The Intelligence Network: A 6G Blueprint for Telcos

A 6G blueprint for AI-native, autonomous and monetizable telecom infrastructure

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Executive Summary

The telecommunications industry is entering a defining transition. For decades, network value has been measured primarily through connectivity: coverage, speed, latency, reliability, and capacity. While these foundations remain essential, connectivity alone is no longer sufficient to create sustainable differentiation or proportional economic value. As traffic growth accelerates and traditional revenue models remain under pressure, the next opportunity for telcos lies in transforming networks from passive transport systems into intelligent platforms that can sense, predict, decide, and act.

6G will be the first mobile generation designed around this shift. It will not simply deliver faster connectivity; it will integrate communication, computing, data, sensing, and artificial intelligence into a unified infrastructure of intelligence. In this model, intelligence becomes a native network capability rather than an external layer. The network continuously learns from real-time data, anticipates demand and risk, optimizes resources before problems occur, and delivers services according to customer intent and business outcomes. This requires an AI-native architecture built on a unified data fabric, AI/ML lifecycle management, cloud-native and service-based network functions, intelligent control and management systems, AI agents, digital twins, telecom world models, and programmable interfaces. Together, these capabilities enable the network to operate as a coordinated decision-making system: one that can observe its environment, evaluate alternatives, validate actions, and improve continuously.

The 6G Radio Access Network will be central to this transformation. It will evolve from a radio transmission layer into an AI-native, sensing-enabled, and increasingly autonomous platform. Advanced spectrum, particularly upper 6 GHz and FR3, will be important in delivering the capacity required for the next decade while maintaining practical continuity with existing macro-site infrastructure. Field evidence discussed in this paper indicates that upper 6 GHz can support macro-cellular deployment with comparable coverage behavior to 3.6 GHz under equivalent conditions, while wider 200 MHz channels create a path toward multi-gigabit performance.

The commercial opportunity is equally significant. Intelligent networks create new monetization models based not only on connectivity consumption, but on insight, assurance, action, and trust. Telcos can expose predictive network intelligence through APIs, offer sovereign AI and edge capabilities, deliver managed autonomous services for enterprises, monetize trusted data products, and provide on-demand service-level guarantees for critical workloads. The same AI-native platform that improves internal operations can support external AI-as-a-Service, network intelligence APIs, Agent-as-a-Service, Digital Twin-as-a-Service, and SLA-as-a-Product offerings.

The journey toward autonomy should begin now, not at the eventual launch of 6G. 5G-Advanced provides the proving ground for unified data, closed-loop automation, cloud-native RAN, intelligent slicing, AI-enabled service assurance, and governed AI agents. Telcos should prioritize scenarios where autonomy has clear operational value and manageable risk, including RAN energy optimization, proactive fault management, capacity planning, service assurance, network slicing, and enterprise SLA management.

The strategic objective is clear: build intelligence-native networks that are more efficient to operate, more resilient by design, and more valuable to customers. In the 6G era, the winning telcos will not be those that simply carry more traffic. They will be those that turn network intelligence into trusted, programmable, and monetizable outcomes.

The New Telecom Reality: Intelligence Becomes the Product

1. Introduction

For more than three decades, the telecommunications industry has been defined by its ability to deliver connectivity, meaning the reliable transport of voice, data, and multimedia services across increasingly advanced network infrastructures. From early circuit switched systems to today's 5G networks, value creation has largely been driven by improvements in throughput, latency, coverage, and reliability.

However, this long standing paradigm is reaching its limits. In the emerging 6G era, connectivity alone is no longer sufficient as a primary value driver.

Instead, a fundamental shift is underway: ***intelligence is becoming the product***.

This transition reflects a broader transformation in the digital economy, where value is increasingly created through data, artificial intelligence, and real time decision making. Networks are evolving from passive transport systems into active cognitive platforms capable of sensing, learning, predicting, and acting. In this new reality, intelligence is not an auxiliary feature layered on top of the network. It is a core and monetizable capability embedded across all layers of the system [1][2].

2. The Limits of the Connectivity Centric Model

The traditional telecom business model is under increasing pressure due to the growing disconnect between traffic growth and revenue generation. Global mobile data traffic continues to grow rapidly, driven by bandwidth intensive applications such as video streaming, extended reality, and industrial Internet of Things. Yet, Average Revenue Per User has remained largely stagnant in most markets.

According to the GSMA Mobile Economy Report (2024), mobile data traffic is expected to more than triple by 2030, while revenue growth remains modest [3]. This imbalance highlights a structural issue: operators are investing heavily in infrastructure expansion without capturing proportional economic value.

At the same time, a significant portion of value creation has shifted toward over the top service providers and hyperscale cloud platforms. These players leverage data and artificial intelligence to deliver differentiated and high value services, while telecom operators increasingly risk being relegated to commoditized connectivity providers [4].

This dynamic creates a clear imperative. Telecom operators must move up the value chain by transforming their networks into platforms that generate and deliver intelligence.

3. Defining Intelligence in Telecom Networks

In next generation networks, intelligence must be understood as a precise and multi dimensional capability rather than a generic reference to artificial intelligence.

Telecom intelligence can be defined through four key capabilities:

- **Context awareness**: continuous ingestion and interpretation of diverse data sources, including network conditions, user behavior, application requirements, and environmental context.

- **Predictive capability**: anticipation of future network states, traffic demand, and potential failures using machine learning models.
- **Autonomous decision making**: execution of actions through closed loop control systems with minimal human intervention.
- **Continuous learning and adaptation**: ongoing improvement of performance through data driven feedback mechanisms.

This definition aligns with the ITU IMT 2030 framework, which identifies artificial intelligence native operation as a core characteristic of future networks [1]. Similarly, 3GPP has introduced architectural support for artificial intelligence and machine learning model lifecycle management and data collection across the network [5].

Together, these developments indicate a shift toward intelligence as an intrinsic property of the network rather than an external enhancement.

4. From Deterministic Networks to Learning Systems

A defining characteristic of this new telecom reality is the transition from deterministic and model driven systems to probabilistic and learning based systems.

Traditional networks rely on static configurations and predefined optimization rules. While effective in stable environments, these approaches are increasingly insufficient for highly dynamic and heterogeneous network conditions.

Artificial intelligence native networks, by contrast, continuously adapt based on real time data. This transformation can be summarized as follows:

Traditional Networks	Intelligent Networks
Static configuration	Continuous adaptation
Reactive management	Predictive optimization
Human driven decisions	Autonomous control
Parameter tuning	Intent driven orchestration

This evolution is formalized in frameworks such as the TM Forum Autonomous Networks model, which defines a progression toward fully autonomous and self evolving networks [6].

In parallel, research published in IEEE venues shows that artificial intelligence driven approaches can outperform traditional techniques in complex radio environments, particularly in dense and high frequency deployments [7].

5. Intelligence Across the Network Stack

The defining shift toward intelligent telecom systems is not the introduction of artificial intelligence into isolated functions, but its systematic integration across the entire network stack as a native capability. This transforms the network from a layered engineering system into a coordinated learning system.

At the physical layer, learning-based methods are beginning to replace analytical models in tasks such as channel estimation, beamforming, and interference management. This is particularly important in high-frequency environments where traditional models struggle to capture complex and rapidly changing propagation conditions. In such scenarios, data-driven approaches provide robustness and adaptability that deterministic techniques cannot achieve [8].

At higher layers, intelligence enables temporal and spatial awareness of network behavior. Instead of reacting to congestion or failures, the network anticipates them. Resource allocation, routing, and service placement become predictive processes, driven by continuously updated models of network state.

Most critically, intelligence becomes central to the control plane. Closed-loop systems integrate observation, inference, and action into continuous cycles, allowing the network to optimize itself in real time. This removes the traditional separation between management and operation and replaces it with unified decision systems.

The architectural implication is fundamental. Intelligence is no longer an optimization tool applied to the network. It becomes the mechanism through which the network operates, effectively transforming it into a distributed cognitive system capable of coordinated adaptation.

6. Data as a Strategic Asset

The effectiveness of intelligent networks is fundamentally determined by the availability, quality, and usability of data. In telecom systems, data is not simply an operational byproduct. It is the primary input to value creation.

Operators possess uniquely rich and continuous data streams that capture network dynamics, user mobility, and service behavior at scale. However, this data has traditionally been used in fragmented and offline ways, limiting its impact. Intelligence-driven networks require a shift toward real-time, integrated data utilization.

This transformation depends on three key capabilities. First, unified data environments that eliminate silos across network domains. Second, real-time processing pipelines that enable low-latency ingestion and analytics. Third, governance frameworks that ensure security, privacy, and regulatory compliance.

Federated learning plays a critical role in this context. It allows models to be trained across distributed data sources without centralizing sensitive information, enabling collaboration while preserving data privacy

[9]. This is particularly important in telecom environments where regulatory constraints are strict and data sensitivity is high.

Ultimately, competitive advantage will depend not on data ownership alone, but on the ability to operationalize data into continuous, system-wide intelligence.

8. Economic Implications: Monetizing Intelligence

The emergence of intelligence as a core capability fundamentally changes how value is captured in telecom systems. Traditional revenue models based on data consumption are increasingly misaligned with the capabilities of intelligent networks.

In an intelligence-driven paradigm, value is derived from performance, predictability, and outcomes. This enables a shift toward outcome-based monetization, where operators provide guarantees on metrics such as latency, reliability, or quality of experience. These guarantees are only possible when the network can predict and control its behavior in real time.

A second dimension of monetization comes from exposing intelligence as a capability. By providing access to network insights, predictions, and control mechanisms through programmable interfaces, operators enable external entities to build services on top of network intelligence. This effectively transforms the network into a platform.

Data itself also becomes a source of value. Aggregated and anonymized insights derived from network data can be monetized across industries, provided that governance and privacy requirements are met.

The key shift is conceptual. Revenue is no longer tied to the transport of data, but to the value of decisions enabled by the network. Operators that do not make this transition risk remaining in low-margin infrastructure roles, while value shifts toward those who control intelligence layers [4], [10].

9. Toward Cognitive and Self Evolving Networks

The long-term trajectory of telecom systems leads toward cognitive networks. These are systems that do not simply automate processes, but continuously learn, adapt, and improve their behavior.

This vision is closely related to the concept of world models, where artificial intelligence systems build internal representations of their environment to enable prediction and planning. In telecom networks, such models allow the system to anticipate future states, evaluate alternative actions, and optimize decisions before execution.

This introduces a shift from reactive control to model-driven operation. Network management becomes a process of reasoning under uncertainty rather than rule-based adjustment.

When combined with digital twins, cognitive systems can simulate network behavior, validate decisions, and refine strategies through continuous interaction between real and virtual environments. This enables a level of precision and adaptability that traditional approaches cannot achieve.

The result is a self-evolving network in which optimization is not an external process, but an inherent system capability.

AI-Native Architecture for Monetizable Intelligence

The transition from Fifth Generation (5G) to Sixth Generation (6G) networks represents a fundamental paradigm shift in telecommunications architecture. While 5G extended mobile broadband capabilities into diverse industrial verticals, 6G is not merely an incremental enhancement in speed or latency. Instead, it introduces a natively intelligent network fabric, conceptualized as an “Infrastructure of Intelligence”, a system designed to seamlessly integrate communication, computation, and Artificial Intelligence (AI). To support the evolution toward IMT-2030, networks must exhibit extreme flexibility to accommodate emerging and unforeseen usage scenarios with heterogeneous requirements. The IMT-2030 framework envisions a modular design approach, enabling incremental feature integration based on regional priorities and market dynamics. These usage scenarios are illustrated in Figure 1.

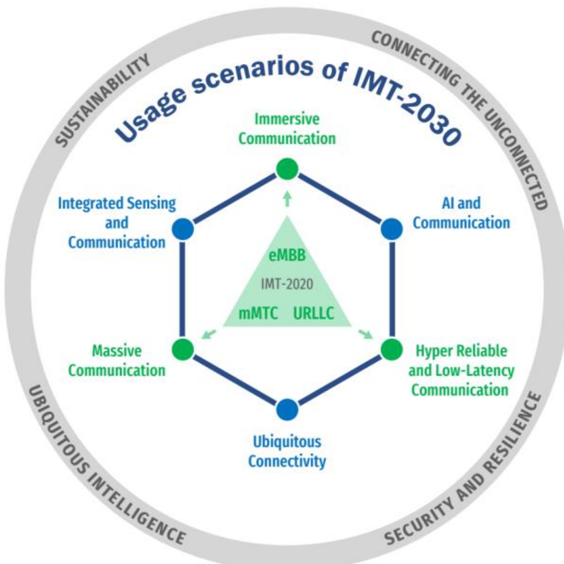


Figure 1: Usage scenarios and overarching aspects of IMT-203

This vision is formally articulated by the International Telecommunication Union (ITU) through its IMT-2030 framework. The foundational Recommendation ITU-R M.2160 identifies “**AI and Communication**” as a core usage scenario, signaling a transition from networks that merely employ AI to networks that are AI-driven at their structural core. Realizing this vision necessitates a new architectural foundation. In this emerging paradigm, the network evolves from a passive data transport mechanism into an active, intelligent, and distributed computational fabric, capable of interpreting, acting upon, and generating value from data. To achieve this transformation, legacy monolithic architectures must be replaced by highly modular and adaptive designs, ensuring resilience and scalability for unforeseen requirements.

The following sections outline the foundational architectural pillars driving this transformation. These pillars encompass frameworks for AI/ML Life-Cycle Management (LCM), Evolved Service-Based Architecture (SBA), Unified Data Fabric, and Intelligent Network Control / Management Plane, which together enable the evolution toward a fully intelligent, context-aware, and self-optimizing network infrastructure. Next, we will examine the key technical enablers and their respective roles in this journey. Finally, the discussion will address integration challenges and explore standardization pathways essential to realizing this vision.

The Core Architectural Pillars of 6G Intelligence

The strategic importance of establishing new architectural pillars for 6G cannot be overstated. These are not incremental updates to existing 5G structures; they are fundamental constructs designed to support an AI-native system where intelligence is a built-in, pervasive capability rather than an add-on function. This architectural reimagining is essential for transforming the network from a passive data conduit into an active, intelligent, and distributed system.

These four pillars form an integrated and interconnected system that defines the network's architectural vision. At the core, the **AI/ML Life-Cycle Management Framework** drives continuous intelligence and automation across all layers. Building on this, the **Evolved Service-Based Architecture** provides a flexible, cloud-native foundation for deploying advanced capabilities. Acting as the system's circulatory network, the **Unified Data Fabric** ensures seamless access to high-quality data, the lifeblood powering intelligent operations. Finally, the **Intelligent Network Control Plane** orchestrates these components, transforming the network from a collection of isolated functions into a unified, adaptive, and cohesive architecture.

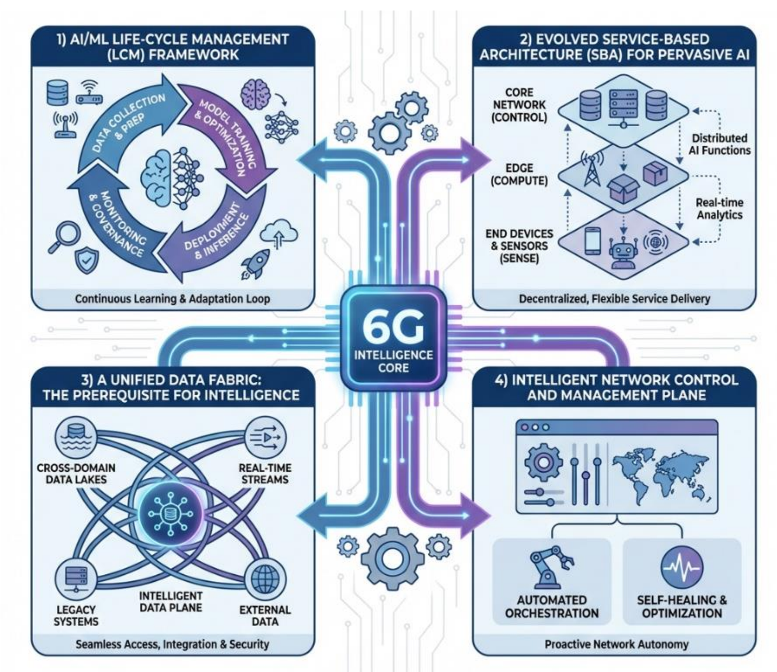


Figure 2: Core Architectural Pillars of 6G Intelligence.

The AI/ML Life-Cycle Management (LCM) Framework

For AI to become a native component of the network, a standardized framework for managing the entire lifecycle of AI and Machine Learning (ML) models, from their creation and training to their deployment, monitoring, and eventual retirement, is a critical necessity. The 3rd Generation Partnership Project (3GPP) has defined such a framework in TR 38.843, which consists of five logical blocks:

Management: This central entity coordinates the operations of the other blocks, closing the performance-governance loop by monitoring model performance and triggering necessary actions like retraining or fallback.

Data Collection: This block gathers the vast amounts of network data required for training, validating, and monitoring AI/ML models.

Model Training/Adaptation: This function is responsible for training new models or adapting existing ones based on fresh data to counteract performance degradation or "model drift."

Model Storage: A repository for storing various versions of AI/ML models, making them available for deployment across the network.

Inference: The block where a deployed model executes its task, such as predicting beam direction or compressing channel state information (CSI).

This comprehensive LCM framework represents a profound evolution from the centralized, analytics-as-a-service model of 5G's **Network Data Analytics Function (NWDAF)**.

In 6G, this structured approach democratizes intelligence, enabling AI/ML to be safely managed as a native, distributed capability within every network domain, not just as a specialized analytics function.

Evolved Service-Based Architecture (SBA) For Pervasive AI

6G will significantly evolve the Service-Based Architecture (SBA) that was first introduced in the 5G Core network. This evolution is characterized by the extension of service-based principles to the Radio Access Network (RAN), a move that fundamentally redefines the RAN from a monolithic entity into a flexible, cloud-native collection of microservices, creating a more agile and modular end-to-end architecture. By refactoring traditional RAN functions into discrete, reusable network function services, the system can dynamically compose and deploy new capabilities, including AI-powered services.

This extension of the SBA to the RAN is strategically critical because it promises to break the vendor lock-in that has historically characterized the radio access domain, fostering a more competitive and innovative ecosystem of specialized function providers.

However, as 3GPP SA5 discussions highlight, this architectural evolution presents a critical challenge: striking the right balance between the flexibility offered by disaggregation and the necessity of ensuring multi-vendor interoperability. While a highly modular architecture fosters innovation, it risks market fragmentation if interfaces are not clearly and robustly standardized. The evolved SBA is thus positioned as the agile foundation that enables the dynamic composition and deployment of AI-powered services, but its success hinges on a carefully managed standardization process.

A Unified Data Fabric: The Prerequisite for Intelligence

Data is the lifeblood of AI and is rightly described as the "prerequisite enabler for many intelligent management technologies in 6G." To fuel the pervasive intelligence of the 6G system, a unified data framework operating across all network domains, from the core to the RAN and the edge, is an essential architectural requirement. This data fabric is the foundational layer necessary to support an AI-native architecture, distributed AI Agents, and sophisticated simulation tools like Network Digital Twins (NDT).

The importance of this unified data access is exemplified in 6G use cases currently under study in 3GPP TR 22.870. One such use case involves Retrieval-Augmented Generation (RAG), where the 6G data fabric exposes network knowledge (e.g., performance statistics, coverage maps, fault information) to authorized third-party Generative AI models. This allows these external AI systems to provide more accurate and context-aware responses by augmenting their prompts with real-time, reliable network data.

Intelligent Network Control and Management Plane

6G marks a decisive shift away from the isolated analytics functions of 5G toward a pervasively intelligent control and management plane. In this new paradigm, potentially every network function is AI-powered, enabling a holistic and automated approach to network operations. As proposed in 3GPP SA5 discussions, an "Intelligent Network Controller framework" will orchestrate these capabilities. This framework is conceptualized around several key components, each representing a distinct axis of intelligent automation:

AI/ML Workflows: These are automated processes that orchestrate complex decision-making sequences, leveraging multiple AI models and data sources to manage network resources and services without human intervention.

Network Digital Twin (NDT): A virtual replica of the network used for emulation, simulation, and predictive analysis. The NDT allows operators to test configuration changes, predict the impact of new services, and model failure scenarios in a safe, offline environment.

Large Language Models (LLMs): Integrated into the management plane, LLMs will enable advanced intent-based management, allowing operators to issue commands and define policies using natural language, which the network can then interpret and execute automatically.

While these four pillars define the network's structural blueprint, their realization depends on a suite of specific technical enablers, the functional building blocks that translate this architectural vision into operational capabilities.

Key Technical Enablers and Their Role

The architectural pillars of 6G are realized through a suite of key technical enablers. These technologies are not merely theoretical constructs but are being actively defined and refined within 6G service requirement studies to address concrete use cases. They represent the functional building blocks that will deliver the network's native intelligence. We will discuss AI agents, Network Digital Twins, and Programmable Interfaces and Third-Party Integration in the next section.

AI agents and intent-driven orchestration

As defined in 3GPP TR 22.870, an **AI Agent** is an automated intelligent entity capable of interacting with its environment, acquiring contextual information, reasoning, and executing tasks autonomously to achieve a specific goal. In the 6G ecosystem, these agents will function as autonomous actors, responsible for managing network resources, optimizing service delivery, and collaborating with other agents to complete complex, multi-domain tasks.

For example, one agent might monitor energy consumption in the RAN, while another manages computational resources at the edge, and they could collaborate to shift workloads to minimize the network's overall carbon footprint.

Definition in TR 22.870

In a 3GPP SA1 contribution (S1-252481), an **"AI Agent"** is defined with the following characteristics:

"An automated intelligent entity capable of interacting with its environment, acquiring contextual information, reasoning, self-learning, decision-making, executing tasks (autonomously or in collaboration with other AI Agents) to achieve a specific goal."

The draft also notes that this definition may evolve throughout the study.

To ensure this collaborative ecosystem can function, a critical requirement identified in IETF discussions is the need for standardized communication protocols and a robust identity management framework. These standards will ensure seamless interoperability, allowing AI Agents from different vendors and network domains to discover, authenticate, and interact with one another securely and efficiently.

Network Digital Twins (NDT): Simulating for Optimization and Resilience

A **Network Digital Twin**, defined in 3GPP TR 22.870 as a "virtual replica of (part of) a mobile network to emulate (or simulate) the behaviour of the actual network," provides a powerful tool for network management and optimization. By creating a high-fidelity, real-time model of the live network, operators gain a risk-free environment to test, predict, and plan. The strategic value of NDTs lies in several primary applications:

Proactive Security Operations: NDTs allow operators to conduct vulnerability scanning and penetration testing in the virtual replica *before* applying security patches or configuration changes to the live network, significantly reducing the risk of unintended consequences.

Performance Optimization: Operators can simulate the impact of new software releases, configuration changes, or the deployment of a new network slice on the NDT to fine-tune performance and ensure service level agreements are met.

Resilience Planning: By modeling network behaviour under various failure conditions (e.g., a fiber cut or base station outage), NDTs help operators design and validate more effective and rapid recovery strategies, enhancing overall network resilience.

Programmable Interfaces and Third-Party Integration

A core strategic goal for 6G is to move beyond a closed, monolithic system and become an open, programmable platform for innovation. The 6G intelligent framework is being designed with this in mind, with a strong emphasis, highlighted by leading operators and vendors in 3GPP 6G workshops, on exposing developer-friendly Application Programming Interfaces (APIs).

These APIs will enable authorized third-party applications to be onboarded, and their lifecycles managed in a standardized way. This fosters a vibrant ecosystem of innovation, allowing external developers to create new intelligent services that leverage the network's unique capabilities, such as sensing data, real-time location information, or AI model inference.

These applications can be deployed flexibly, either centrally in the cloud or distributed at the network edge to meet specific latency and performance requirements. This API-driven programmability signals a strategic pivot for network operators: from providing mere connectivity to becoming true platform enablers, monetizing network intelligence and capabilities by fostering an application ecosystem akin to the mobile OS app stores.

Telecom World Models: The Foundation of Intelligent Networks

The next generation of communication networks will need to move beyond reactive automation toward predictive intelligence. Today’s networks can monitor, diagnose, and optimize after events occur, but intelligent networks must be able to anticipate what is likely to happen before it happens. A Telecom World Model provides this capability by learning how network conditions, user behavior, traffic demand, radio environments, services, and control actions evolve over time. Rather than treating the network as a collection of isolated functions, it offers a unified predictive representation of the telecom system and its surrounding environment.

Telecom World Models can serve as the cognitive foundation that connects data, simulation, AI agents, and network control. Digital twins can provide high-fidelity validation, foundation models can interpret intent and coordinate tools, and optimization engines can search for better policies. The world model sits at the center of this ecosystem by enabling the network to imagine alternative futures: what happens if capacity is reallocated, if a failure occurs, if traffic suddenly shifts, or if a new service is admitted? This ability to evaluate possible outcomes before acting is essential for safe automation, efficient resource use, and resilient service delivery.

In the longer term, Telecom World Models may become a core abstraction for AI-native 6G and beyond networks. They can enable networks that are not only self-monitoring and self-optimizing, but also self-anticipating: able to reason about uncertainty, explain trade-offs, and adapt decisions to changing goals and environments. Such models will help transform network intelligence from a collection of task-specific AI tools into a coherent decision-making layer, supporting autonomous operations while preserving human oversight, trust, and accountability.

6G RAN as an AI Platform

The 6G Radio Access Network (RAN) marks a significant evolution from 5G, transforming into an AI-native, sensing-enabled, and highly disaggregated system focused on intelligent, adaptive wireless communication. It integrates new spectrum bands, advanced physical layer technologies, and cloud-native architectures to meet extreme performance and sustainability goals.

RAN evolution and architecture: 6G RAN advances 5G foundations by introducing fully AI-native control, deeper disaggregation, and native support for sensing and non-terrestrial functions, shifting from reactive to predictive autonomous optimization and expanding spectrum use to sub-THz bands. It also ensures continuity by reusing existing infrastructure and enabling gradual software-defined upgrades.

Multi-layer spectrum and design challenges: The 6G RAN employs a multi-band spectrum strategy with sub-6 GHz for coverage, FR3 (7–24 GHz) as the primary capacity layer, mmWave for dense hotspots, and sub-THz for ultra-short-range high data rates. Challenges such as path loss, blockage, and uplink limitations are addressed with advanced antennas, intelligent beam management, and AI-driven control.

Physical layer and AI-native operation: The physical layer remains OFDM-based but includes enhancements like wider bandwidths, giga-MIMO antenna arrays, advanced coding, and AI-assisted waveform adaptation. AI is embedded to dynamically optimize modulation, beamforming, spatial multiplexing, and interference coordination, enabling non-static, intelligent performance. The RAN transitions from rule-driven SON to autonomous, intent-based, continuous learning systems with two-sided AI intelligence on both network and device sides.

Sensing, open architecture, and sustainability: 6G RAN introduces integrated sensing for positioning, object detection, and adaptive coverage, improving outdoor planning accuracy. It continues open, disaggregated RAN trends with functional separation, open interfaces, and cloud-native deployment, requiring enhanced synchronization and AI workload management. Energy efficiency aims for 10–100× improvement through AI-driven sleep modes, RIS-assisted propagation, and traffic-aware resource activation, supporting operator goals of lower OPEX and sustainability.

6G Radio Access Network (RAN): Architecture, Evolution, and Strategic Implications

The Radio Access Network (RAN) is undergoing its most profound transformation since the introduction of cellular systems. In the sixth generation of mobile communications (6G), the RAN evolves from a primarily radio-transmission-centric subsystem into an AI-native, sensing-enabled, and highly disaggregated platform. We will focus on the 6G RAN, and architectural principles, with emphasis on spectrum evolution, physical layer innovation, AI-native operation, and deployment implications for mobile network operators. For operators such as *du*, where dense urban coverage, outdoor capacity, and energy efficiency are strategic priorities, the 6G RAN represents both a continuity of 5G investments and a structural shift toward intelligent, software-defined, and cloud-integrated radio networks.

Why RAN Is Central to 6G

Mobile network evolution traditionally focused on throughput, latency, and spectral efficiency. Current configuration options in the user plane do not support a range of performance that allows the device to match App requirements. Standard is defined to produce predictable performance and simple compliance test of protocol functions instead of allowing flexibility to adapt to various scenarios. 6G introduces a paradigm shift:

"The defining feature of 6G is not faster radio - it is smarter radio".

While previous generations placed architectural emphasis on the core network, 6G places the RAN at the center of system intelligence. The RAN is no longer a passive endpoint delivering bits, but an active participant in perception, decision-making, and service optimization. This shift is driven by:

- Extreme performance targets (sub-0.1 ms latency, Tbps peak rates)
- Expansion into new spectrum ranges (7–24 GHz and sub-THz)
- Native integration of artificial intelligence and sensing
- The need for sustainable, energy-efficient networks

In 6G, the RAN becomes a context-aware and intent-driven system, tightly coupled with edge computing and cloud-native control.

Evolution from 5G RAN to 6G RAN

Architectural Evolution

5G RAN introduced virtualization, functional splits, and cloud-RAN concepts. While many of the foundational concepts envisioned for next-generation networks—such as cloud-native RAN, Massive MIMO (mMIMO**),** and advanced automation—were introduced as part of 5G, their deployment in current networks has not yet reached full maturity or realized their complete potential. In practice, 5G implementations often reflect transitional architectures, where cloud adoption remains partial, with workloads still anchored to dedicated hardware, and mMIMO deployments are constrained by cost, energy consumption, and suboptimal coordination across cells. 5G-Advanced builds on this foundation by improving efficiency, scalability, and intelligence, but still operates within the boundaries of evolutionary enhancements. The transition to 6G will unlock the full potential of these concepts by enabling truly cloud-native, distributed, and AI-native RAN architectures, alongside fully optimized ultra-massive MIMO systems with tighter coordination and higher spectral efficiency. In this context, 6G should be viewed not as a departure from 5G, but as the stage where the original 5G vision is fully realized and extended, supported by advances in compute, data, and intelligent control frameworks. 6G extends these foundations toward:

- Fully AI-native RAN control loops
- Deeper disaggregation and open interfaces
- Native support for non-terrestrial and sensing functions

Dimension	5G RAN	6G RAN
Control	Policy-based	AI-native, intent-driven
Optimization	Reactive	Predictive & autonomous
Spectrum	Sub-6 + mmWave	Sub-6, FR3 (7–24 GHz), sub-THz
Role	Data transmission	Communication + sensing + intelligence

Continuity with Existing Deployment

Importantly, 6G RAN is not a disruptive replacement. It is designed to:

- Reuse existing site grids and transport infrastructure
- Enable multi-RAT and multi-band coexistence
- Support gradual introduction via software-defined upgrades

This continuity is critical for operators managing dense outdoor macro and small-cell layers.

6G RAN is not being defined as greenfield nor replacement of existing mobile networks, but rather as a natural evolution of mature 5G and 5G-Advanced (5G-A) deployments. By the time 6G is introduced, operators will already operate dense macro and small-cell grids, high-capacity transport networks, and software-centric RAN platforms established during the 5G-A phase. The 6G vision explicitly builds on this foundation, ensuring continuity of radio planning, transport architecture, and spectrum utilization, while protecting recent investments made in 5G and 5G-Advanced networks.

From a deployment and planning perspective, 6G emphasizes reuse, coexistence, and gradual capability introduction. Existing site grids and transport infrastructure are expected to remain the anchor for future evolution, with long-term multi-RAT and multi-band coexistence across LTE, 5G, 5G-Advanced, and 6G layers. New 6G capabilities will be introduced progressively, largely through software upgrades and selective hardware evolution aligned with asset lifecycles. This approach enables operators managing dense outdoor macro and small-cell networks to transition from 5G-Advanced to 6G in a predictable, cost-efficient, and operationally stable manner, avoiding repeated large-scale replanning cycles.

The target date for "Technology proposals for IMT-2030" has been defined by ITU to be early 2029, and resulting specifications (i.e. full system definition) are to be submitted by mid-2030 at the latest.

Spectrum and RAN Implications

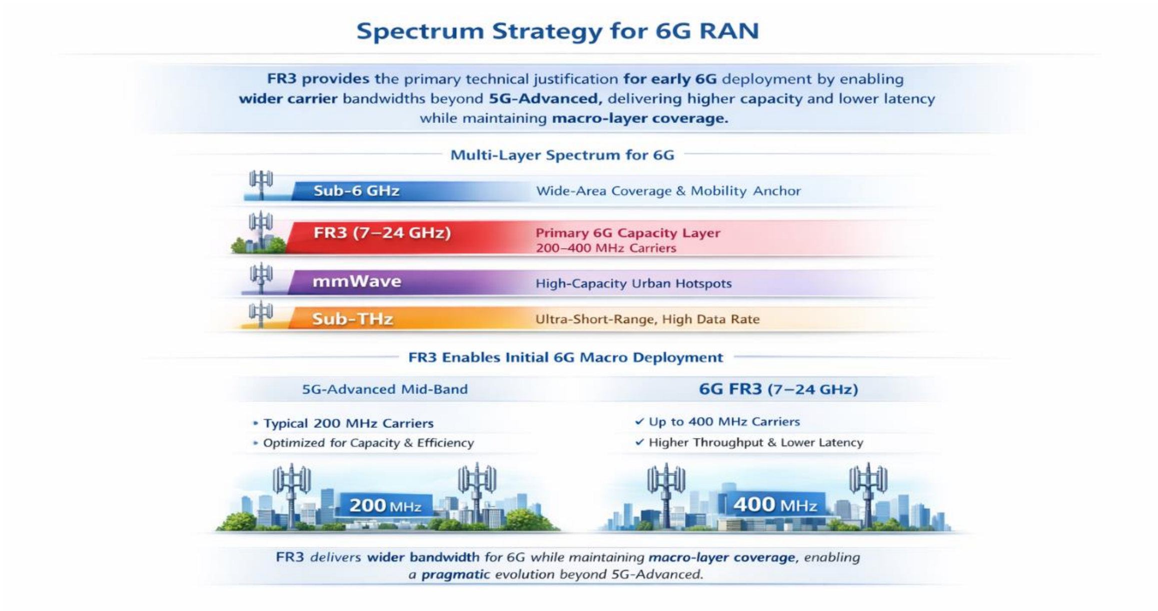
Multi-Layer Spectrum strategy

In line with emerging IMT-2030 (6G) framework principles, 6G RAN is expected to adopt a multi-layer spectrum architecture, in which each frequency range serves a defined and complementary role within the overall radio access network:

- Sub-6 GHz: Wide-area coverage layer, mobility anchor, and uplink reliability
- FR3 (7–24 GHz): Primary wide-area capacity layer, balancing propagation characteristics and increased bandwidth availability
- mmWave (24–90 GHz): High-capacity layer for localized dense traffic environments
- Sub-THz (90–300 GHz): Ultra-short-range layer targeting extremely high data-rate and sensing-oriented use cases

For a justified and scalable 6G rollout, it is essential that 6G introduces tangible performance advancements beyond those already delivered by 5G-Advanced, which is itself highly optimized through advanced MIMO, AI-assisted RAN functions, and software-driven enhancements. In this context, FR3 is expected to play a foundational role in enabling early 6G differentiation, in a manner analogous to the role of C-band in initial 5G macro deployments.

While 5G-Advanced Sub6 Ghz deployments typically operate within 100 MHz carrier components bandwidths with aggregating capability in the ~300 MHz range, 6G will enable the evolution toward wider contiguous carriers, from 200MHz to 400 MHz carrier components bandwidth, with aggregating capability in the ~1000 MHz range providing the technical basis for higher user throughput, improved spectral efficiency, and reduced latency through increased capacity headroom. Importantly, these gains can be realized while maintaining coverage characteristics compatible with existing macro site grids, making FR3 the most pragmatic, spectrum-efficient, and regulator-aligned option for initial wide-area 6G deployment, ahead of broader reliance on higher-frequency bands with more constrained propagation.



As such, FR3 U6G band represents the most practical and spectrum-efficient foundation for early 6G macro deployment, providing a clear advancement beyond 5G-Advanced capabilities.

RAN Design Challenges

Operation in higher-frequency spectrum such as FR3 introduces fundamental RAN design challenges driven by propagation physics, including increased path loss, higher sensitivity to blockage, and more constrained uplink coverage compared to sub-6 GHz bands. In addition, mobility in FR3 environments becomes increasingly beam-centric, requiring accurate beam tracking, fast adaptation, and tighter coordination between radio layers.

To enable macro-layer 6G deployment in FR3, these limitations must be mitigated through significant advancements beyond current 5G-Advanced RAN designs. This includes the use of higher-order massive MIMO configurations, extremely large antenna arrays (ELAA), and enhanced beamforming and beam-management techniques to compensate for propagation loss and sustain wide-area coverage. Initial trials with 128T128R active antenna units (AAUs) incorporating up to 784 antenna elements have demonstrated the feasibility of such approaches from a radio-performance perspective. However, these trials have also highlighted practical deployment constraints, particularly increased AAU size and weight leading to tower loading and site-engineering challenges.

As a result, achieving scalable FR3 macro coverage will require not only antenna and beamforming innovation, but also optimized AAU form factors, advanced materials, higher MIMO mode UEs 4x4 being minimum, and architectural trade-offs, complemented by carrier aggregation with existing Sub6Ghz (C-band) spectrum. Such aggregation enables FR3 coverage extension toward C-band-like macro characteristics, allowing FR3 to deliver the primary capacity expansion while supporting a pragmatic and deployable 6G macro-layer strategy on existing site grids.

Field Trials and testing

Technical detail

The field tests were conducted in two types of live environments: outdoor and indoor. The outdoor test measured throughput in a suburban base station site in Mohamed Bin Zayed, Abu Dhabi, UAE. Indoor measurements were made at Commercial compound in nearby base station (100m to 200 m). The tests compared the performance of the upper 6 GHz and 3.6 GHz radios deployed on the same base station structure, using license reserved for du in the range of 6.775 GHz–7.125 GHz of the upper 6 GHz band. The pre-commercial concept radios and user equipment used for the upper 6 GHz band have limitations as compared to the commercial equipment used for the 3.6 GHz band, not having yet undergone full performance optimization and validation. Future standardized commercial equipment for the n104 band (6425–7125 MHz) will have significantly improved performance over current pre-commercial equipment. Additionally, the test was limited to carrier component channel bandwidth of 100 MHz due to device test limitation.

Base station characteristics

Radio Configuration and Test Methodology:

The field trial employed Massive MIMO radio units representative of both an advanced FR3 U6G band concept design and a commercial Sub6Ghz band baseline. Specifically, the upper 6 GHz layer was implemented using a conceptual Massive MIMO Active Antenna Unit (AAU) with 128 transmit/receive chains (128TRX), while the 3.6 GHz reference layer utilized a commercially deployed Massive MIMO AAU with 64 transmit/receive chains (64TRX).

Both radio systems were configured to operate with Sounding Reference Signal (SRS)–based beamforming, which is a fundamental mechanism for Massive MIMO operation. SRS-driven beamforming enables accurate uplink channel acquisition and reciprocity-based downlink beam optimization, thereby extending cell coverage, improving user-experienced throughput, and enhancing spectral efficiency.

For the purpose of ensuring a fair and technically consistent comparison, the carrier bandwidth was set to 100 MHz for both frequency bands. This bandwidth selection was constrained by the capabilities of the available test user equipment and does not reflect the maximum achievable bandwidth of the upper 6 GHz band.

Beamforming Validation and Measurement Integrity:

To ensure measurement validity and comparability between the two frequency bands, a beamforming verification procedure was conducted at every measurement location. This procedure assessed the effectiveness of SRS-based beamforming on both the upper 6 GHz and 3.6 GHz radios, confirming correct beam selection, beam tracking, and link adaptation behavior.

This validation step was critical to exclude performance deviations arising from beamforming misconfiguration or sub-optimal spatial adaptation. The analysis confirmed that both radios were operating under comparable beamforming conditions, thereby endorsing the reliability of the collected performance measurements. As a result, the observed differences and similarities between the upper 6 GHz and 3.6 GHz bands can be attributed to intrinsic propagation characteristics and radio frequency behavior rather than implementation artifacts.

Bandwidth Extrapolation Towards 6G-Oriented Operation:

While the measurements were conducted using a 100 MHz carrier, it is recognized that future 6G systems targeting the upper-band spectrum FR3 and above are expected to support a minimum carrier component bandwidth of at least 200 MHz, consistent with ongoing 3GPP studies and early 6G requirements [11].

To align the trial insights with this anticipated 6G operating paradigm, the measured results were extrapolated to estimate performance trends for wider bandwidth configurations in the upper 6 GHz band. This extrapolation provides an indication of the additional capacity and throughput gains that can be achieved when leveraging the full spectral potential of the band under large-bandwidth operation.

The detailed technical specifications and key parameters of the deployed gNodeB during the field trials are summarized in the table below.

Table 1. gNodeB main parameters configurations:

gNodeB parameters	**Upper 6 GHz concept radio**	**3.6 GHz commercial radio**
Frequency range	6425–7125 MHz	3600–3700 MHz
Bandwidth	100 MHz	100 MHz
Subcarrier spacing	30 Khz	30 Khz
Tx/Rx channel	128x128	64x64
Maximum effective isotropically radiated power (EIRP)	77.2 dBm	77.2 dBm
Antenna gain	30 dBi	24.5 dBi
Number of antenna elements	768	192
TDD frame structure	DDDSU	DDDSU
Antenna height (ACL)	20 m	20 m

Terminal characteristics

The pre-commercial user equipment employed in the trial was equipped with integrated omnidirectional antennas supporting both the 3.6 GHz and upper 6 GHz frequency bands. Identical RF and operational parameters were applied across both bands to ensure a consistent and unbiased performance comparison.

Table 2. Test UE main parameters configurations:

Test UE parameters	**Upper 6 GHz concept radio**	**3.6 GHz commercial radio**
Tx/Rx channel	2Tx/4Rx	2Tx/4Rx
Max transmit power	24dBm (250mw)	24dBm (250mw)

Network traffic generation and performance verification were conducted using the iPerf tool operating over the Transmission Control Protocol (TCP)**.** In a TCP session, reliable data transfer is ensured through acknowledgment signaling, whereby each successfully received packet is confirmed by the receiver. Accordingly, when downlink TCP data packets were received by the user equipment, corresponding uplink acknowledgements were transmitted back to the iPerf server. At each measurement location**,** multiple iPerf TCP throughput measurements were executed in both downlink and uplink directions to robustly capture the key performance metrics of the radio link.

Suburban outdoor-to-outdoor

The outdoor-to-outdoor (O2O) evaluation assessed the performance of the upper 6 GHz concept radio against that of a commercial 3.6 GHz radio within the same suburban environment in Mohamed bin Zayed City, Abu Dhabi. Both radio units were co-sited on the same macro location, with their principal radiation beams oriented toward the surrounding residential area. Figures 2 and 3 illustrate the base-station location and delineate the geographical extent of the trial area.

Figure 2. Suburban COW site with upper 6 GHz and 3.6 GHz radios

Received signal performance was validated by generating controlled traffic flows at the test terminal using the iPerf application over TCP. Downlink signal levels were recorded at receiver locations ranging from 55 m to 500 m from the serving base station, covering representative propagation conditions. The measurement campaign included:

- Line-of-sight (LOS) links over distances of 55–500 m
- Non-line-of-sight (NLOS) links over distances of 170–370 m

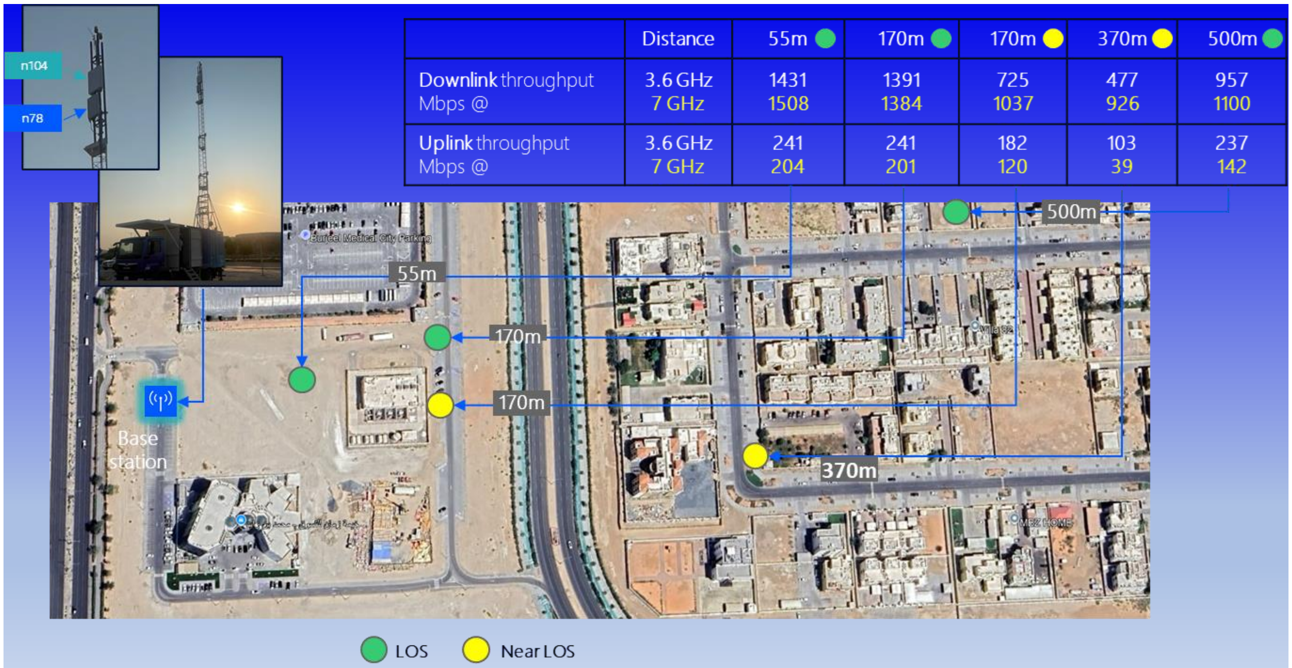


Figure 3. Field test measurement of UE from COW (cell on Wheel) site

Field measurement results:

For the stationary measurements, the test terminal was hand-carried by a drive-test engineer during a walk-test campaign, as illustrated in Figure 4. At each predefined measurement point, the user equipment (UE) was held stationary for the duration of the test to ensure stable and repeatable measurement conditions.

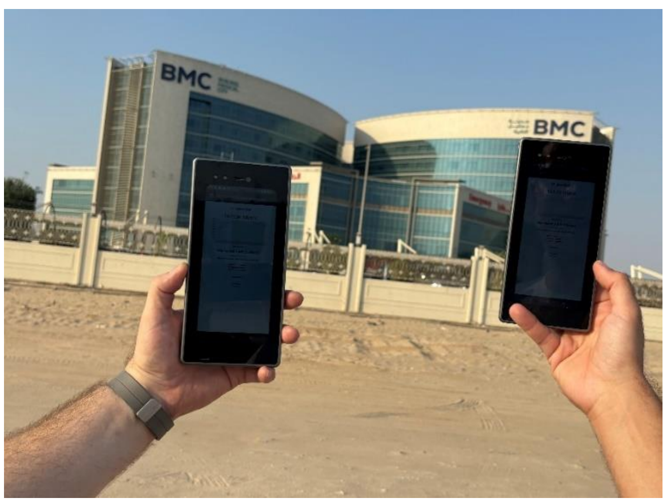


Figure 4. UE Test terminal position in O2O test

Average measured values for downlink throughput are illustrated in Figure 5:

- Under line-of-sight (LOS) conditions, the average downlink throughput measured in the upper 6 GHz and 3.6 GHz bands was generally comparable. A slight performance advantage was observed for the upper 6 GHz band, which is attributed to the interference-limited conditions affecting the 3.6 GHz measurements, caused by signal leakage from surrounding operational commercial cells sharing the same frequency band. In contrast, the upper 6 GHz trial operated in a comparatively cleaner interference environment.
- Under non-line-of-sight (NLOS) conditions**,** the downlink throughput achieved in the upper 6 GHz band followed the expected propagation trend. This behavior is consistent with the higher path loss at upper-mid-band frequencies, while noting that the 3.6 GHz results were concurrently constrained by inter-cell interference, caused by signal leakage from surrounding operational commercial cells sharing the same frequency band. In contrast, the upper 6 GHz trial operated in a comparatively cleaner interference

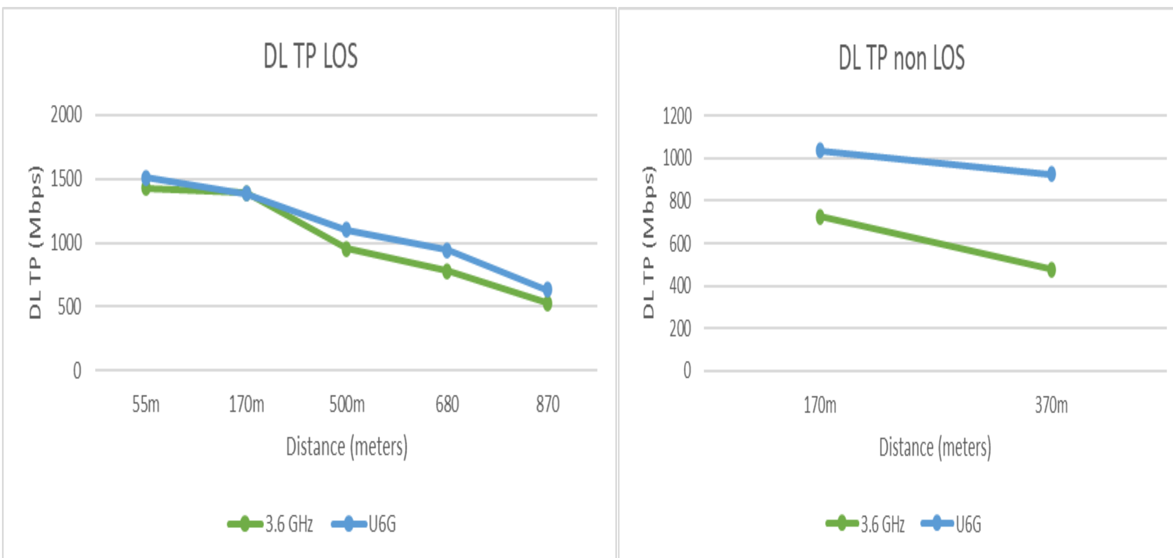


Figure 5. Downlink LOS and non-LOS test results

The average uplink throughput results, as presented in Figure 6, demonstrate solid performance of the upper 6 GHz band. Under line-of-sight (LOS) conditions. Under non-line-of-sight (NLOS) conditions, the corresponding uplink throughput in the upper 6 GHz band was around 65% of the 3.6 GHz reference level.

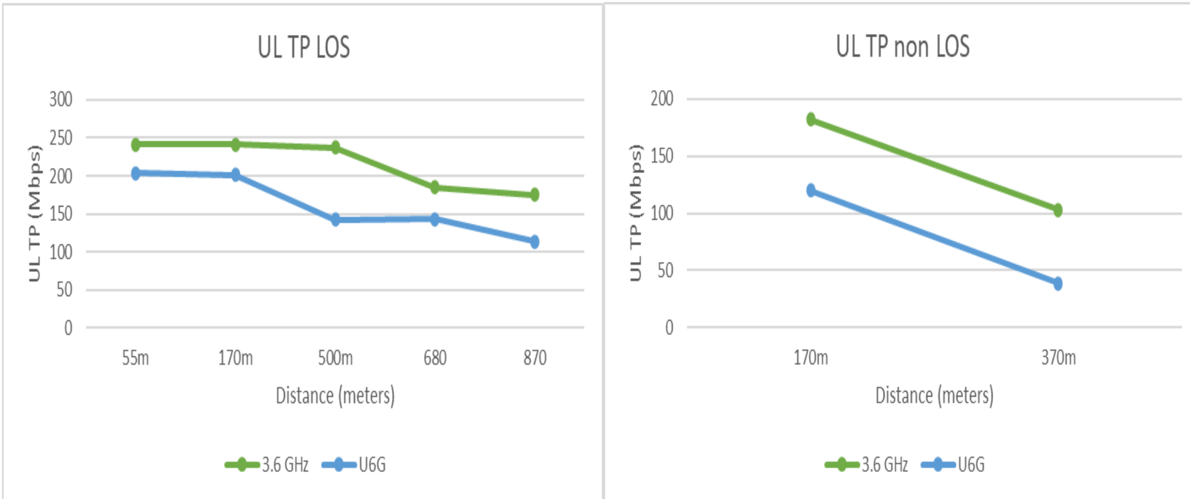


Figure 6. Uplink LOS and non-LOS test results

When evaluated under a typical macro-cell configuration, employing a 100 MHz carrier and an effective radiated power of 77.2 dBm normalized to 100 MHz, the measurement outcomes confirm that the upper 6 GHz layer behaves consistently with radio-theoretical expectations. The empirical results further demonstrate that, when deployed under like-for-like conditions, the upper 6 GHz band can replicate the coverage footprint and capacity characteristics traditionally associated with the 3.6 GHz band.

- **Macro-range behavior:** Measurements show that the upper 6 GHz layer maintains parity with the 3.6 GHz band in terms of both coverage reach and capacity, sustaining equivalent outdoor performance out to approximately 500 m from the macro base-station antenna.
- **Distance resilience:** Even beyond the mid-cell region, the upper 6 GHz downlink exhibits robust behavior, continuing to deliver stable performance from 370 m up to 500 m, confirming its suitability for wide-area macro-operation.
- **Capacity potential:** At shorter link distances, the trials recorded peak outdoor downlink rates approaching 1.5 Gbps.

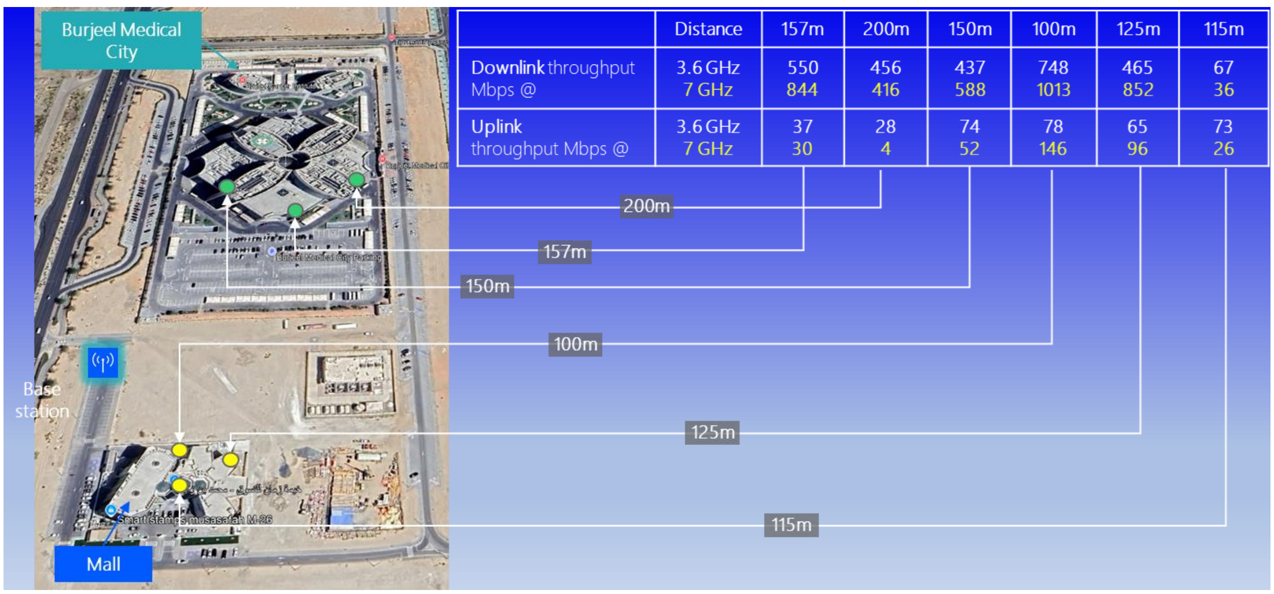
These results validate that, when paired with high-power Massive MIMO antenna systems, the upper 6 GHz band can deliver substantial incremental capacity while preserving macro-cell coverage on an existing 5G site grid. Collectively, the findings support a seamless site-level evolution toward 6G, leveraging the 6–7 GHz spectrum range as a high-capacity extension of current mid-band deployments.

Suburban Outdoor-to-indoor

The field trial conducted in the Burjeel Medical City / Mall area, where downlink and uplink performance of the upper 6 GHz band was evaluated against the commercial 3.6 GHz band at multiple indoor measurement locations. The test points were distributed at distances ranging from approximately 100 m to 200 m from the serving macro base station, covering representative suburban indoor propagation conditions.

The measured results indicate that, across most test locations, the upper 6 GHz band achieved downlink throughputs comparable to those of the 3.6 GHz band**,** particularly at shorter and mid-range distances. Peak downlink rates above 1 Gbps were observed in the upper 6 GHz band at close-in locations, demonstrating the strong capacity potential enabled by the wider spectrum and Massive MIMO beamforming. Performance advantage was observed for the upper 6 GHz band, which is attributed to the interference-limited conditions affecting the 3.6 GHz measurements, caused by signal leakage from surrounding operational commercial cells sharing the same frequency band. In contrast, the upper 6 GHz trial operated in a comparatively cleaner interference environment.

Uplink throughput measurements show that the upper 6 GHz uplink performance followed expected trends, remaining lower than 3.6 GHz in several locations due to higher path loss and UE power constraints, while still delivering usable uplink data rates across the trial area.



	Distance	157m	200m	150m	100m	125m	115m
Downlink throughput Mbps @	3.6 GHz 7 GHz	550 844	456 416	437 588	748 1013	465 852	67 36
Uplink throughput Mbps @	3.6 GHz 7 GHz	37 30	28 4	74 52	78 146	65 96	73 26

Figure 7. O2I measurement points

Indoor walk test measurements results:

Figure 8 presents the measured downlink and uplink throughput results from the outdoor-to-indoor (O2I) evaluation.

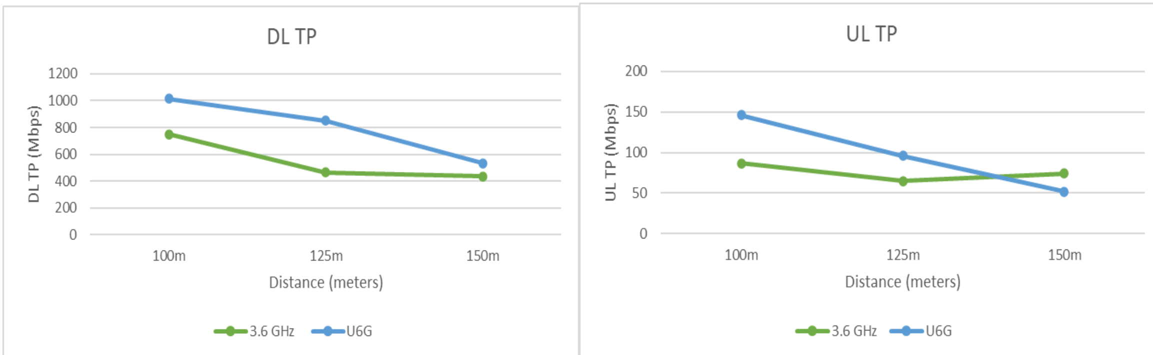


Figure 8. O2I throughput measurements

Overall, the spatial distribution of results confirms that the upper 6 GHz band can effectively support indoor propagation for macro coverage within a typical 5G site grid. The trial highlights the feasibility of deploying upper 6 GHz as a macro capacity layer, delivering substantial downlink gains while maintaining acceptable uplink performance across realistic deployment distances.

Summary of field measurements results:

The measurement campaigns conducted across the two test locations consistently demonstrate that the upper 6 GHz band is well suited for macro-cellular outdoor deployment. The results confirm that this spectrum can simultaneously extend coverage and unlock substantial additional capacity for mobile networks, while also providing effective service continuity for indoor users in proximity to the macro layer.

Although the trial was subject to practical constraints, such as the use of pre-commercial radio prototypes and commercial 3.6Ghz cells surrounding trial area causing intercell interference, the observed performance clearly indicates that upper-mid-band spectrum represents a credible and scalable solution to address the forecast growth in mobile data demand. As traffic volumes continue to rise due to the surge in AI usage in unprecedented way as per 2024 Omdia study [12], these bands will play a central role in expanding radio network capacity beyond what is achievable with today's Sub6Ghz band allocations alone.

Looking ahead, the introduction of commercial-grade upper 6 GHz radio equipment, featuring higher-order Massive MIMO antenna systems, extremely large antenna elements, and wider carrier component channel bandwidths, is expected to deliver performance gains beyond those recorded in this trial. This evolution will enable operators to realize significant capacity expansion while reusing the existing macro-cell site grid**,** supporting fast, cost-efficient, and environmentally sustainable network rollouts.

Field measurements performed with an upper 6 GHz carrier bandwidth of 100 MHz, normalized to an equivalent maximum EIRP of 77.2 dBm per 100 MHz, demonstrated outdoor coverage distances of up to 500m**,** together with peak outdoor downlink rates approaching 1.5 Gbps at shorter ranges. Complementary indoor evaluations conducted at distances of up to 100 m achieved peak indoor downlink throughputs of approximately 1 Gbps, while maintaining solid uplink performance.

Taken together, these results reinforce the role of the upper 6 GHz band as a high-capacity macro extension**,** enabling a smooth and practical evolution of existing 5G networks toward future 6G deployments.

Significant potential for 6G networks: Extrapolation of test results for larger bandwidths

By extrapolating the upper 6 GHz measurement results to a 200 MHz carrier bandwidth with an equivalent maximum EIRP of 77.2 dBm per 100 MHz, the analysis indicates that peak data rates exceeding 3 Gbps are achievable in both outdoor and indoor scenarios. Such performance levels would enable mobile operators to efficiently absorb the additional radio capacity demands anticipated over the remainder of the decade. In very deep indoor environments, overall uplink performance can be further optimized through carrier aggregation (CA) between the 3.6 GHz and upper 6 GHz layers**,** combining coverage robustness with added capacity.

Looking toward the 2030 timeframe, du considers that the successful introduction of 6G must deliver a clear performance uplift beyond advanced 5G capabilities. Consequently, operation in FR3 and higher frequency ranges will necessitate a minimum carrier component bandwidth of 200 MHz to fully realize the expected gains of next-generation radio systems.

From this perspective, the availability of the upper 6 GHz band with at least 200 MHz of contiguous spectrum per operator is viewed as a key prerequisite. Narrower bandwidth allocations would significantly diminish the attractiveness of the band and reduce spectral efficiency. In line with this assumption, throughput values were normalized to a 200 MHz carrier bandwidth**.** The corresponding Massive MIMO performance figures—assuming four downlink layers and two uplink layers—are derived using a maximum EIRP of 80 dBm per 200 MHz**,** thereby preserving the same power spectral density applied in the 100 MHz evaluations.

The resulting normalized throughput outcomes for 200 MHz carrier component bandwidth in suburban outdoor-to-outdoor (O2O) and outdoor-to-indoor (O2I) scenarios are presented in Tables 4 and 5, respectively.

Table 4. Normalized throughput values for a 200 MHz bandwidth in a suburban O2O environment

U6G	**Outdoor distance**		
200MHz OBW	55m	170m	500m
DL MU-MIMO	3 Gbps	2.6 Gbps	2.2 Gbps
UL MU-MIMO	408 Mbps	400 Mbps	284 Mbps

Table 5. Normalized throughput values for 200 MHz bandwidth in a O2I environment

U6G	**Indoor distance**		
200MHz OBW	100m	157m	200m
DL MU-MIMO	2.02 Gbps	1.68 Gbps	832 Gbps
UL MU-MIMO	292 Mbps	60 Mbps	16 Mbps

The extrapolated results clearly highlight the performance benefits of operating the upper 6 GHz band with a 200 MHz carrier component bandwidth. Maintaining comparable power spectral density conditions, the use of wider channels translates into approximately three-fold throughput gains relative to 100 MHz operation, consistently observed across both outdoor-to-outdoor (O2O) and outdoor-to-indoor (O2I) scenarios, for both downlink and uplink.

The fundamental strength of the upper 6 GHz spectrum lies in its ability to support large contiguous channel allocations of at least 200 MHz per operator, which is a decisive enabler for very high data rates, lower latency, and enhanced quality of service. This capability is essential for addressing future network capacity requirements and mitigating the expected capacity shortfall in mobile networks as traffic demand continues to accelerate.

Trial Key Takeaways

The field evaluation of the upper 6 GHz band conducted using the existing macro-cellular infrastructure, confirms its strong potential as a foundation spectrum for the next generation of mobile networks. The results demonstrate that multi-gigabit mobile connectivity can be delivered efficiently in both outdoor and indoor scenarios, addressing the accelerating demand for higher data rates and network capacity.

Key observations from the trial include:

- **Macro feasibility at upper 6GHz frequency:** The measurements validate that upper 6 GHz Massive MIMO radios can be effectively deployed in dense urban environments, where current 5G sub6GHz capacity is expected to saturate. Access to new spectrum at these frequencies is therefore essential to sustain future traffic growth.
- **Comparable macro performance to existing Sub6GHz:** Under equivalent deployment conditions, the upper 6 GHz concept radio exhibited performance comparable to commercial 3.6 GHz systems. This confirms that upper 6GHz band spectrum is not limited to small-cell use but can operate as a macro layer. The transition to commercial-grade equipment supporting wider bandwidths is expected to further enhance this performance.
- **Capacity scaling on the existing site grid:** The trial results indicate that significant additional capacity can be unlocked without densifying the network, by reusing the current macro-cell footprint. This enables faster rollouts with lower cost and reduced environmental impact, which is critical for large-scale adoption.
- **Readiness for initial 6G deployment:** Performance extrapolations show that gigabit-class connectivity becomes highly efficient with 200 MHz carrier component channel in the upper 6 GHz band, positioning this spectrum as a strong candidate for early 6G deployment on legacy macro infrastructure.
- **Future performance upside:** As 6G systems evolve, wider carriers, higher-order Massive MIMO, and increased multi-user MIMO layers will significantly boost throughput—particularly in scenarios with favorable SNR and SINR conditions. These gains will exceed what is achievable with current 5G-Advanced configurations.
- **Technology evolution beyond the trial:** The introduction of advanced beamforming techniques, AI-native air interfaces, and enhanced UE antenna capabilities will further improve performance

in commercial upper 6 GHz networks. As a result, the trial outcomes should be viewed as conservative, with future deployments expected to outperform the results presented in this study.

Physical Layer Innovations in 6G RAN

The 6G physical layer (PHY) remains OFDM-based but incorporates major enhancements:

- Wider bandwidths (up to hundreds of MHz per carrier)
- Giga MIMO with extremely large antenna arrays
- Advanced channel coding and probabilistic shaping
- AI-assisted waveform and numerology adaptation

AI models embedded in the RAN PHY dynamically optimize:

- Modulation and coding schemes
- Beam patterns and spatial multiplexing
- Interference coordination across cells

This enables performance optimization that is no longer static, or rule based.

AI-Native RAN Architecture

From SON to Autonomous RAN

AI becomes intrinsic to the Radio Access Network (RAN) itself, core to how spectrum is allocated, how beams are formed, how mobility is managed, and how networks heal or adapt in real time. Self-Organizing Networks (SON) in 4G and 5G were rule-driven and reactive. In contrast, 6G RAN is autonomous by design, characterized by:

- Continuous learning from radio, mobility, and service data
- Closed-loop control across PHY, MAC, and RRC layers
- Intent-based policies rather than parameter tuning

Two-Sided Intelligence

A defining feature of 6G RAN is two-sided AI, where:

- Network-side intelligence (gNB, edge cloud) optimizes cell-wide behavior
- Device-side intelligence (UE) assists in beam selection, channel prediction, and energy optimization.

This collaboration significantly improves robustness and efficiency, especially in high-frequency outdoor deployments.

Key remarks

The 6G Radio Access Network marks a fundamental transition from static, rule based radio design toward intelligent, adaptive, and context aware wireless systems. By natively embedding artificial intelligence across the RAN stack, expanding operation into new spectrum domains, and adopting open, cloud native architectures, the 6G RAN emerges as the core enabler of future mobile connectivity, capable of simultaneously delivering communications, sensing, and real time network optimization.

For network planners and radio designers, particularly in dense outdoor and urban macro environments, 6G is not simply an incremental addition of spectrum or another generational upgrade. Instead, it represents a shift in how radio networks observe their environment, make autonomous decisions, and continuously evolve to meet dynamic service demands. In this context, the 6G RAN becomes a living system, redefining performance, efficiency, and scalability as the mobile industry moves toward the 2030 era and beyond.

Monetization: Turning Intelligence into Revenue

From Connectivity to Intelligence Revenue

The 6G commercial opportunity begins with a change in what is being sold. In the traditional model, the unit of value is access: a subscription, a bandwidth tier, a data allowance, or a network site. These services remain essential, but they are increasingly difficult to differentiate and do not fully reflect the value created by an AI-native network. When a network can understand context, predict risk, select an action, and verify an outcome, it can monetize more than the resources it transports. It can monetize the quality of the decision and the certainty of the result.

This changes the operator's role fundamentally. Rather than only carrying digital activity, the network can actively improve its outcome: preventing an outage before it disrupts production, guaranteeing performance for a time-critical application, verifying a transaction, adapting a private-network policy for an enterprise asset, or optimizing resource use in real time. Customers are no longer buying only connectivity. They are buying insight, assurance, action, and trust.

The New Unit of Value

These four forms of intelligence provide a practical framework for product design and monetization. They should not be viewed as separate product silos. A common data fabric, model layer, control plane, and governance framework can support all four, allowing one investment in network intelligence to generate multiple commercial products.

Intelligence form	What telcos can sell	Illustrative customer proposition
Insight	Visibility, prediction, and decision support	Forecasted congestion, mobility patterns, RF conditions, capacity risk, or quality-of-experience insights.
Assurance	Verified and guaranteed network performance	On-demand latency, reliability, coverage, security, or service-quality commitments for a defined workload.
Action	Governed autonomous execution	An enterprise agent or managed service that optimizes a private network, application slice, or operational process against an agreed goal.
Trust	Identity, security, provenance, and compliant execution	Verified device, SIM, and agent interactions; fraud prevention; sovereign processing; and auditable policy enforcement.

The Certainty Premium

The most important economic shift is from selling capacity to selling certainty. For many enterprise and public-sector workloads, additional bandwidth has limited value unless the network can make a reliable commitment around it. A port does not buy connectivity for its own sake; it buys dependable coordination of vehicles, cranes, sensors, and applications. A manufacturer buys predictable uptime and response time. A broadcaster buys a verified uplink during a live event. A financial institution buys confidence that a transaction, identity check, or fraud-control signal can be trusted. In each case, the commercial value is created by reducing operational risk, not simply by delivering more megabits per second.

This creates a certainty premium. Bandwidth is becoming increasingly abundant; predictable latency, reliability, security, availability, and response time are scarce. AI-native control, network slicing, digital twins, and continuous assurance make that scarcity measurable and, therefore, priceable. The operator can move from offering best-effort connectivity toward a differentiated portfolio of verified outcomes.

From Static Contracts to Live Service Markets

In this model, a service-level agreement is no longer a static contractual appendix negotiated once and reviewed after an incident. It becomes a live, programmable product with a real-time price, an admission decision, a risk model, continuous verification, and automated enforcement. An enterprise application, and increasingly an enterprise agent, can request a defined outcome: maintain a latency threshold for the next two hours, reserve reliable uplink for a live production, protect a private-network workload during a peak shift, or provide verified connectivity for an autonomous operation.

The network then evaluates whether it can safely make that commitment, taking account of location, duration, current demand, available resources, service priority, and operational risk. A telecom world model can forecast the likely outcome, while a digital twin can test the impact before a policy is applied to the live network. This makes dynamic, risk-aware pricing possible: the customer pays for the performance guarantee it needs, at the time and place it is needed, rather than for a generic bundle of resources.

The Intelligence Flywheel

The most credible route to external intelligence revenue begins inside telcos. Every closed loop deployed in network operations generates three assets: measurable savings, operational proof, and reusable intelligence. A model that predicts faults, optimizes energy consumption, or improves capacity planning is first validated in telcos's own environment. Once governed, hardened, and exposed through secure interfaces, the same capability can become an enterprise product, an API, an agent service, or a performance guarantee.

This flywheel is strategically important because it avoids creating disconnected businesses. The data fabric that supports operational intelligence can also supply governed data products. The model lifecycle platform that trains internal models can support enterprise fine-tuning and sovereign inference. The agent framework used to operate the network can be adapted for enterprise automation. The world model and digital twin used to assess network actions can be extended to test customer scenarios. One AI-native platform can therefore support multiple revenue surfaces while becoming stronger with every deployment.

Emerging Monetization Surfaces

Beyond the core revenue streams detailed below, an AI-native network creates several adjacent products that telcos can develop as the platform matures:

Network Intelligence APIs: programmable access to forecasted congestion, predicted coverage quality, expected uplink reliability, anomaly detection, quality verification, or application-aware traffic steering.

Digital Twin and World Model as a Service: a secure environment in which an enterprise can test site layouts, device fleets, traffic policies, automation workflows, or connectivity requirements before committing to deployment.

RF Intelligence as a Service: spectrum occupancy analytics, interference detection, indoor coverage intelligence, site planning, private-network diagnosis, and RF-environment understanding for regulated and industrial customers.

Trust as a Service: device, SIM, and agent identity verification; fraud and SIM-swap protection; policy compliance; data provenance; and trusted execution for highly regulated digital interactions.

Green Connectivity: energy- and carbon-aware service options, including low-carbon routing, sustainable edge placement, and measurable efficiency commitments for ESG-sensitive customers.

Outcome- and Gainshare-Based Commercial Models: pricing linked to the economic value created, such as avoided outages, reduced energy use, higher asset uptime, prevented fraud, lower logistics delays, or improved service performance.

For telcos, the strategic advantage does not come from data ownership alone. It comes from the ability to combine trusted network control, real-time operational context, local and sovereign processing, customer proximity, programmable exposure, and accountable service assurance. Connectivity remains essential, but it will no longer be the sole source of value. The differentiator will be the network's ability to understand, predict, assure, and act on behalf of customers. The following revenue streams show how that intelligence can be translated into an integrated commercial portfolio.

New Revenue Streams

The architecture set out in the previous chapters the data fabric, the world model, the agent layer, network slicing, and intent-based exposure was described as an operational upgrade. It is also a revenue architecture. Every capability we build to run the network better has a second life as something we can sell. Connectivity margins are flat, and adding raw capacity no longer adds proportional value. The intelligence layer is where the next margin sits.

What makes the economics work is that one set of infrastructure feeds all of it. The GPU cluster that trains a fault-prediction model also serves external inference. The data fabric that feeds the world model also supplies the data marketplace. The slicing controller that isolates an internal test slice also delivers a guaranteed enterprise SLA. We are not standing up five separate businesses; we are exposing five monetization surfaces on top of one AI-native platform. The streams below are ordered deliberately, from inward to outward: the first pays for the platform and proves it works, and the last sells the guarantee that only such a platform can credibly make.

AI-Native Network Operations (Internal ROI)

The first customer for telco's AI is telcos. Before any of this is sold externally, it has to earn its place inside the network, and that is where the first and most certain return comes from. AI-native operations attack the largest cost lines directly. Energy is the obvious one: the radio access network dominates network power draw, and learned policies for cell sleep, carrier shutdown, and traffic-aware scheduling cut consumption without degrading coverage. Fault prediction moves maintenance from reactive to pre-emptive fewer site visits, shorter outages, and engineers dispatched against problems that have not happened yet. Capacity planning driven by the world model lets us defer capital spend by getting more out of the spectrum and sites we already operate.

These are not soft savings. They land on the OpEx and CapEx lines, and they fund everything downstream. There is a second reason this stream comes first: we will not sell an operations capability we have not run on our own network. Every closed loop we harden internally moving from TM Forum autonomy Level 2 toward Level 3 becomes a de-risked, referenceable product. The internal deployment is both the cost saving and the proving ground for everything that follows.

AI-as-a-Service (External)

Once the AI platform is running the network, the compute, models, and tooling behind it can be turned outward. Telcos are already building the foundation: sovereign cloud and GPU capacity through its Oracle Alloy and Nvidia partnership, and a dedicated AI data center developed with Microsoft. That infrastructure does not have to serve internal workloads alone.

The offering is GPU-as-a-Service, sovereign inference, and model hosting and fine-tuning for enterprises and government bodies that cannot send their data to a global hyperscale. This is where telcos holds an advantage a hyperscale cannot copy. Data residency is enforced locally, inference sits close to the network edge for latency-sensitive workloads, and the full stack operates under UAE governance. For regulated sectors government, finance, healthcare that combination of sovereignty, proximity, and trust is the product, not a feature of it. The telecom-specific models we build for ourselves, from RF and channel models to network-tuned language models, become assets we can license to other operators and vendors who face the same problems without the data to solve them.

Telco Data Marketplace

The network sees things no other system sees : where devices are, how they move, how the radio environment behaves, and the quality of every connection in real time. Aggregated and anonymized under proper consent and governance, this becomes a set of data products with real buyers. The data fabric described earlier is what makes this safe to sell it handles anonymization, consent, and lineage so that a data product can never be traced back to an individual.

There are two layers to monetize. The first is analytics: mobility and population-density products for retail sitting, transport planning, and urban management. The second is API-exposed signals delivered through GSMA Open Gateway and the CAMARA standard device location, number verification, SIM-swap detection, and quality-on-demand. This channel is no longer experimental. As of early 2026, Open Gateway covers operator groups representing roughly 80% of global mobile connections, and aggregators such as Aduna let a developer or a bank reach telco's APIs without a bilateral integration. The UAE's fintech and public-sector demand for fraud, identity, and location signals maps directly onto APIs that are already standardized and certifiable. The same data that trains our world model is the data we expose here the marketplace and the internal intelligence draw on one substrate.

Agent-as-a-Service

The architecture chapter defined AI agents as autonomous actors inside the network. The same agents, exposed through the programmable and intent-based interfaces, become a product enterprises consume. A customer states an intent keep this private-5G campus optimized for these robots, hold this latency for this application, renegotiate this slice when demand shifts and an agent translates that intent into network actions and carries them out.

This is a different sale from AI-as-a-Service. There we sell compute and models; here we sell goal-directed autonomy that acts on the network and on the customer's behalf, and the pricing moves with it from GPU-hours and tokens toward outcomes. Vertical agents, for ports, logistics, manufacturing, and large venues, package network access with domain logic the customer would otherwise have to build in-house. The agent framework we run internally to operate the network is the same one we expose; productizing it is a matter of governance and interface, not new technology.

SLA-as-a-Product

This is where the previous four streams converge. Today an SLA is a static clause, negotiated once and difficult to verify. With network slicing, intent-based exposure, digital twins, and closed-loop assurance, the service-level guarantee becomes a product the customer can dial: guaranteed latency, reliability, or throughput, per application, per session, for a defined window, requested on demand and enforced automatically.

The world model is what makes this profitable rather than risky. Before admitting a guarantee, it predicts whether the network can hold it, and the digital twin validates the commitment before it touches the live network. That lets us price a guarantee against real risk instead of padding every contract for the worst case. The buyers are the workloads that cannot run on best-effort connectivity: industrial automation, cloud gaming and XR, live broadcast, connected and autonomous systems, remote healthcare. They do not pay for capacity; they pay for certainty. SLA-as-a-Product is the highest-margin stream because it monetizes assurance and assurance is precisely what an AI-native network, proven first on our own operations in the first stream, is uniquely able to sell. The loop closes here: the intelligence we built to run the network becomes the capability the market is willing to pay the most for.

Deployment Models

The deployment model underpinning each monetization strategy is not merely a technical decision, it is a core determinant of margin structure, time-to-market, and competitive defensibility. Telcos must architect their AI deployment to align infrastructure economics with the revenue streams they intend to capture.

On-Premises Deployment maximizes control over data residency and minimizes recurring cloud costs, making it the optimal model for monetizing sensitive assets such as the Telco Data Marketplace and SLA-as-a-Product offerings. While CapEx-intensive, it delivers superior unit economics at scale and satisfies the data sovereignty and regulatory compliance (GDPR, sector-specific mandates) that enterprise and government clients demand—commanding premium pricing.

Cloud-Based Deployment via hyperscaler partnerships (AWS, Azure, GCP) shifts spend from CapEx to OpEx, enabling rapid go-to-market for AI-as-a-Service and Agent-as-a-Service products. This model accelerates customer acquisition and supports usage-based, consumption-driven pricing that scales elastically with demand, critical for capturing external revenue without stranded capital.

Hybrid Deployment is the strategic sweet spot for most operators: latency-sensitive, mission-critical workloads (AI-Native Network Operations) remain on-premises to protect internal ROI and SLA guarantees, while customer-facing services burst to the cloud during peak demand. This optimizes total cost of ownership (TCO) while preserving flexibility.

Edge Deployment pushes inference to the network periphery, cell sites, MEC nodes, and customer premises, unlocking ultra-low-latency, high-margin services (real-time analytics, autonomous optimization, premium IoT SLAs) that pure-cloud competitors cannot replicate. Edge becomes a key monetization differentiator, justifying tiered pricing for guaranteed performance.

Ultimately, the deployment portfolio must be mapped directly to each revenue stream's margin profile and customer requirements, transforming infrastructure choices into deliberate levers for monetizing intelligence.

Roadmap Toward Autonomous Networks

Autonomous networks will not emerge through a single technology upgrade. They will be built through a phased transformation in which automation, intelligence, data, cloud-native platforms, AI governance, and operating-model maturity evolve together. For telcos, the roadmap toward autonomy must therefore be treated as both a network architecture journey and a business transformation journey: the objective is not simply to reduce manual operations, but to create a network that can sense, reason, decide, act, and continuously improve while supporting new revenue models based on guaranteed performance, programmable services, and intelligence exposure.

This roadmap is particularly relevant because the industry is entering a transition period from 5G-Advanced toward 6G. ITU's IMT-2030 framework defines future 6G principles around sustainability, security and resilience, connecting the unconnected, and ubiquitous intelligence, while its 2026 technical requirements identify AI and communication, integrated sensing and communication, ubiquitous connectivity, immersive communication, massive communication, and hyper-reliable low-latency communication as key 6G usage scenarios. At the same time, 3GPP positions Release 20 as the bridge between 5G-Advanced evolution and 6G studies, with Release 21 expected to produce the first formal 6G technical specifications aligned with IMT-2030 submission requirements.

For telcos, this timing creates a strategic opportunity: the company does not need to wait for full 6G commercialization to begin the autonomy journey. The foundations are already being established through 5G-Advanced, cloud-native RAN evolution, autonomous network slicing, AI-enabled automation, and alignment with TM Forum autonomous-network frameworks. Publicly, du has already signed the TM Forum Autonomous Networks Manifesto, strengthening its commitment to intelligent and automated network development, and has announced 5G-Advanced achievements, including high-capacity spectrum combinations, Cloud RAN vision work, and autonomous network slicing capabilities.

Strategic Direction

The roadmap toward autonomous networks should be guided by a simple principle: autonomy must be introduced first where it creates measurable value and controlled operational risk. Instead of attempting to automate the entire network at once, telcos should prioritize high-value domains such as RAN energy optimization, fault prediction, service assurance, network slicing, enterprise SLA management, capacity planning, transport optimization, and customer-experience-driven assurance.

TM Forum classifies Autonomous Network Levels from Level 0 to Level 5, moving from manual management toward fully autonomous networks; the level is assessed by scenario, such as RAN fault management or IP network quality optimization, rather than by declaring the whole operator network autonomous at once.

L0- Manual Operations: All operational decisions and execution are performed by humans; tools provide visibility only.

L1- Assisted Operations: Tools execute repetitive subtasks under continuous human supervision; data is collected automatically but decisions remain manual.

L2- Preliminary / Partial Autonomy: Closed loops exist for specific tasks in well-defined contexts; humans configure, supervise and intervene routinely.

L3- Conditional Autonomy: The system perceives, decides and acts within a defined operational domain; humans intervene only when the system requests support.

L4- Highly Autonomous: The network self-configures, self-heals and self-optimizes across one or more end-to-end scenarios, delivering zero-wait, zero-touch, zero-trouble experiences for those scenarios; humans set intent and govern.

L5- Fully Autonomous: The network is self-sustaining across all services and contexts, learning continuously and operating without human involvement except for strategic governance.

Phase 1: The first phase establishes the foundation for autonomous operations through unified data collection, accurate network inventory, real-time telemetry, cloud-native platforms, AI/ML lifecycle management, and standardized interfaces. At this stage, AI enhances visibility, supports anomaly detection, assists decision-making, and improves operational efficiency.

Phase 2: The second phase introduces closed-loop automation within selected domains such as RAN optimization, energy efficiency, fault prediction, capacity management, network slicing, and service assurance. These closed loops enable the network to detect conditions, analyze impact, execute approved actions, and verify outcomes within defined operational boundaries.

Phase 3: The third phase extends autonomy across RAN, core, transport, cloud, and service platforms. Cross-domain coordination enables end-to-end service awareness, intent translation, policy-based orchestration, and dynamic optimization across the full network stack. Network digital twins become an important capability for validating actions before deployment in the live network.

Phase 4: The fourth phase aligns autonomous operations with the evolution toward 5G-Advanced and 6G. AI-native control, distributed intelligence, edge-cloud orchestration, autonomous slicing, and programmable service exposure enable the network to support advanced use cases requiring guaranteed latency, reliability, security, sustainability, and service-level assurance.

Phase 5: The final phase moves toward self-configuration, self-healing, self-optimization, and self-learning capabilities. AI agents operate as autonomous actors within governed boundaries, coordinating network functions, service policies, digital twins, and business objectives. Human roles evolve from manual intervention toward governance, policy definition, risk management, and strategic supervision.

Execution Priorities and Expected Outcomes

To translate this roadmap into action, telecom companies, should prioritize autonomy by scenario rather than by network-wide transformation. The first step is to identify a small set of high-impact use cases where autonomy can deliver clear value with controlled risk, such as RAN energy optimization, proactive fault management, service assurance, network slicing, and enterprise SLA management. Each use case should be assessed according to its current autonomy level, target maturity level, data readiness, operational risk, and expected business impact.

The deployment of autonomous capabilities should also remain governed by clear operational guardrails. Closed-loop systems and AI agents should operate within approved policy boundaries, with explainable decisions, auditability, rollback mechanisms, cybersecurity controls, and human override. This ensures that autonomy increases progressively while maintaining trust, service continuity, and regulatory alignment.

The expected outcome is a network that evolves from assisted operations toward AI-native, intent-driven, and self-optimizing operations. For telcos, this creates value through faster service provisioning, stronger SLA assurance, improved energy efficiency, reduced manual intervention, better customer experience, and new monetization models built around programmable and guaranteed network intelligence.

Integration Challenges and Standardization Pathways

The realization of this intelligent architecture hinges on resolving the central, defining tension in 6G standardization: the conflict between the drive for extreme architectural flexibility and the non-negotiable requirement for global, multi-vendor interoperability. For this vision to become a reality, the industry must navigate this core challenge, with global standards bodies playing the crucial role of forging a common pathway to prevent the 6G ecosystem from fracturing into proprietary, non-interoperable islands.

Ensuring Multi-Vendor Interoperability

Interoperability is perhaps the most critical and pervasive challenge in architecting 6G. It spans multiple layers of the new, intelligent network stack and requires a concerted standardization effort to resolve.

AI Model Interoperability: A particularly difficult challenge arises with "two-sided" AI models, where one part of the model (e.g., an encoder for CSI compression) resides on the user device and the other part (the decoder) resides in the base station. Ensuring that an encoder from one vendor can work seamlessly with a decoder from another requires either standardizing reference models or defining complex procedures for inter-vendor model training and validation.

SBA and API Harmonization: The flexibility of the evolved Service-Based Architecture, especially its extension into the RAN, must be carefully balanced with the need for standardized, interoperable interfaces. Without strong API harmonization, the 6G ecosystem could fracture into proprietary, walled-garden implementations, defeating the goal of an open platform.

AI Agent Communication: For autonomous AI Agents to collaborate effectively across the network, they must rely on standardized protocols for discovery, identity management, and interaction. This is essential for creating a trusted, multi-vendor environment where agents can securely exchange information and coordinate actions.

Managing Architectural Complexity and Performance

The new architectural paradigms of 6G, while powerful, introduce new layers of complexity and potential performance trade-offs that must be carefully managed. For example, while disaggregating the RAN into a service-based architecture offers immense flexibility, it also introduces performance risks, as tightly integrated monolithic functions are replaced by inter-service communication that can increase latency and processing overhead.

Furthermore, the complexity of AI-native designs presents unique monitoring and management challenges. A specific example is found in two-sided AI models; it is difficult to monitor the downlink quality on a user's device when it only has the lightweight encoder, as it cannot assess the final output of the network's complex decoder. Replicating the full decoder on the device for monitoring purposes would significantly increase its cost and power consumption, making it impractical for mass-market deployment.

The Role of Standardization Bodies

Resolving these challenges to create a unified, global 6G system is the central role of international standardization organizations. The coordinated efforts of these groups are essential for defining the technical specifications that will ensure interoperability and guide the industry toward a common architectural vision. Key contributions are being made by several groups:

3GPP TSG SA (Service and System Aspects): This group is at the forefront of defining the vision for 6G, leading the development of use cases and service requirements in documents like TR 22.870, which form the foundation for subsequent technical work.

3GPP TSG RAN (Radio Access Network): This group is responsible for specifying the AI-native air interface. Its work in Releases 19 and 20 focuses on integrating AI/ML for core radio functions such as mobility management, beam management, and Channel State Information (CSI) feedback.

ITU-R (Radiocommunication Sector): As the United Nations' specialized agency for information and communication technologies, the ITU-R establishes the global framework, defining the high-level usage scenarios, capabilities, and timeline for IMT-2030 (6G) in key documents like Recommendation M.2160.

Quick Note on the AI/ML in the Air interface

The work in 3GPP and in the standardization bodies proves that AI / ML, is no longer hype—it is entering the specifications for many 6G uses cases. However, it has been observed that there were areas of rejection of certain complex collaborations and prediction models. It signals that standardization bodies remain conservative. 6G will likely see a battle between proprietary AI (vendor-locked performance) and standardized AI (interoperable but potentially lower performance).

In some 6G uses cases, it seems that the industry is cautious about "breaking" the air interface with AI. The 6G battle will not be about if AI is used, but who owns the weights of the model. Will the intelligence reside in the open standard, or will it be locked inside the vendor's proprietary silicon? The TR 38.843 suggests the latter is currently winning, as standardization bodies struggle to regulate the "black box."

Conclusion

6G represents a strategic inflection point for telecommunications. Its significance will not be defined only by higher peak rates, wider channels, or lower latency. Its real value lies in the transition from networks that transport information to networks that understand context, predict outcomes, and act intelligently.

This shift creates the opportunity for telcos to build a new type of network: AI-native, autonomous by design, programmable by customers, and commercially aligned with the needs of the digital economy. Such networks will combine advanced radio capabilities, multi-layer spectrum, cloud-native architecture, unified data, AI agents, digital twins, world models, and intelligent control loops into a single operational and commercial platform.

The path to this future does not begin with a distant 6G launch. It begins now, through 5G-Advanced evolution, cloud-native RAN, unified data environments, AI/ML lifecycle management, and targeted closed-loop automation. By progressing scenario by scenario, telcos can create measurable gains in energy efficiency, fault prevention, network performance, service assurance, and customer experience, while building the capabilities required for higher levels of autonomy.

The commercial model must evolve in parallel. The future value of telecom will increasingly come from the ability to sell insight, assurance, autonomous action, and trust. This means moving beyond static connectivity packages toward programmable network services, dynamic SLAs, sovereign AI capabilities, trusted data products, intelligent APIs, and outcome-based enterprise services. The strongest opportunities will emerge where network intelligence directly improves a customer’s business outcome: reducing downtime, protecting transactions, optimizing operations, guaranteeing performance, or enabling autonomous systems.

This transformation must remain grounded in trust. AI agents and closed-loop systems should operate within transparent governance frameworks, with strong security, auditability, explainability, rollback mechanisms, and human oversight. Open standards and multi-vendor interoperability will be essential to ensure that intelligence can scale across the broader ecosystem rather than remain confined within proprietary silos.

The ambition is therefore not simply to build faster networks. It is to position telcos as trusted intelligence infrastructure providers: connecting people, enterprises, machines, and AI systems while enabling the decisions, assurance, and outcomes that the next digital economy will require.

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