

Research on Development Trends of AI-Driven Mobile Communication Technology

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Abstract: The deep integration of artificial intelligence and mobile communication technology is reshaping the information and communication industry at a visible pace—not only the technology itself but also the underlying business logic is being overturned and rebuilt. The starting point of this discussion is the core logic of "bidirectional empowerment." Following this thread, we can examine layer by layer: networks are becoming increasingly intelligent, connectivity capabilities are being continuously redefined, and future-oriented 6G native design—all these are key dimensions driving transformation. Of course, the road ahead is never smooth—business model transformation, security governance challenges, and global coordination difficulties are all structural hurdles that cannot be avoided.

A clear trend is emerging from these analyses: mobile communication networks are accelerating toward a historic inflection point—transforming from a mere "pipeline" focused solely on connectivity into a true "foundation" capable of supporting intelligence. By the time we enter the 6G era, AI-native will become the core design principle of networks. As for how deep and how fast this integration can ultimately go, it hinges on whether the restructuring of the industrial ecosystem can keep pace and whether innovations in business models can be effectively implemented. These two factors will be the decisive variables that determine success or failure.

Keywords: artificial intelligence; mobile communications; autonomous networks; 6G; integrated sensing and communication

1. Introduction

The evolution of mobile communication technologies from 1G to 5G has consistently followed an upward spiral centered on the ultimate enhancement of connectivity. However, with the exponential advancement of artificial intelligence, this decades-long trajectory of progress is now undergoing a fundamental shift in its defining logic. The industry has designated 2025 as the "Year Zero for 6G Standardization," and the compelling signals emerging from the Mobile World Congress 2026 (MWC26) further confirm a pivotal transformation: the integration of AI and mobile communications is rapidly progressing from the "shallow waters" of exploratory research into the "deep waters" of industrial deployment. As a result, the very essence and scope of mobile communication networks are being redefined, gradually unveiling a new technological frontier[1].

On one front, emerging application scenarios epitomized by generative AI (such as ChatGPT), embodied intelligence, and the low-altitude economy are exerting unprecedented tension on the load-bearing walls of traditional network infrastructure. Challenges—ranging from the explosive growth in uplink bandwidth requirements and the exacting demands for deterministic latency to the real-time necessity for computing power coordination—each present a systemic test to established network capabilities. On the other front, AI technology itself is undergoing a profound role transition in this wave. It is no longer merely an "auxiliary tool" superimposed upon the network; instead, it is entrusted with the historic responsibility of serving as the "first principle of network design." Starting from this foundational logic, it is

reshaping network architecture, restructuring operational models, and rewriting the commercial ecosystem. It is this two-way empowerment mechanism—driven by both demand-pull and technology-push—that intertwines like two distinct threads, together pulsating as the most dynamic heartbeat in the current evolution of mobile communication technology[2].

2. Core Logic: The Technological Paradigm of Bidirectional Empowerment

The GSMA and GTI have jointly released the Mobile AI White Paper, which, for the first time, systematically defines the paradigm-shifting integration of mobile communications and artificial intelligence from a theoretical standpoint, and formally introduces the core conceptual framework of "Mobile AI." At the heart of this paradigm lies a bidirectional, co-evolutionary innovation mechanism: downward, it leverages ubiquitous communication networks to enable the pervasive deployment of AI capabilities, embedding intelligence into every industry as naturally as the very air we breathe; upward, it harnesses the inherent power of AI to drive network systems toward higher-order intelligence, endowing the network itself with the capacity to perceive, reason, and evolve. In this way, mobile communications and artificial intelligence are no longer a mere layering of tools, but are deeply integrated, each empowering the other to weave a synergistically evolving technological ecosystem. This is not merely a confluence of technologies, but a mutual progression of two defining imperatives of our era[3].

2.1 Network for AI: Connectivity as the Foundation for AI Scaling

The ubiquitous deployment and large-scale application of artificial intelligence technologies are forging an increasingly profound symbiotic relationship with communication infrastructure. At present, the computing architecture of AI applications is undergoing a fundamental transformation—rapidly evolving from a singular model of cloud-centric centralized inference toward a new paradigm of ubiquitous intelligence enabled by device-edge-cloud collaborative computing. Massive numbers of terminal sensors, smart cameras, and wearable devices collect data ceaselessly around the clock, and this data must be continuously streamed to edge nodes for real-time processing and inference. This evolutionary trend is fundamentally reshaping the spatial distribution and temporal characteristics of network traffic: in stark contrast to the downlink-dominated traffic model of the mobile internet era, the proportion of uplink traffic in AI-driven scenarios is rising exponentially. This, in turn, imposes unprecedented and stringent demands on network uplink transmission capacity, end-to-end deterministic latency, and massive connection density. It is based on this profound insight that the industry has reached a broad consensus: the true bottleneck for future large-scale AI deployment will no longer lie in computing power itself, but will be rooted in connectivity capabilities and energy efficiency—these two factors are becoming the scarcest foundational resources in the intelligent era[4].

2.2 AI for Network: Networks Transitioning from Rule-Driven to Intelligent Adaptive

Meanwhile, the systematic integration of artificial intelligence is fundamentally reshaping the operational logic of networks from the ground up. Traditional network architectures have long been confined to rigid models dominated by preset rules and manual intervention, rendering them inadequate for flexibly responding to complex and dynamic service scenarios[5]. The AI-driven evolution toward network intelligence is now endowing network systems with unprecedented capabilities in perception, autonomous decision-making, and continuous learning, catalyzing a qualitative transformation in operational paradigms: shifting from "passive response"—reacting after issues occur—to "proactive adaptation"—anticipating and preempting challenges.

On the stage of MWC26, Huawei's inaugural "AI-Centric Network" architecture vision and Ericsson's landmark "Intelligent Fabric" technology concept converged on the same proposition: AI is no longer merely an upper-layer

application hosted by the network, but is evolving into the fundamental logic underpinning network architecture design, resource scheduling strategies, and performance optimization mechanisms. It is becoming the intrinsic DNA and design departure point for network systems, propelling communication networks toward a truly AI-native era[6].

3. Trends in Technological Evolution

3.1 Autonomous Networks: From Concept to Large-Scale Deployment

3.1.1 The Intent-Driven Operational Closed Loop

Traditional operations and maintenance (O&M) models have long been entrenched in the confines of expert experience and static rules, relying on passive manual inputs to sustain operations. When confronted with the need for real-time optimization of complex network systems in dynamic environments, these models are increasingly overwhelmed and inadequate. The paradigm of Intent-Based Operations (IBO) pioneers an entirely new path: it autonomously translates business-level service objectives (e.g., "guaranteeing user experience quality in a specific area during a particular time period") into network-executable configuration policies, while establishing a continuous closed-loop feedback and dynamic optimization mechanism. This transforms O&M processes from cumbersome complexity to elegant simplicity, making manual intervention the exception rather than the rule[7].

In this cutting-edge direction, the A2A Intent Interface jointly released by Huawei and TM Forum represents a landmark breakthrough. By enabling cross-domain and multi-vendor network capability abstraction and intelligent coordination, this interface provides a viable technical pathway and open interface specifications for end-to-end intent-driven operations. It is dismantling the barriers of proprietary device ecosystems, empowering the network to truly understand the "language of intent" from business requirements, and infusing soul into the future vision of autonomous networks.

3.1.2 The Application of RAN Agents

The Radio Access Network (RAN), as the most intricate and resource-intensive domain within mobile communication systems, has a level of intelligence that directly determines the marginal gains in overall network performance. RAN Agents, built upon Communication Foundation Models and Radio Digital Twin Systems (RDTs), are injecting unprecedented vitality into this critical field. These agents can precisely sense service dynamics, predict network states proactively, and dynamically recalibrate resource allocation. This enables the construction of a nearly independent autonomous closed loop at the RAN level, turning single-domain management from an ideal into a tangible reality.

A compelling example is the "Digital Employee" incubated from China Telecom's self-developed Network Foundation Model. This application has carved out a breakthrough in live network operations, delivering quantifiable results in cost reduction and efficiency enhancement: the monthly average frequency of on-site fault handling by maintenance personnel has dropped by 35%, the proportion of AI-assisted code generation has surged to 40%, and overall R&D efficiency has increased by 20%. Behind these three data points lies a tangible leap of AI transitioning from concept to productive force. They are not merely a footnote to technological feasibility but rather a quantifiable, replicable, and promising harbinger for the future of AI-driven network operations[8].

3.1.3 Accelerating Commercial Deployment

According to the latest research report outlined by TM Forum, the global penetration rate of L4-level high-order autonomous networks is projected to reach approximately 23% by 2026. Alongside the ongoing evolution of relevant

standard systems and the deepening advancement of industrial practices, autonomous networks are accelerating their transition from the proving grounds of concept validation to the main battlefield of large-scale commercial deployment. They are no longer merely a technological vision; they are progressively becoming strategic anchor points for operators to restructure operational cost structures, unlock resource efficiency, and reshape user experiences, injecting a continuous stream of resilient momentum into their competitive edge in the intelligent era. This represents not just a leap in network capability, but a watershed moment for operators on their journey toward high-order autonomy.

3.2 Computing and Network Convergence: Deep Synergy Between Connectivity and Computation

The end-to-end performance of AI applications has never been merely a simple reflection of network connectivity—it depends not only on the bandwidth and quality of service (QoS) of the connection pipeline, but more fundamentally on the efficient scheduling and cross-domain coordinated allocation of computing resources. In an era where intelligent services are becoming increasingly complex, the quality of connectivity and the distribution of computing power are interweaving into a double helix that determines application experience. It is based on this profound insight that the deep integration of computing resources and network capabilities is no longer an optional path in technological evolution, but rather a foundational prerequisite for supporting the ubiquitous deployment and large-scale application of AI. They empower each other, collectively weaving the underlying fabric of the intelligent era. This is not merely an architectural upgrade, but the indispensable path for AI to journey from the cloud to everything.

3.2.1 Computing-Aware Networking and Scheduling

An invisible barrier has long persisted within traditional network architectures—the chronic absence of real-time awareness regarding computing resource status has kept connectivity and computation flowing like two separate rivers, rarely converging, let alone achieving collaborative optimization. The introduction of Computing-Aware Networking (CAN) is precisely aimed at shattering this barrier: it integrates the dynamic pulse of computing resources into the lifeblood of routing decisions, enabling service traffic to navigate with purpose rather than 盲目, directing it precisely toward optimal computing nodes. This infuses the deep integration of connectivity and computation with an agile intelligence. The significance of this mechanism extends far beyond merely pioneering a technical pathway—for time-critical AI application scenarios such as autonomous driving and industrial control, it underpins not just the flow of data, but split-second decisions where safety hangs in the balance. In a profound sense, Computing-Aware Networking is emerging as the foundational cornerstone for the intelligent world's journey from the cloud to reality, from abstract concept to operational lifeline.

3.2.2 Data Centers Evolving Toward AIDC

The infrastructure architecture of traditional telecom data centers is struggling to withstand the computing power surge unleashed by large-scale AI training and inference tasks—the twin onslaught of high concurrency and extreme computing density is punching through the load-bearing walls of legacy designs. The shift toward Artificial Intelligence Data Centers (AIDC) is therefore no longer a matter of incremental upgrades, but a systemic overhaul that touches every layer from hardware to energy: chip selection, heterogeneous computing architectures, high-speed interconnect topologies, cooling and thermal management systems, and even power delivery schemes—every change sends ripples across the entire ecosystem. On the global stage of MWC26, Huawei's Atlas 950 SuperPoD—a computing supernode hardware platform making its overseas debut—stands as a signature wave in this technology transformation tide. Beneath the surface, however, a deeper imperative is emerging: computing-power synergy—the coordinated orchestration and dynamic matching of computing loads with electricity resources—is moving from the periphery to the core, emerging as

a critical frontier for intelligent computing infrastructure to achieve optimal energy efficiency and a sustainable future. When computing begins to converse with power, every joule flowing through the data center will precisely fuel every breath of intelligence. This is more than an architectural rebirth—it is the indispensable path forward for the intelligent computing era.

3.3 6G Evolution: The Generational Characteristics of AI-Native Design

For the 6G networks slated for commercial deployment around 2030, the industry has already sketched a clear vision of the future: they are widely defined as "AI-Native" mobile communication systems—a designation that in itself heralds a profound generational revolution. In stark contrast to the 5G era, where AI capabilities were often tacked on as bolt-on modules or application-layer afterthoughts, 6G has AI etched into its genetic code from the very beginning. It is no longer about forcing intelligence into the shell of a network; rather, it is about letting intelligence grow organically from the network's bone and marrow. Starting from the very origin of architectural design, AI capabilities are embedded within the system's foundational fabric, becoming an innate endowment for network operation and capability generation—as intrinsic to the system as breathing or a heartbeat, seamlessly fused with communication itself. This is not merely a divergence in technological pathways; it is a fundamental transformation of the network's essence. When AI ceases to be a tool and becomes the intrinsic mode of network existence, 6G will usher in a new communication epoch where intelligence is pervasive and inherent.

3.3.1 AI-Native Design of the Architecture

Unlike the transitional compromise of adopting Non-Standalone (NSA) architecture in the early days of 5G to accelerate commercial deployment, the industry has reached an unprecedented consensus for 6G: this next-generation network must firmly embrace Standalone (SA) architecture from the very first line of standardization, embedding AI capabilities inherently into every corner of the Radio Access Network and core network—not as a post-hoc patch. Ericsson's pioneering silicon design, which achieves a direct physical handshake between baseband signal processing and AI modules, stands as the first declaration of the "AI-native" concept written at the physical layer. Examined from the perspective of systemic capability, AI-native design is far from an empty concept: it means that every network node possesses a locally intelligent brain for inference, the air interface protocol stack must reserve pathways for AI model transmission and over-the-air updates, and the protocol stack functions themselves can dynamically optimize and self-evolve in response to fluctuating service demands. Thus, a systematic architecture with AI genes embedded throughout—from underlying hardware to upper-layer protocols—is moving from blueprint to reality. This represents not merely technological iteration, but a fundamental rewriting of the genetic code for the mobile communications generation.

3.3.2 Integrated Sensing and Communication: A New Functional Dimension

The technological evolution of 6G networks, targeted for commercial deployment around 2030, is undergoing a systemic leap from quantitative accumulation to qualitative transformation. It no longer confines itself to the linear improvement of traditional performance metrics such as peak data rates; instead, it is endowed with entirely new functional dimensions, including Integrated Sensing and Communication (ISAC), environmental intelligence sensing, and digital twins. Among these, ISAC stands as a crown-jewel technology of 6G, fundamentally reinventing the network by granting it a radar-like passive sensing capability—enabling the real-time capture of a target's position, velocity, and attitude, and endowing invisible electromagnetic waves with the power to perceive the surrounding world. The infusion of this capability lays a solid perceptual foundation for emerging scenarios such as the low-altitude economy and

vehicle-to-everything (V2X) coordination. It is the convergence of these novel capabilities that drives a profound metamorphosis in the functional positioning of mobile communication networks—from the silent connectivity pipes of the past to a converged integrated platform uniting "sensing, connectivity, and computing." The network is no longer merely a conduit for data; it is evolving into an intelligent hub where the physical world and digital space are mapped onto one another.

3.3.3 Spectrum and Technology: Pioneering Exploration

The U6GHz band, with its inherent advantages of large bandwidth and extensive coverage, has been designated as one of the global key frequency bands for mobile communications, serving as a critical strategic pivot for the smooth transition from 5G-Advanced to 6G. At the forefront of industrial practice, Qualcomm has already taken the lead in launching 6G ultra-massive MIMO field trials and, in collaboration with Nokia Bell Labs, has successfully completed interoperability validation for wireless AI technologies. These breakthroughs have laid a solid technical foundation for the scheduled arrival of 6G pre-commercial terminals by 2028. Of particular note, the World Radiocommunication Conference 2027 (WRC-27) will deliver the final decision on candidate frequency bands for 6G. During this critical window that will shape the industrial landscape for the next decade, the global industry must join forces and consolidate efforts to drive the formation of a unified, open, and inclusive global 6G standard system—building a common foundation for the sustainable development and scaling benefits of future mobile communications.

4. Industrial Challenges and Responses

4.1 Redefining the Business Model

Amid the wave of deep integration between artificial intelligence and mobile communication networks, how to establish a pricing mechanism for network capabilities that aligns with the AI era has become a core challenge confronting both operators and equipment manufacturers. Squeezed by persistently high capital expenditures for 5G networks and intensifying competition in the traffic market, the traditional traffic-based billing model—with its single dimension—is running into unprecedented structural constraints. Faced with this dilemma, the industry broadly pins its hopes on the "productization" of network capabilities and their opening up via APIs, aiming to propel operators from their former role as silent "pipes" to actively empowering "platforms." This transition is expected to give rise to multi-tiered charging models based on differentiated capabilities such as network slicing, quality of on-demand service (QoD), and computing resource scheduling. As the GSMA Director General has cautioned, the industry still needs to confront three towering mountains ahead: "completing the 5G journey," "embracing the AI challenge," and "ensuring network security." Systemic innovation in business models represents the critical path to surmount these mountains and journey toward the future intelligent world. This is not merely an act of self-redemption for operators, but the indispensable route for the entire mobile communications industry to redefine its value proposition in the AI era.

4.2 A New Dimension of Security Governance

The systematic integration of artificial intelligence is unveiling a new and challenging chapter for the security governance of mobile communication networks. On one hand, AI models themselves are facing unprecedented security threats—adversarial attacks, data poisoning, model theft, and other emerging risks are proliferating, turning AI systems from defenders into targets. On the other hand, AI-powered automated attack methods, with their heightened stealth and destructive efficacy, are continuously amplifying network risks, prying open Pandora's box. As Liu Guiqing, President of China Telecom, has emphatically stated: "Without security, there is no intelligence." In essence, AI security governance is

no longer an optional supplement but has become a critical determinant of operators' service capabilities and core competitiveness. Confronting the complex and volatile threat landscape of the intelligent era, only by establishing a full-lifecycle security protection system that encompasses the data layer, the model layer, and the application layer—building multi-layered defenses from the source to the endpoint—can we safeguard the lifeline of security amid the wave of intelligence.

4.3 Global Synergy and Ecosystem Co-construction

The globally coordinated allocation of spectrum resources is the fundamental prerequisite and cornerstone for weaving a truly seamless global hardware ecosystem and terminal industry landscape, and for reducing overall industry chain costs at the source. However, with the international standards for 6G yet to be finalized, countries and regions continue to explore their own differentiated technological paths, presenting a landscape of parallel and diverse evolution. During this critical transitional window, the industry urgently needs to build closer communication bridges and collaboration mechanisms within the multilateral frameworks of international organizations such as the International Telecommunication Union (ITU) and the 3rd Generation Partnership Project (3GPP), in order to avoid ecosystem fragmentation and technological isolation caused by standard divergence. At the same time, as the computing infrastructure landscape continues to expand, the accompanying pressure of energy consumption is emerging as a persistent challenge of our times—green communications and sustainable development are no longer optional, but have become mandatory imperatives within the global consensus. Moving forward, we must find a dynamic balance between pushing the boundaries of technological innovation and accelerating large-scale industrial deployment—a path toward efficiency, low carbon, and sustainability that enables the mobile communications industry to both ride the waves of the intelligent era and safeguard the planet we share. This is not merely technological evolution; it is a reshaping of industrial responsibility and the very fabric of our civilization.

5. Conclusions and Prospects

Artificial intelligence technology is, with an unstoppable momentum, profoundly reshaping the technological core and industrial boundaries of mobile communications. Through the detailed analysis of the "bidirectional empowerment" logic presented earlier, it becomes clear that this convergence is far more than a simple layering of technologies—it represents a systemic restructuring that extends from the underlying architecture to the commercial ecosystem. What will the future mobile communication network become? It will evolve into an AI-driven, ubiquitously intelligent infrastructure characterized by deep cloud-network convergence and intrinsic intelligence. Its mission has long transcended that of a silent transmission pipeline merely connecting everything; instead, it is poised to complete a historic leap, transforming into a core carrier that perceives the physical world, intelligently schedules computing resources, and hosts distributed intelligence.

Examining the integrated development of mobile communications and artificial intelligence from a broader perspective reveals a clear underlying logic of evolution. In the near term, AI-empowered network optimization takes center stage. The focus of this phase lies in building autonomous operation capabilities, liberating the network from the rigid model of passive response and enabling it to learn proactive prediction and dynamic adaptation. This is not merely an efficiency improvement, but a fundamental shift in the network's operational logic: as the network begins to acquire the capacity for "thought," it transcends its role as a mere tool and evolves into an intelligent partner for operators. Looking ahead to the medium term, the network will truly become the solid foundation for large-scale AI deployment. Capabilities that today may sound somewhat futuristic—such as integrated sensing and communication, and computing-network convergence—will mature during this period, progressing from nascent stages to widespread

application. By then, connectivity and perception, computation and intelligence, will truly interweave into a ubiquitous fabric of wisdom. This network will not only transmit data but also perceive subtle changes in the physical world and deliver intelligent responses within milliseconds. Over the long term, as the 6G era arrives as promised, AI-native will become the core design principle of the network. This is not merely a choice of technological pathway, but a fundamental metamorphosis of the network's essence: communication systems will truly possess the characteristics of a living organism—capable of environmental perception, autonomous decision-making, and continuous evolution. That will herald a new epoch where network and intelligence are seamlessly integrated, communication and sensing interpenetrate, and the physical world and digital space map onto one another. Perhaps, looking back from that future vantage point, the issues that currently concern us—business models, security governance, standard coordination—will appear as merely necessary passages on the road leading there.

For the industry players at the heart of this profound transformation, embracing the "Mobile AI" integration paradigm is not only an inevitable choice to ride the wave of technological iteration, but also the strategic high ground from which to win the future digital competition. Technological breakthroughs form the cutting edge, business model reconstruction provides the blueprint, strengthened security governance defines the baseline, and globally coordinated advancement builds the consensus. Not one of these four dimensions can be neglected; each demands dedicated effort. Only by exerting multi-dimensional forces in synchronized resonance can we propel the deep integration of mobile communications and artificial intelligence from vision to reality, driving continuous evolution toward broader industrial practice. This path will certainly not be smooth, but it is precisely for this reason that it holds such promise. After all, what truly shapes the future is never what comes easily, but those distant shores that can only be reached by overcoming numerous obstacles. And that distant shore—a future where intelligence is ubiquitous and all things are connected in seamless communication—is beckoning us forward.

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