TECH mahindra

WHITEPAPER

Network and AI

Demystifying AI for Telecom Networks

Contents

1. Executive Summary

The convergence of AI and telecom is reshaping the industry, transforming networks into intelligent systems that can predict, adapt, and act autonomously. As we move towards 6G, the interplay between AI and network infrastructure is becoming foundational to achieve resilient, adaptive, and service-aware digital ecosystems.

This white paper introduces a strategic framework centered on four key dimensions of AI and network integration, each contributing uniquely to the evolution of next-generation networks: AI for Networks, Networks for AI, Network of AI, and AI-Native Networks. Our analysis provides a strategic guide for operators and enterprises to build resilient, high-performance infrastructure, ensuring they harness the full potential of AI and 6G to drive new value and innovation.

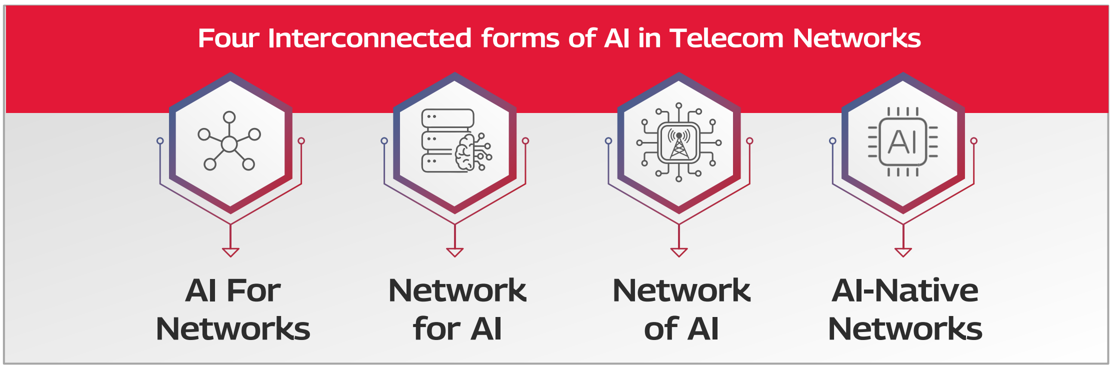

Figure 1: AI in Telecom Networks - Four Dimensions of Interplay

2. Introduction

Telecom networks stand at the forefront of the transformational era – an inflection point where intelligence, scale, and agility must converge to meet the demands of a hyper-connected, AI-driven economy. The traditional model of centralized control, manual tuning, and static policies is no longer sustainable in an era of explosive data growth, on-demand intelligent services, and personalization. This legacy approach creates operational friction, limits innovation, and cannot deliver the real-time responsiveness that modern applications demand.

Our viewpoint is that AI is the catalyst for the next paradigm and is becoming the foundation upon which next-generation networks will be built, operate, and monetized. It infuses networks with a degree of autonomy and contextual intelligence, transforming them from rigid infrastructure into living systems that can sense, analyze, decide, and act—much like a biological nervous system. This intelligence is fundamentally changing every aspect of the ecosystem, from network design and operations to service creation and user experience.

To provide a clear path through this transformation, this white paper introduces a four-part dimension that maps the journey from optimizing today's networks to architecting the fully AI-native systems of tomorrow.

1. **AI for Networks:** Optimizing existing network elements with AI capabilities *(explained in following section 3)*
2. **Networks for AI:** Enabling AI applications by providing high-performance infrastructure *(explained in following section 4)*
3. **Network of AI:** Distributed and coordinated intelligence embedded in and across the network *(explained in following section 5)*
4. **AI-Native Networks:** Designing networks with AI as a foundational design and control principle *(explained in following section 6)*

This white paper elaborates on each form and highlights the standards, architecture evolution, and performance indicators that will define the industry roadmap.

3. AI for Networks

AI for Networks is the most visible and practical application of AI in telecom, focusing on enhancing existing network infrastructure. It refers to the integration of AI into the network's operational and management layers to improve performance, resilience, and efficiency. Operators can leverage AI/ML algorithms to automate, optimize, and secure functions across the RAN, transport, core, and cloud layers, and unlock significant efficiencies.

This approach is already delivering tangible results across the networks in areas of network management and operational metrics, including energy efficiency, spectral optimization, and fault prediction.

While the potential applications are vast, key use cases include:

- **Predictive Maintenance:** Using anomaly detection and historical logs to preempt failures
- **Energy Savings:** Deploying AI models that adapt power usage to real-time traffic
- **Closed-Loop RAN Optimization:** Automating parameters like power control and beamforming
- **Autonomous Operations:** Enabling root cause analysis and self-healing without human intervention

As AI technology continues to evolve and contribute across various domains, industry standardization is critical to ensure the efficiency of these initiatives within telecom networks. Key efforts currently underway include standardization and ecosystems:

- **3GPP Release 17/18:** Introduced foundational AI/ML model management, inference APIs, and feedback loops for the RAN
- **Release 19:** Adds modular lifecycle support for ML models embedded in network functions
- **Release 20:** Advances toward more sophisticated policy-based and intent-driven orchestration
- **O-RAN Alliance:** Enables modular deployment of xApps and rApps for AI-driven RAN optimization via the near-RT and non-RT RIC

Key benefits of AI for Networks:

- **Automated Fault Management:** Closed-loop automation for faster fault detection and recovery
- **Cost Reduction:** Reduced operational expenditure (OPEX) through predictive maintenance and fewer manual tasks
- **Performance Optimization:** Improved network performance via dynamic optimization of RAN, transport, and core functions
- **Proactive Anomaly Detection:** Real-time anomaly detection to mitigate outages and improve service continuity
- **Smarter Resource Planning:** Intelligent capacity planning and traffic forecasting to match resource allocation with demand
- **Energy Efficiency:** Energy efficiency gains through AI-driven load balancing and intelligent shutdown of underused resources
- **Enhanced Customer Experience:** Fewer dropped calls, faster response times, and optimized application quality of service (QoS)

While technology and standards are crucial, tracking specific KPIs for targeted AI use cases is essential to assess their efficiency, effectiveness, and business impact. Effective KPIs for this stage include:

- **Mean Time to Repair (MTTR):** Reduction in repair time achieved through predictive analytics
- **Time to Action:** The speed and frequency of converting AI predictions into automated actions
- **Model Accuracy:** Percentage accuracy for traffic and load prediction models, with a target of >90%
- **AI Coverage:** The percentage of network functional domains enhanced with AI capabilities
- **Energy Efficiency:** Reduction in energy usage per gigabyte of traffic (Watts/GB)

4. Networks for AI

As AI becomes pervasive across industries, telecom networks must evolve into scalable, intelligent platforms for data movement, model inference, and real-time analytics. This form positions the network not merely as an infrastructure, but as an intelligent enabler for AI ecosystems and, ultimately, as an enabler of new revenue streams.

The key requirements to enable the 'Network for AI' approach include:

- Distributed compute and AI accelerators at the edge for ultra-low latency
- Network slicing and deterministic QoS for time-sensitive AI applications
- Federated learning support for privacy-preserving collaborative training
- Robust data pipelines with observability and telemetry for AI models

Meanwhile, the developments in standards and the ecosystem to support these requirements comprise:

- **3GPP Rel-17/18:** Introduces low-latency data plane enablers and MEC support
- **3GPP Release 19/20:** Aims to initiate AI-aware QoS and service exposure enhancements
- **O-RAN:** Provides a data-driven RAN architecture that can expose real-time features to external AI agents or platforms

Let's look at the real-world applications:

- **Industrial Automation:** Using 5G for real-time visual inference on robotic arms
- **New Revenue Models:** Offering AI-as-a-Service (AIaaS) and Infrastructure-as-a-Service (IaaS)
- **Immersive Experiences:** Network support for AR/VR in gaming and education
- **Smart Agriculture:** Edge AI for crop health monitoring, local weather forecasting, and autonomous irrigation

Key benefits of Networks for AI:

- **Ultra-Low Latency Connectivity:** Enables real-time AI applications such as AR/VR, robotics, and autonomous vehicles
- **High-Bandwidth Transport:** Supports AI workflows and large datasets required for model training and inference
- **Intelligent Workload Distribution:** Facilitates energy-aware AI workload balancing and optimization of compute offloading
- **Edge Enablement:** Empowers federated learning and latency-sensitivity use-cases near the data source
- **AI-as-a-Service (AIaaS) Enablement:** Enables AIaaS to transform telco infrastructure and deliver scalable, on-demand AI services

While technology and standards each play a critical role, it's equally important to monitor specific KPIs for targeted AI use cases to evaluate their efficiency, effectiveness, and overall business impact. Some of the typical KPIs are as follows:

- **Edge Inference Delay:** Time taken for an AI model at the edge to return a decision (~<5 ms for safety-critical apps)
- **Platform Availability:** The uptime of AI data pipelines and service exposure layers
- **Model Update Latency:** The speed and accuracy of distributing model updates from the cloud to the edge
- **Throughput Efficiency:** The network's data throughput performance during concurrent AI sessions

5. Network of AI

In this dimension, the network itself becomes a distributed system of AI agents or models, embedded across layers and domains—spanning cloud, edge, and devices. Unlike centralized AI systems, this paradigm enables localized intelligence that can interact, learn, and coordinate autonomously across multi-vendor, multi-domain, and multi-access environments. Each module (a mobile, a router, a base station, a data node) can run its own intelligence, making decisions locally and coordinating globally. These multiple agents or models communicate and cooperate to enable end-to-end service assurance, intent translation, and real-time adaptation.

The technologies enabling this architecture include:

- Multi-Agent Reinforcement Learning (MARL)
- Knowledge graphs for intent-sharing and environment modelling
- Cross-domain coordination using standard ontologies
- Local model training and federated aggregation

As it's a new dimension, the telecom standards are evolving along with the new technology components and ecosystem, e.g

- **3GPP Rel-19/20:** Exploring architecture for distributed AI agents and cooperative intelligence
- **O-RAN:** Multiple RICs across domains can be coordinated via shared policies and metadata

This dimension of the distributed intelligence model delivers significant advantages:

- Scalability through reduced central processing
- Resilience via distributed fallback logic
- Contextual optimization of KPIs like throughput, latency, or jitter based on local parameters/conditions

To measure the performance of this collaborative model, KPIs include:

- **Inter-Agent Latency:** Measures the decision-making speed and synchronization frequency between collaborating AI agents (~<10 ms in active clusters, depending on the use cases) Includes:
  - Round-trip time and jitter
  - Inference-to-response time
  - Inter-agent synchronization frequency
  - Improvement in slice elasticity via cooperative AI
- **Autonomous Resolution Rate:** The number of network anomalies that are self-resolved by distributed AI agents without central intervention
- **Policy convergence time:** The time taken to reach a consistent decision

6. AI-Native Networks

AI-Native Networks are designed with intelligence at their core. These networks abandon legacy constraints and reimagine every protocol, function, and interface as an intelligent, self-optimizing element. 6G is envisioned to be AI-native, with standards bodies, alliances, and the ecosystem concentrating efforts in this direction.

The key design features expected from these networks include:

- **Semantic Communication:** Transmitting meaning instead of raw data
- **Pervasive Intelligence:** Introducing AI at all nodes and layers of communication
- **Goal-Based Orchestration:** Managing the network through high-level intents instead of manual configurations
- **Real-time Digital Twins:** Employing simulation environments that mirror real-time network behaviour

The standards/ecosystem readiness to support these requirements is summarized below:

- **3GPP 6G Study Items:** Focused on intent-based networking, semantic protocol design, and AI-native protocol stacks
- **O-RAN Vision:** Integration of advanced AI engines with end-to-end lifecycle management, autonomous SLA assurance, and policy engines

As we move toward 6G, this approach is expected to have a transformational impact on the telecom networks fundamentally. Some of the key components of this transformation include:

- The network becomes an intelligent service broker
- Business models are based on dynamic, context-driven SLA delivery
- There is a total separation of the intent, execution, and feedback planes

Measuring the performance of a fully AI-native network requires a new set of advanced KPIs:

- **Intent-to-Execution Latency:** The time taken for the network to translate a high-level business intent into an executed action
- **Autonomous SLA Compliance:** An index measuring the network's ability to meet Service Level Agreements automatically and proactively
- **AI Service Invocation Rate:** The success rate and speed of creating and deploying new AI-driven services on demand
- **Network Adaptability Score:** A metric evaluating how quickly services can be modified under dynamic network conditions

7. A Unified Framework for Strategy and Policy

The four dimensions represent a continuum from augmentation to transformation, with each stage building the capabilities for the next phase of AI maturity. To bring these concepts to life, a unified strategy and focused effort from key stakeholders are essential. This requires alignment across the entire ecosystem:

1. **Strategic Stakeholder Focus:**
    - Regulators must ensure trust, transparency, explainability, and accountability in AI-driven networks
    - Standards Bodies need to align data semantics, AI orchestration primitives, and interoperability models
    - Operators should invest in modular infrastructure and multi-layer AI integration roadmaps
    - Enterprises can leverage the network as a programmable AI fabric tailored to vertical-specific use cases

2. **Technical Strategy:**
    - **Native AI Lifecycle Management:** AI lifecycle management must be treated as a native function, not a sidecar
    - **Modular Architecture:** Modularization of network functions is essential to support plug-and-play AI modules
    - **Closed-Loop Communication:** APIs must support bidirectional feedback between AI agents and orchestration logic

To measure success, a strategic approach to KPIs is essential, categorized by their business function.

3. Strategic KPI Categories

- **Technical:**

  These KPIs measure the technical efficacy of AI models and the readiness of the underlying infrastructure. They assess whether AI systems are delivering accurate, timely, and scalable performance that meets the real-world demands of the network.

KPI	Description	Strategic Importance
Model Convergence Time	Time taken for the AI model to reach acceptable accuracy during training	Reflects the efficiency of the model development and training pipeline
Inference Latency	Time between data input and AI-generated decision	Crucial for real-time applications like handovers or anomaly detection
AI Resource Utilization Ratio	Utilization of compute, memory, and storage dedicated to AI workloads	Indicates infrastructure efficiency and scalability readiness
API Exposure Breadth	Number and richness of network functions accessible via APIs for AI interaction	Measures how programmable and AI-friendly the network is

- **Operational (Scalable):**

  Operational KPIs evaluate the reliability, automation maturity, and real-time effectiveness of AI in live network environments. These indicators are crucial for ensuring closed-loop control, efficient model lifecycle management, and minimizing the need for manual intervention.

KPI	Description	Strategic Importance
Automation Success Rate	% of AI decisions/actions successfully executed without manual override	Gauge the maturity of AI-driven operations
AI Model Drift Detection Rate	Frequency of identifying and correcting outdated model behavior	Ensures continuous model relevance in dynamic network environments
Closed-Loop Resolution Time	Time taken to detect an issue, act via AI, and resolve it automatically	Key metric for self-healing and intent-based networking
Data Pipeline Reliability	Uptime and quality of data streams feeding AI models	Reflects the robustness of AI infrastructure integration with network data sources

- **Business:**

  Business KPIs focus on the financial and customer-facing impact of AI initiatives. These metrics help validate whether AI adoption is driving tangible outcomes in terms of revenue growth, customer satisfaction, and operational cost reduction.

KPI	Description	Strategic Importance
AI-Driven ROI	Financial return from AI-based optimizations (e.g., OPEX savings, efficiency gains)	Core business justification for AI investments
Time-to-Market for AI-Enhanced Services	Duration from concept to launch for new services powered by AI	Measures innovation, agility, and competitiveness
Customer Churn Reduction	Change in customer retention rates due to improved service experience from AI	Indicates AI's impact on customer loyalty and satisfaction
AI-Upsell Effectiveness	Uplift in revenue from personalized, AI-curated service recommendations	Shows how AI can drive new monetization opportunities

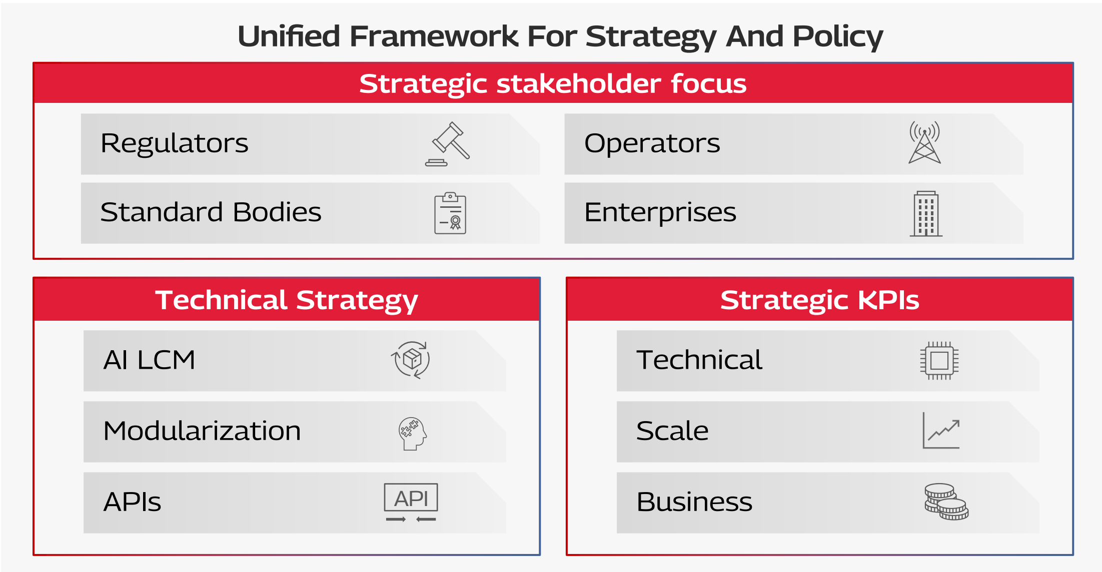

Figure 2: Unified Framework for Strategy and Policy

8. The Role of Data in Realizing Effective AI in Telecom Networks

While strategy and KPIs provide the roadmap, the entire AI evolution is powered by one foundational ingredient: data. Although algorithms and models often get the spotlight, their performance and accuracy are fundamentally dependent on the quality, variety, and timelines of the data they consume.

The quality of data is paramount, as it directly determines the success of AI in three critical areas:

- **Training Accuracy:** The success of AI models depends on diverse and representative datasets that accurately reflect the network's operational reality
- **Inference Precision:** Real-time AI applications rely on fresh, granular data to make accurate decisions at the edge or core
- **Adaptive Intelligence:** AI systems require continuous feedback loops, made possible by consistently updated and labeled datasets

However, realizing this data-centric vision to deploy effective AI in telecom networks requires overcoming several significant hurdles:

- **Siloed Data:** Data fragmentation across domains (RAN, transport, core, OSS/BSS) inhibits holistic AI learning
- **Privacy and Security:** Sensitive user data must be handled with strict compliance with regulatory frameworks like GDPR
- **Volume and Velocity:** Telecom networks generate massive volumes of data that must be filtered and processed efficiently
- **Data Labeling and Quality:** Labeled datasets for supervised learning are scarce and expensive to produce
- **Latency in Data Access:** Real-time applications require low-latency access to streaming data across domains

Addressing these data challenges requires a combination of architectural innovations and robust data management practices:

- **Data Federation and Virtualization:** Abstracting data from silos without physically moving enables broader access without compromising governance
- **Synthetic Data Generation:** Using digital twins and simulated environments to train and validate models where real-world data is sparse
- **Edge-Aware Data Pipelines:** Designing data flows that prioritize locality to reduce transport latency and optimize compute efficiency
- **Distributed Data Intelligence:** Leveraging techniques such as federated learning and differential privacy to protect user data while enabling collaborative AI
- **Metadata and Cataloguing:** Establishing a robust metadata layer to track data lineage, schema, access control, and relevance

While technology and standards play a vital role, monitoring data readiness KPIs for specific AI use cases is equally crucial to assess their efficiency, effectiveness, and business impact. Common KPIs include:

- **Data Accessibility:** The percentage of required data sources across all network domains that are available to AI models
- **Data Freshness:** The ingestion latency of data, measured from event occurrence to its availability for AI inference (real-time vs. batch)
- **Impact on Model Performance:** The quantifiable improvement in model accuracy from new or enriched datasets
- **Data Preparation Efficiency:** The reduction in time and cost to label and validate training data
- **Governance Compliance Score:** The adherence rate to data privacy and security policies, measured against internal and regulatory standards

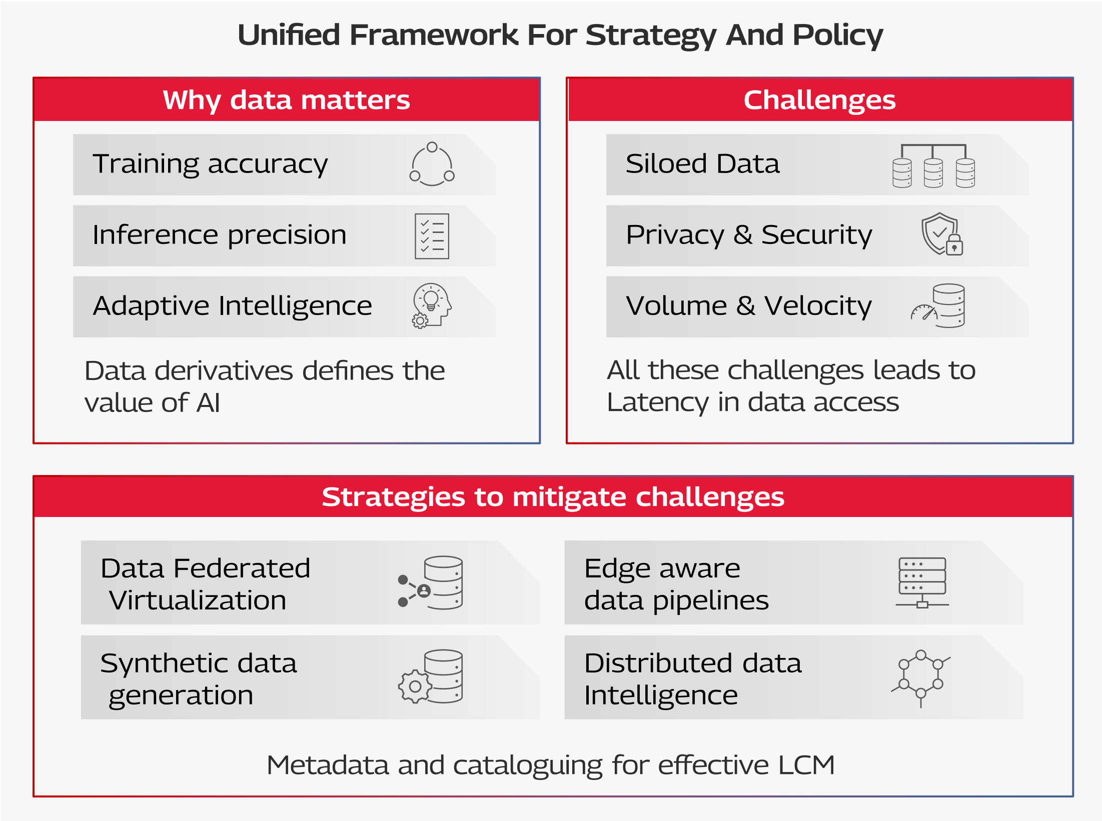

Figure 3: Unified Framework for Strategy and Policy: Importance of Data

A data-centric AI strategy is indispensable for the telecom industry. This union of data and AI must be treated as a core competency, impacting everything from technical outcomes to competitive differentiation and regulatory trust. As we advance toward 6G and AI-native networks, data is not just the fuel for AI—it is its foundation.

9. Orchestrating the Intelligent Future with Tech Mahindra

As the telecom industry transitions from being a connectivity provider to an intelligent digital enabler, the role of system and AI integrators, such as Tech Mahindra, becomes increasingly pivotal. We're moving from isolated systems to integrated intelligence platforms that unify technology, user experience, and business outcomes.

This transformation is inherently modular. Future networks must be built on open architectures, with intelligence distributed across the entire stack. As integrators, we ensure AI capabilities embedded in the RAN, edge, and core are abstracted into reusable building blocks for rapid deployment in industry-specific solutions.

A key insight from our experience is that AI success depends as much on data pipelines, governance, and lifecycle orchestration as on the models themselves. Deploying AI is not enough; it must continuously learn, adapt, and stay aligned with evolving business goals.

Moreover, sustainability must be a first-class design objective. As AI workloads grow, so does their energy footprint. Integrators must apply green AI principles, select energy-efficient models, and align compute-intensive operations with renewable energy schedules to minimize their environmental impact. We believe digital transformation and environmental responsibility must reinforce one another.

We see the journey to AI-native telecom as a process of co-creating value with our partners and customers, driven by a focus on several key areas:

- **Leading the Curve:** Actively participating in and contributing to next-generation wireless technologies, such as AI-RAN and 6G initiatives, to shape the future and deliver the best for our customers
- **Strategic Differentiation:** Helping operators and enterprises adopt AI in ways that align with their business models and create new revenue streams
- **Accelerated Innovation:** Enabling faster service rollouts, new use case prototyping, and AI model experimentation through agile platforms.
- **Operational Efficiency:** Automating repetitive processes and intelligently orchestrating network resources to reduce cost-to-serve
- **Sustainability Leadership:** Embedding AI in energy management and carbon reduction strategies to meet ESG goals
- **Resilience and Reliability:** Designing AI-infused, self-healing architectures that can respond to network failures in real time

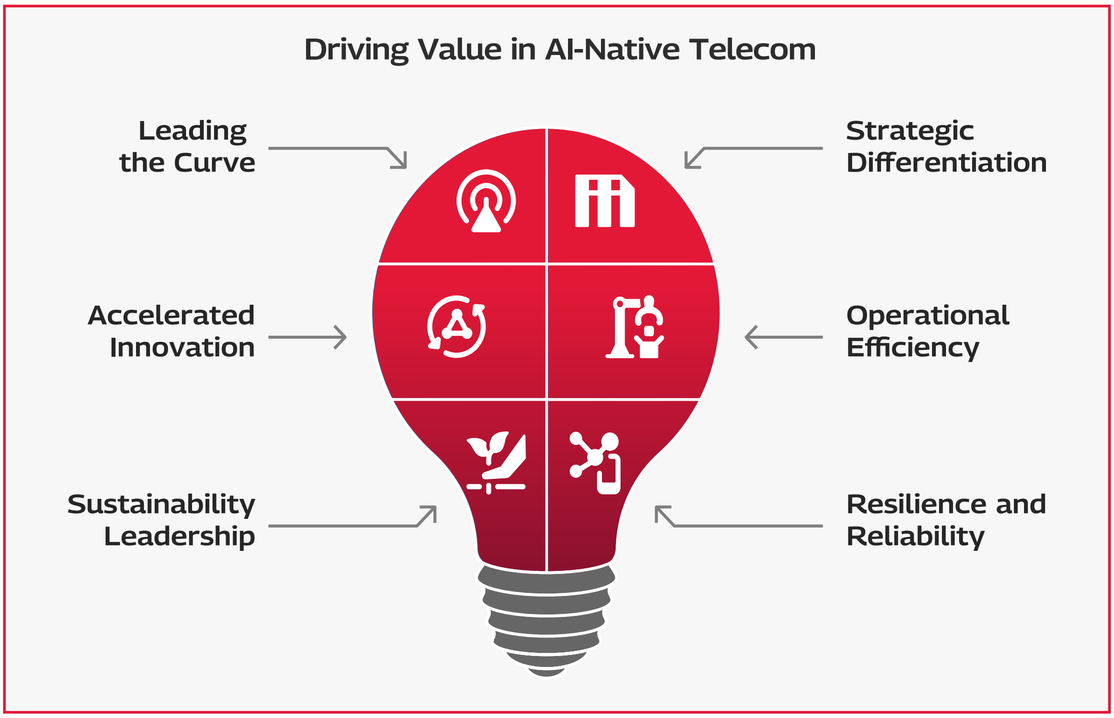

Figure 4: TechM Driving Value in AI-native Telecom

10. Conclusion

As a system and AI integrator, Tech Mahindra is uniquely positioned at the intersection of telecom, IT, and AI with its domain expertise, platform engineering capabilities, and a service-driven mindset. By embracing this expanded role, we are shaping the intelligent networks of tomorrow, delivering value that goes beyond connectivity, grounded in insight, adaptability, and long-term partnership."

The future of telecom is not just about faster speeds or lower latencies. It is about intelligent systems that can learn, adapt, and collaborate. As integrators, let us not merely connect the world—let us empower it with intelligence.

About the Author

Sandeep Sharma

Vice President, Head of Emerging Technologies,
Network Services, Tech Mahindra

A seasoned telecom leader with over two decades of experience in next-gen wireless technologies, including 5G, O-RAN, and AI-powered networks, Sandeep drives innovation, shapes industry standards, and builds strategic partnerships that are redefining the future of telecommunications. A recognized thought leader, Sandeep is a frequent speaker at high-impact forums and author of influential white papers that are helping steer the industry toward 6G. With deep expertise in product management, network planning, and pre-sales, he has led world-class teams across both mature and emerging markets. His vision continues to unlock new growth opportunities and enhance network capabilities in an increasingly digital world..

Rajat Agarwal

Solution Lead, Emerging Technologies,
Network Services, Tech Mahindra

Rajat is a passionate telecom professional with over 18 years of experience, specializing in product management and pre-sales for 4G/5G RAN and O-RAN solutions. As Solution Lead for Emerging Technologies in Network Services at Tech Mahindra, he actively contributes to thought leadership in areas such as NTN, 6G, AI-RAN, and network evolution consulting.

About Tech Mahindra

Tech Mahindra (NSE: TECHM) offers technology consulting and digital solutions to global enterprises across industries, enabling transformative scale at unparalleled speed. With 152,000+ professionals across 90+ countries helping 1100+ clients, Tech Mahindra provides a full spectrum of services including consulting, information technology, enterprise applications, business process services, engineering services, network services, customer experience & design, AI & analytics, and cloud & infrastructure services. It is the first Indian company in the world to have been awarded the Sustainable Markets Initiative's Terra Carta Seal, which recognizes global companies that are actively leading the charge to create a climate and nature-positive future. Tech Mahindra is part of the Mahindra Group, founded in 1945, one of the largest and most admired multinational federation of companies. For more information on how TechM can partner with you to meet your Scale at Speed™ imperatives, please visit https://www.techmahindra.com

TECH mahindra

www.youtube.com/user/techmahindra09
www.facebook.com/techmahindra
www.twitter.com/tech_mahindra
www.linkedin.com/company/tech-mahindra
www.techmahindra.com
mktg@TechMahindra.com