNOs Terrestrial frequency bands (reusing of Terrestrial bands for NTN in service link e.g. 700/800/1900/2100)
- Partnerships with the MNOs are in place (an MNO-dependent solution) to secure the frequency bands and control RF Interference for service links
- Existing device ecosystem will support this approach

Standards-based Solution (3GPP) in 2026/27

- Develop a regenerative RAN/Core solution (onboard LEOs support) that will work with dedicated bands (e.g. L, S, Ka, KU, both FR1 and FR2 bands) for NTN services
- No dependency and partnerships are required with the MNOs to launch services
- Launch global services to provide similar services to Terrestrial MNOs
- Device chipset development to be aligned with chipset vendors



11. Core Network Considerations for Non-Terrestrial Networks

In 3GPP Rel-17, there is a clear strategic focus on optimizing the utilization of existing 5G Core Network functionalities to support the unique requirements of Non-Terrestrial Networks. The goal is to ensure seamless integration and interoperability between terrestrial and non-terrestrial segments of the network architecture.

One critical aspect of the specifications is the adoption of a transparent payload architecture, complemented by position-based and fixed Tracking Area (TA) access mechanisms. This approach minimizes the need for extensive modifications to TA and Routing Area (RA) definitions, preserving the integrity of core network procedures and functional elements related to TA and RA updates. By maintaining consistency in these areas, network management and mobility management functions can operate efficiently across both terrestrial and non-terrestrial environments.

However, the extended delays inherent in satellite access necessitate adjustments to certain timers within session management and mobility management functions. These adjustments accommodate significantly longer values, ensuring that network operations remain synchronized and responsive despite the increased latency. The specific adjustments required may vary depending on the Radio Access Technology (RAT) type utilized, with tailored configurations to optimize performance and resource utilization.

To address these challenges effectively, enhancements within the Access and Mobility Management Function (AMF) are essential. In particular, this requires a focus on refining UE positioning and registration processes to align with the unique characteristics of NTN deployments. These enhancements aim to optimize network resource allocation, streamline handover procedures, and enhance overall network efficiency and reliability.

Mavenir offers a comprehensive core network solution that aligns with these principles and addresses the specific requirements of NTN deployments. Mavenir's 5G Core solution provides a robust and scalable platform designed to support diverse network architectures, including NTN integrations. With features tailored to optimize performance, manage latency and ensure seamless interoperability between terrestrial and non-terrestrial segments, Mavenir's core solution is well-suited to meet the evolving demands of next-generation networks. For more details, visit Mavenir's Packet Core webpage: <https://www.mavenir.com/portfolio/mavcore/converged-packet-core/>

By leveraging Mavenir's core solution, operators can effectively navigate the complexities of integrating non-terrestrial elements into their network infrastructure while maximizing the benefits of 5G technology.



12. NTN Use Cases

Non-Terrestrial Networks present tailored solutions for connectivity challenges in isolated rural, urban, remote areas and economic fringes where 5G deployments may not justify the cost and investments. In rural regions, NTN facilitates essential services, including agricultural data access, e-learning, and telemedicine, empowering farmers and improving healthcare and education outcomes. In urban settings, NTN supplements terrestrial networks to address coverage gaps, supporting IoT applications for smart cities, public safety and traffic management. For remote areas lacking terrestrial infrastructure, NTN becomes essential, providing access to vital services from healthcare to e-commerce and distance learning, fostering socio-economic growth and inclusion.

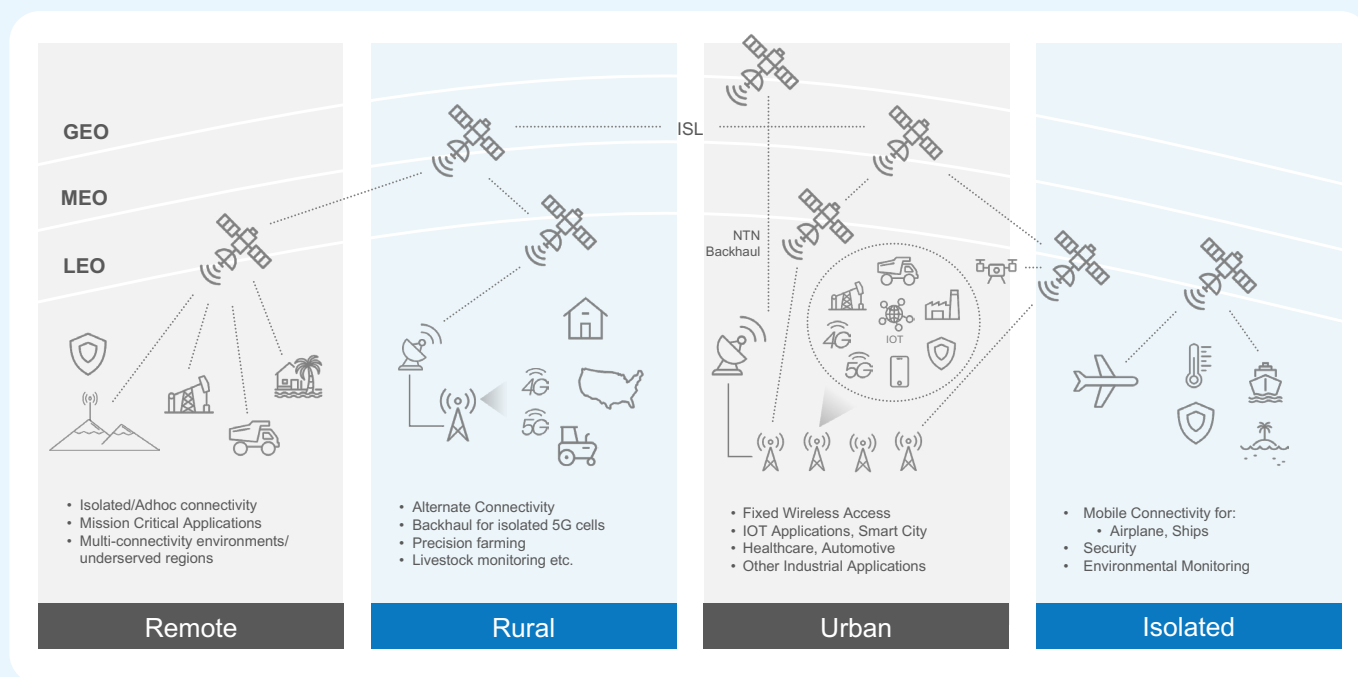


Figure 8 : NTN Use Cases

By catering to the specific needs of these diverse areas, NTN plays a pivotal role in bridging the digital divide and enabling comprehensive global connectivity.

13. Conclusion

The emergence of Non-Terrestrial Networks represent a pivotal moment in the evolution of telecommunications, extending the transformative power of 5G beyond terrestrial boundaries. With the introduction of 3GPP Rel 17, the stage is set for the seamless integration of satellite-based communication into the 5G ecosystem, unlocking unprecedented opportunities for connectivity in remote and underserved areas.

As the global demand for ubiquitous connectivity continues to surge, NTN solutions offer a pathway to bridge the digital divide and enable comprehensive global coverage. Leveraging advancements in satellite technology, NTN deployments promise to revolutionize industries, drive innovation and empower communities worldwide.

Mavenir stands at the forefront of this technological revolution, offering a comprehensive cloud-native solution tailored to the unique requirements of NTN deployments. With adherence to 3GPP standards and a commitment to innovation, Mavenir's NTN solution ensures robust connectivity, agility and scalability – empowering operators to harness the full potential of 5G technology.

As the industry embarks on this journey towards regenerative NTN architecture, collaboration, innovation and standardization will be key drivers of success. By embracing these principles, the telecommunications industry can deliver the vision of a connected world, where the boundaries of connection are limitless, and opportunities abound for all.

About Mavenir

Mavenir is building the future of networks today with cloud-native, AI-enabled solutions which are green by design, empowering operators to realize the benefits of 5G and achieve intelligent, automated, programmable networks. As the pioneer of Open RAN and a proven industry disruptor, Mavenir's award-winning solutions are delivering automation and monetization across mobile networks globally, accelerating software network transformation for 300+ Communications Service Providers in over 120 countries, which serve more than 50% of the world's subscribers.

www.mavenir.com

Appendix

Further reading

<https://www.3gpp.org/specifications-technologies/releases/release-17>

<https://www.3gpp.org/specifications-technologies/releases/release-18>

<https://www.3gpp.org/specifications-technologies/releases/release-19>

[5G NTN Market Size, Growth Analysis & Forecast, \[Latest\] \(marketsandmarkets.com\)](#)

[5G NTN Market Size, Share & Forecast Analysis Report, 2032 \(gminsights.com\)](#)

[5G NTN Market Size, Share | Industry Forecast - 2032 \(alliedmarketresearch.com\)](#)

<https://www.3gpp.org/technologies/ntn-overview>

[5G And Non-Terrestrial Networks - 5G Americas](#)

[Mavenir Successfully Demonstrates Narrowband IoT Non-Terrestrial Network Connectivity on Ligado SkyTerra Satellite Network - Mavenir](#)

[Mavenir and Terrestar Solutions Partner to Accelerate Commercial Deployment of 5G New Radio Non-Terrestrial Network - Mavenir](#)

Acronyms

| | | | |
|--------|---|---------|---|
| 3GPP | 3rd Generation Partnership Project | LEO | Low Earth Orbit |
| 5G | Fifth Generation | NBI | Northbound Interface |
| AI | Artificial Intelligence | NB-IoT | Narrowband Internet of Things |
| AMF | Access and Mobility Management Function | NGSO | Non-Geostationary Orbit |
| CAGR | Compound Annual Growth Rate | NR | New Radio |
| CN | Core Network | NR-Uu | New Radio - Uu Interface |
| DFE | Digital Front End | NTN | Non-Terrestrial Networks |
| eMTC | enhanced Machine Type Communication | OAM | Operations, Administration, and Maintenance |
| FCAPS | Fault, Configuration, Accounting, Performance, and Security | O-RAN | Open Radio Access Network |
| FR1 | Frequency Range 1 | OSS/BSS | Operations Support Systems/ Business Support Systems |
| FR2 | Frequency Range 2 | PLMN | Public Land Mobile Network |
| GEO | Geostationary Earth Orbit | QoS | Quality of Service |
| gNB | gNodeB | RA | Routing Area |
| gNB-CU | gNodeB Centralized Unit | RAN | Radio Access Network |
| gNB-DU | gNodeB Distributed Unit | RAT | Radio Access Technology |
| GUI | Graphical User Interface | SIAP | SI Application Protocol |
| HARQ | Hybrid Automatic Repeat Request | SA | System Architecture |
| HTS | High-Throughput Satellites | SRI | Satellite Radio Interface |
| IoT | Internet of Things | TA | Tracking Area |
| ISL | Inter-Satellite Links | TR | Technical Report |
| KPI | Key Performance Indicator | UE | User Equipment |

References

¹ [GSA: Non-Terrestrial 5G Networks and Satellite Connectivity \(April 2024\)](#)

² [5G NTN Market Size, Share | Industry Forecast - 2032 \(alliedmarketresearch.com\)](#)

³ [Satellite 5G New Radio \(NR\) Market-A Global and Regional Analysis, BIS Research 2023](#)



MAVENIR

For further information or enquiries, please contact
info@mavenir.com

Copyright © Mavenir 2024. All rights reserved.