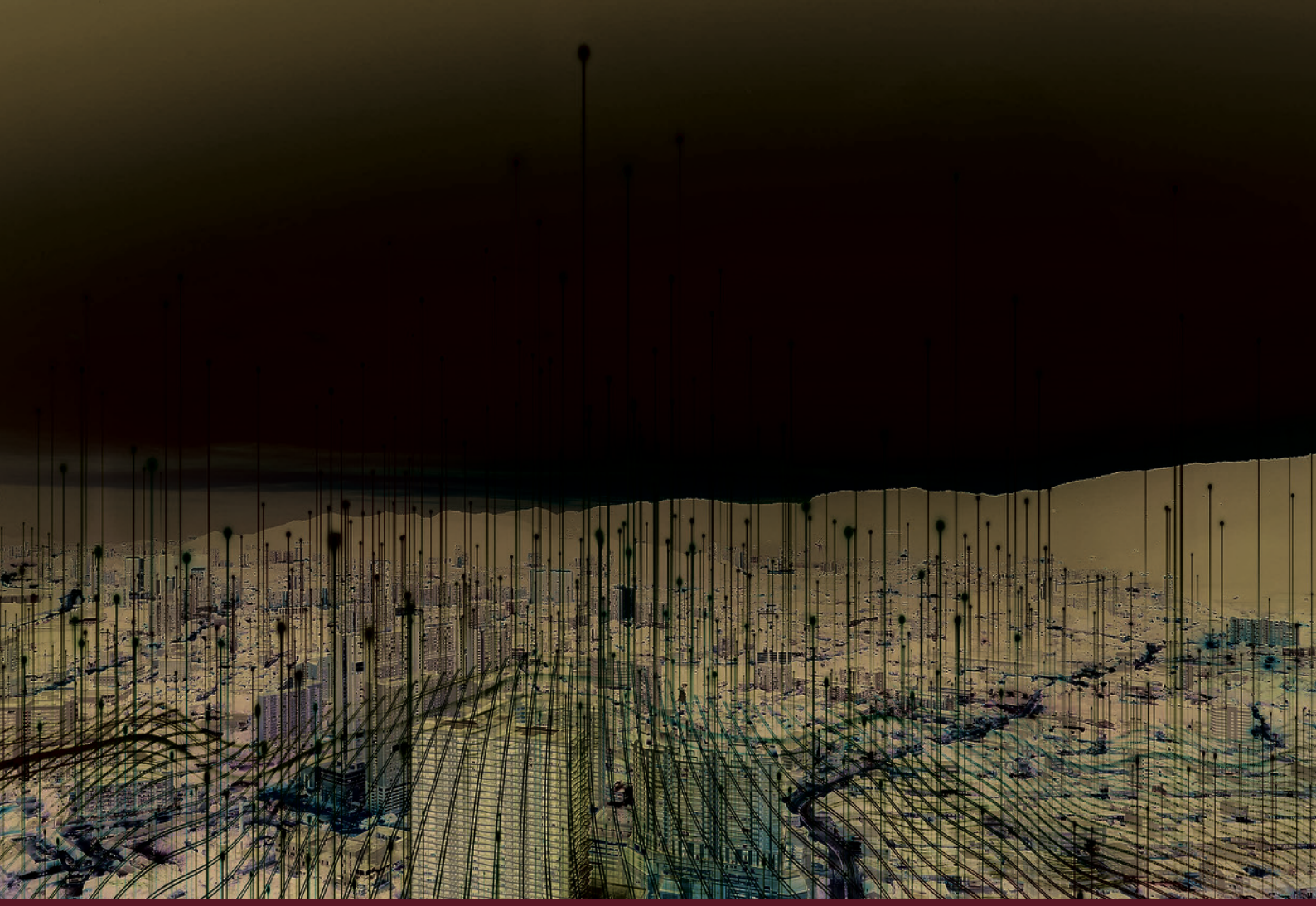

How The Intelligent Packet Core Drives 5G/5G-A Monetization

GSMA™

February 2026

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Contents

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1. Executive Summary

With the larger-scale deployment of 5G/5G-Advanced (5G-A) globally, more operators are shifting their focus from promoting 5G user growth to monetizing 5G/5G-A. At the same time, artificial intelligence (AI) continues to develop rapidly across various fields. On one hand, it brings new capabilities to the telecommunications industry; on the other hand, emerging AI formats such as AI agents and embodied intelligence also offer potential new value scenarios and business opportunities for the telecom sector. In addition, the widespread adoption of smart home devices and the rapid development of new energy vehicles globally have also created new opportunities for connecting people with vehicles and for new connections between people and their homes devices.

With the ongoing global deployment of 5G, operators are accelerating the 5G/5G-A monetization: The Network Data Analytics Function (NWDAF), integrated with AI capabilities, has been deployed and put into commercial use in multiple countries around the world, becoming a crucial enabler for operators to experiences monetization. Some operators have began exploring the User Plane Function (UPF) integrated Media over QUIC (MOQ) relay function defined by 3GPP, which will fundamentally resolve technical and business model challenges, driving an increase in the proportion of mobile high-definition video. In addition, multiple operators have completed testing for Mobile Home Assurance and have entered the practical commercial phase.

As the carrier exploration of 5G monetization deepens, new use cases continue to grow assurance and have entered the practical commercial phase. There has been an acceleration of key services such as cloud gaming, video conferencing, live broadcasting, and Fixed Wireless Access (FWA) enabling experience acceleration for key scenario such as high-speed rail or large-scale events. There has also been collaboration with Over The Top (OTT) players to provide high-definition video acceleration services for the consumers and providing private domain network services for smart homes and smart car users. Looking further ahead, with the enhancement of AI agents throughout the network, it is intended to provide personalized intelligent online services for large-scale events and to offer travel experience planning for users. This will enable every user to enjoy a customized online experience, transforming the internet into an intelligent companion that understands and serves users' needs.

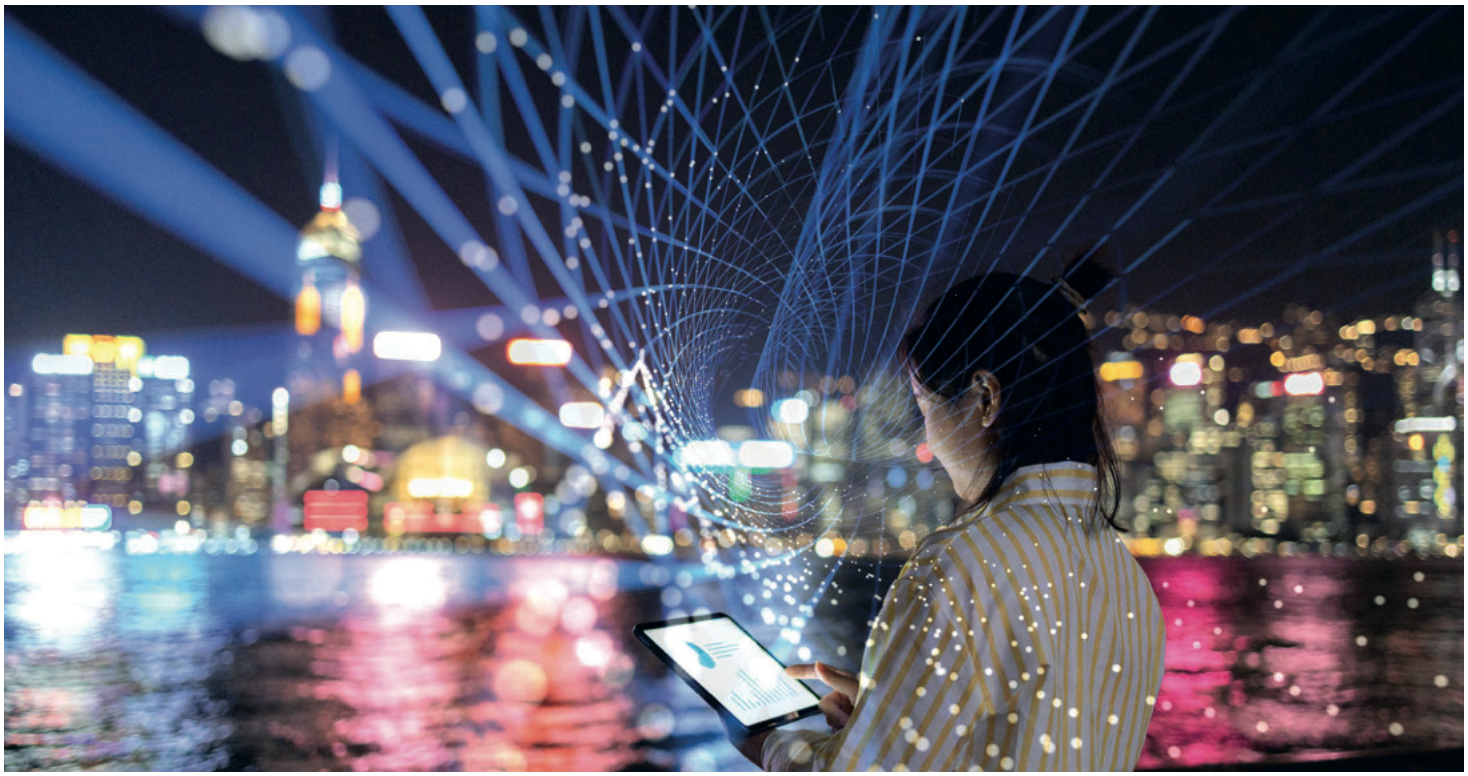
Standards are also continuously being improved, defining more monetization capabilities for 5G/5G-A.3GPP standards have defined the NWDAF and Policy Control Function (PCF), and continue to refine and enhance differentiated service capabilities. In addition, many operators have also proposed the requirement for dynamic User Equipment (UE) logos to provide differentiated services for users and hoping to achieve this through unified standards. 3GPP Release 19 (R19) also introduces a new MOQ Relay feature, which is borrowed from the IETF and integrated in the UPF to improve the efficiency of mobile video distribution and enhance high-definition video acceleration services for public users. With the development of AI Agents, AI-based digital identity authentication has become a key new scenario. 3GPP SA1 introduced security requirements and related use cases at the September 2025 meeting. 3GPP TR 22.870 [1] includes security-related content such as trust establishment, security management, and digital identity.

Enabling the Intelligent Packet Core (IPC) Network should be considered in phases, and different operators can build their networks based on their own specific conditions. World-leading operators have started to explore the 5G/5G-A monetization with CMCC, e& UAE, Globe, KT and Turkcell having started commercial use, trials, and PoCs. To allow the IPC to fully unleash the potential of 5G/5G-A monetization, there is a need for End-to-end industry collaboration to continue to explore new scenarios and business opportunities for network intelligence.

2. Introduction

This white paper will describe how to support 5G/5G-A commercialization from the perspective of mobile networks, focusing on the following scenarios:

1. Using NWDAF integrated AI capabilities to enhance user experience.
2. Operator collaboration with OTTs based on Intelligent Packet Core integrated MOQ Relay, to increase the proportion of High Definition (HD) video.
3. Increase understanding of the new value propositions for mobile networks that can be enabled by AI as well as the new requirements to the core network and new opportunities brought to the IPC and terminals.
4. New use cases and business opportunities in the Human-Vehicle-Home scenario.



3. 5G/5G-A Monetization Trend

3.1. 5G Consumer Market Challenges

he 5G consumer market faces the challenge of weak growth due to the initial connection growth due to the demographic dividend having faded away. Based on forecast published by Department of Economic and Social Affairs Population Division of the United Nations (UN), more than half of all countries and areas globally have fertility below the replacement level of 2.1 live births per woman. This result means that each generation is followed by another roughly equal in size. Most countries where 5G has been deployed on a large scale face the problem of insufficient fertility. As a result, these operators cannot rely on the connection growth brought by the demographic dividend. The growth in the number of mobile connections, as forecast by GSMA, is shown in Figure 1.

Recently, mobile traffic growth has also slowed down. According to the mobile annual data traffic forecast by GSMA, the growth rate of mobile traffic has slowed down this year. The growth rate of mobile traffic has decreased to below 30% since 2025 and to below 20% in 2028. Figure 2 illustrates the overall trend.

The Mobile traffic growth slowdown is caused by many factors. Some key factors are as follows:

— As the mainstay of mobile traffic, the proportion of video traffic in many countries is approaching its peak value, and the penetration rate has slowed down.
— The Time of Mobile network usage for each user has reached its peak. With the rapid development of mobile Internet in the past decade, the Mobile Minutes of Usage (MOU) of most countries has peaked.
— The introduction of new video encoding technology

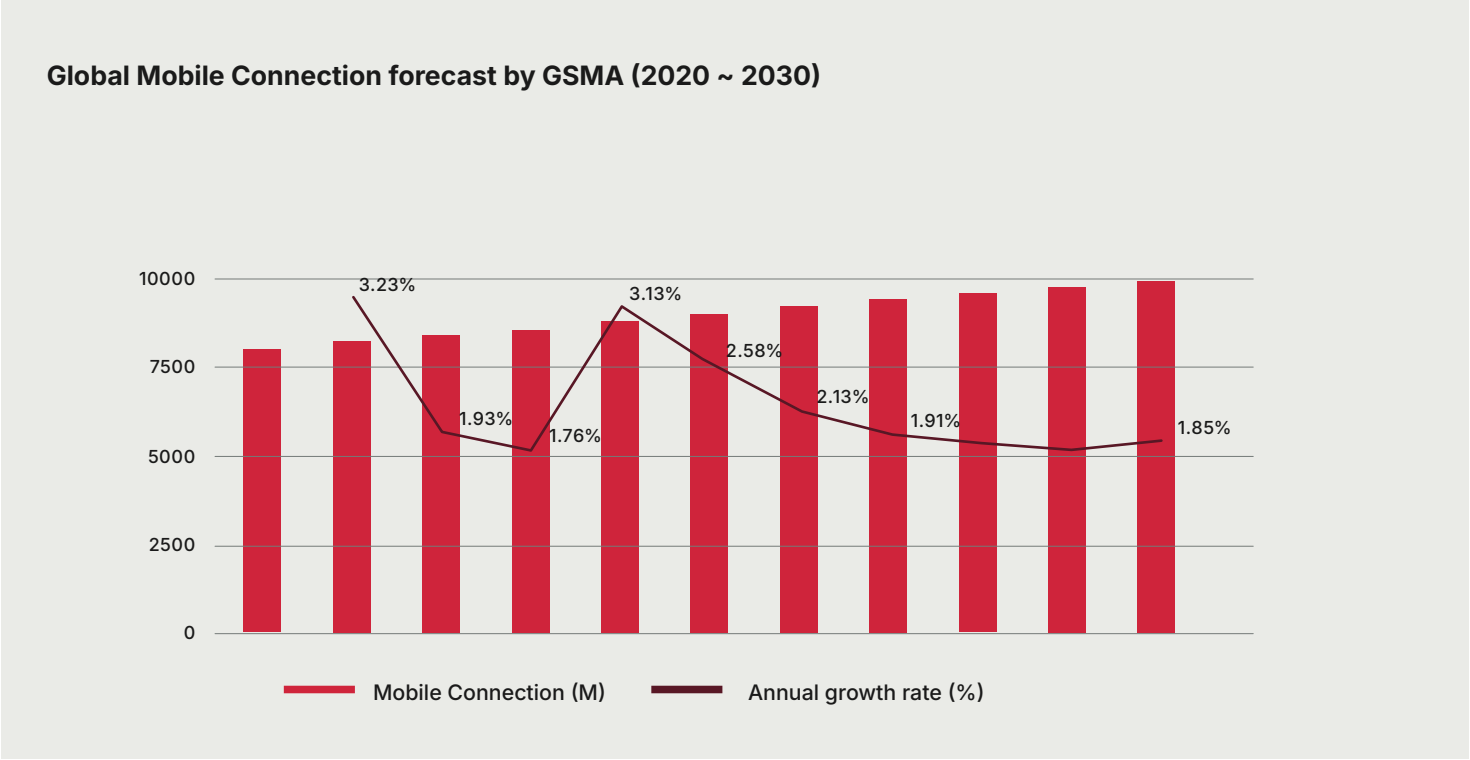
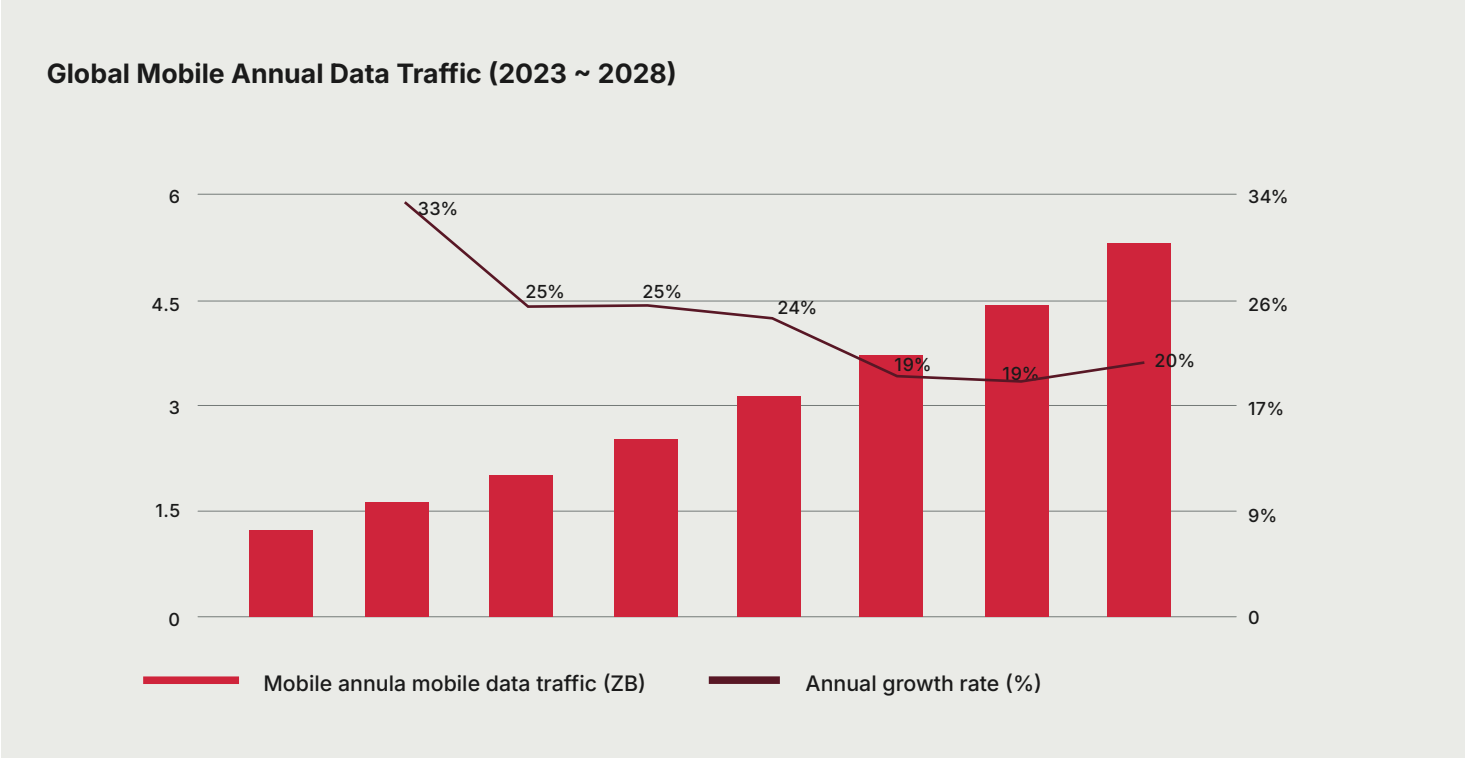


Figure 1, Global Mobile Connection forecast.



Source: GSMA "mobile data traffic will grow over fourfold by the end of the decade with multiple growth drivers"

Figure 2, Global Mobile Annual Data traffic forecast.

such as H.265 is also a key factor that weakens the growth of mobile traffic. Based on recent statistics, the size of the same video after H.265 compression is almost half of that in comparison to H.264 compression. This greatly weakens the growth trend of mobile video traffic.

— On the other hand, new high-bandwidth applications are developing slowly, resulting in a small scale and related growth of mobile traffic has not yet been shown.

The Dilemma of Continuing Traffic Management, the prioritization of cost and network forwarding efficiency, has led to a slowdown in the growth rate of HD video on mobile networks, resulting in a deceleration in mobile traffic growth.

3.2 5G Consumer Market Opportunity

The recent and rapid development of AI in various fields is profoundly transforming the technical architecture and industrial ecosystem of mobile communications. This white paper, from the perspective of mobile communications, systematically analyzes the potential value scenarios brought by AI terminals and applications, as well as the core requirements of the network. This paper also explores the industrial opportunities of the IPC with built-in AI and collaboration between terminals and OTT.

Simultaneously, with the widespread adoption of digital homes and the rapid development of new energy vehicles globally, opportunities have emerged for mass consumers. These opportunities extend from human-to-human connections to human-to-vehicle connections and human-to-home links.

3.3 Acceleration for 5G/5G-A Monetization

5G networks can provide differentiation. Compared with 4G, 5G has more spectrum and higher spectral efficiency, enabling networks to have more resources. In addition, the convergence of the mobile core network and intelligence enables the core network to provide more network capabilities. With intelligent enablement, the core network also can attain awareness of users in real time. Real time awareness and experience, real-time network status awareness, and dynamic decision-making lay the foundation for differentiated operations.

Different users have different requirements for differentiated experiences. For consumer users, 5G has improved bandwidth, but user experience has not been greatly improved. Users are more concerned about ensuring and improving user experience. As more 5G networks are deployed in vertical industries, enterprises' requirements for 5G are shifting from production auxiliary systems to production systems with higher requirements. In this case, enterprises' requirements for low latency and high bandwidth are even stronger. There has been a rapid development of scenarios such as Manufacturing Automation, smart cities, medical surveillance, and agriculture whilst the .. growth of electric vehicles and self-driving this year has resulted in the provision of low-latency and highly reliable links becoming a key requirement of 5G. For home users, with the large-scale deployment of 5G FWA, which provides a higher bandwidth than 4G FWA, the provision of differentiated latency experience for home entertainment, especially games, has become a widespread requirement.

According to a survey conducted by GSMA in 2022, customers are willing to pay an extra 18% for better experience to obtain better bandwidth and latency. In addition, these high-end users also want to have a better or more exclusive experience.

With the ongoing global deployment of 5G, operators are accelerating the 5G/5G-A monetization. The NWDAF, integrated with AI capabilities, serves as a key component of the intelligent core network. It effectively addresses critical challenges in experience management, such as being accurately aware of users and services, precisely evaluating service experiences, and dynamically and promptly ensuring and enhancing user experience. It has been deployed and put into commercial use in multiple countries around the world, becoming a crucial enabler for operators to realize monetization. As some operators begin exploring the 3GPP defined UPF integrated MOQ relay function, this will fundamentally resolve technical and business model challenges, driving an increase in the proportion of mobile HD video. In addition, multiple operators have completed testing for Mobile Home Assurance and have entered the practical commercial phase.

4. Use Cases

4.1 AI Agent

4.1.1 Personalized Intelligent Network Service for Large-Scale Events

The traditional network service model, primarily based on standardized data packages, struggles to meet individual users' growing demand. By deeply understanding user intent, network AI agent enables on-demand customization and dynamic allocation of network resources, driving the evolution of network services from a "one-size-fits-all" manner to a "highly individualized" manner. This represents not only an upgrade in service models but also a reshaping of the network value chain — empowering every user with a tailored network experience and transforming the network into an intelligent partner that understands and serves the users.

When the users plan to conduct HD live streaming at hot-spot venues hosting large-scale events, such as theatres or stadiums, they only need to convey their service requirements in natural language to a network AI agent. Then, upon the user request, the network AI agent can automatically complete complex processes such as venue network quality assessment, assurance plan generation, and resource reservation configuration, thus ensuring an optimal live streaming experience throughout the events. In this use case, the network AI agent enables direct translation of user intent into network actions, delivering personalized and dynamic assurance services through interactive service processing and experience feedback. For Mobile Network Operators (MNOs), refined package design and operations based on dimensions such as user, service, time, and location, along with retail-style package subscriptions, help to increase service revenue.

4.1.2 User Travel Experience Planning Services

The network demands of business professionals in mobile scenarios such as high-speed trains and airplanes are becoming increasingly prominent. The network AI agent can automatically query travel routes based on the user's itinerary, analyze route network quality in advance, intelligently recommend assurance solutions, and continuously optimize network configurations during the journey to ensure that critical services like video conferences remain unaffected.

When it comes to a one-stop travel service involving flight tickets, hotel booking, and cross-regional arrangement, multi-agent collaboration is required. OTT/terminal agent initiates network evaluation and optimization based on key service requirements. The user only needs to express simple intents, such as a business trip, and the terminal agent can collaborate with other trustworthy agents, e.g., airline agents, hotel agents, etc., to automatically complete an end-to-end service, such as flight booking, hotel arrangement, and international roaming activation. In this process, the network AI agent not only provides communication assurance but also acts as a collaborative hub, ensuring seamless integration of all services. This is shown in Figure 3.

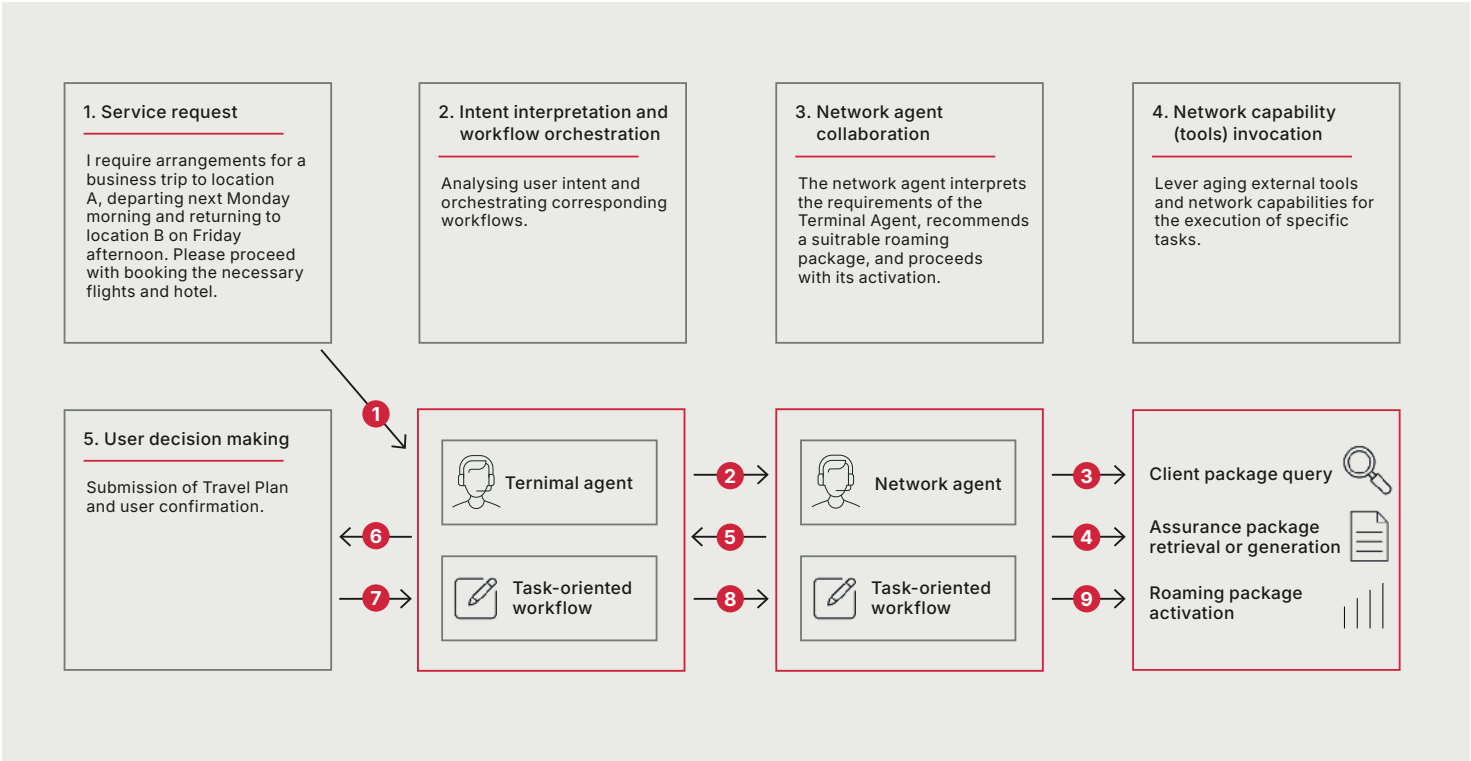


Figure 3, Multi-Agent Coordinated Travel Service.

4.2 Differentiated Assurance for Key service

The following subsections describe several user cases related to Service Assurance.

4.2.1 Live Broadcast Assurance

The live broadcast has become a mainstream service around the world. In China, the number of live broadcast e-commerce users reached 590 million in 2024. South-east Asia is one of the most active regions for overseas live broadcast and has become a new blue ocean for live e-commerce. TikTok Shop's total market share in Southeast Asia rose to 13.2 percent in 2023, with Gross Merchandise Volume (GMV) reaching $16.3 billion. In the US market, live broadcast e-commerce has been encouraged by officials, and there is a large growth expected in the future. On May 31, 2024, Jeffee Star, the top-stream network in the USA, conducted an eight-hour live broadcast on TikTok, setting a record GMV of $665,000 for a single live broadcast. In the European market, taking Spain as an example, the e-commerce market will reach US$87.9 billion, with an Internet penetration rate of 93% and an online purchase rate of 63%.

Live broadcast services are commonly accessed through cellular and FWA connections. Travel, food, and adventure broadcast services must occur in a real environment to attract audiences. A wide-coverage mobile network is required.

The main requirements of live broadcast services are high upstream bandwidth to meet the requirements of 1080p and higher resolution. Thus, stable and reliable connections to ensure continuous network availability during mobility is a rigid requirement. However, the mobile network bandwidth is affected by multiple factors such as the number of accessed users, cell congestion, radio signal strength, and core network gateway and transport network element congestion, all of which can affect the user experience.

With intelligent capability, the mobile core network can detect the services in use and service experience in real time. Based on the awareness of network resources and status, the network can dynamically adjust network resource allocation, such as improving Quality of Service (QoS) levels, setting up dedicated bearers, delivering Guaranteed Bit Rate (GBR) guarantees, and dynamic slicing, to optimize user experience.

China Mobile has already commercially deployed experience assurance for live streaming services on a large scale in more than ten provinces with over 30 million subscribed users. China Mobile has enabled the NWDAF based packet core network intelligent capabilities, accurately senses service experience in real time, evaluates network quality, and dynamically provides resources and services for users on demand. The effectiveness of the solution has been commercially verified.

In addition, China Unicom has launched 5G live streaming services for specific scenarios such as tourism, agricultural product sales, and marine fisheries. By introducing network data analysis Network Elements (NEs) and slicing technologies, 5G live streaming services are provided to provide targeted uplink bandwidth and speed assurance for live streaming users and provide "High Density (HD) and low latency" user experience. This helps carriers increase the Average Revenue Per User (ARPU) and Data Of Usage (DOU). The package includes 90 Gbit/s to 150 Gbit/s traffic, 150 Mbit/s to 200 Mbit/s upstream rate, and a distinguished Very Very Important Person (VVIP) guarantee.

In 2023, AIS Thailand launched a 5G Live Mode add-on package, which costs US$1.38 for three hours. Users can purchase the package as needed to guarantee the experience of popular applications such as Facebook, Tik Tok, Shopee, and Lazada, especially during network congestion. During the assurance process, users can monitor their experience and assurance effect in real time through the myNetwork app. In the three-month rollout period, the average number of subscriptions per month was 3000, which increased the ARPU by 23%. The user complaint rate was also greatly reduced from 2.5% to 1.2%. In 2024, the GSMA GLOMO Best Mobile Operator Service for Connected Consumers Award was awarded to China Unicom. Live experience assurance is a very important service for operators in the future, helping operators deliver business models and increase revenue.

4.2.2 Video Conference Call Assurance

Video conference service has been widely used in a wide range of fields, such as Government communication, Remote office, online training, telemedicine, and online education have gradually become a new trend. Bezers Consulting forecasts that the global cloud based video conferencing services market will reach 3 billion by 2029, growing at a Compound Annual Growth Rate (CAGR) of 11.3%.

With the continuous increase of network bandwidth and the development of video coding technologies, videoconferencing systems will be revolutionized by higher definition and higher intelligence, which will further drive market growth. In addition, videoconferencing has higher requirements for high-speed and stable Internet connections to ensure good audio and video quality and real-time communication. Video conferences require high bandwidth, especially in multi-party conferences or HD video conferences.

In March 2024, China Mobile officially launched the layered service assurance. Based on intelligent policy control, China Mobile provides users with dynamically customized resources to ensure optimal user experience. By 2025, China Mobile has already commercially deployed experience assurance for video conference services on a large scale in more than ten provinces with subscribed users exceeding 30 million.

4.2.3 Cloud Gaming Assurance

Cloud gaming is a game mode that runs games on the cloud without installing game clients locally. Players can play games anytime, anywhere through a lightweight device, such as a phone, tablet or computer, without worrying about hardware underperformance or insufficient storage.

Currently, Google, Microsoft, Amazon, Migu Express, HUAWEI CLOUD, Activision Cloud, Haima Cloud, Xishanju, and Nvidia GeForce Now have launched their own cloud game products. According to the Grand View Research analysis report [1], the global cloud gaming market will grow by nearly 50% every year and reach US$7 billion by 2027.

Cloud games are sensitive to latency and have many interactive requirements. Therefore, the response delay must be within 100ms. In the worst case, the response delay should not exceed 150ms. The shooting class of games have higher operating precision requirements as the game needs to control the response delay to 60ms or less. The strictest targets are virtual reality (VR) games, where the response delay is generally believed to be less than 25 milliseconds to slow the player's vertigo because the content displayed needs to be closely matched with any physical movement.

In 2023, AIS Thailand will launch a 5G Game Mode add-on package, which is customized for game users. The fee is US$1.38 per three hours. Users can purchase the package as required. Three months after the launch, more than 20% of game users said they were willing to pay for the package.

Like live streaming and conferencing assurance, by 2025, China Mobile has already commercially deployed large-scale game experience assurance in more than ten provinces.

4.2.4 FWA Assurance

5G FWA has shown remarkable growth worldwide and has become one of the most successful 5G services. According to GSA statistics, 150 operators had launched 5G FWA services by 2023, and another 18 operators have announced plans to launch 5G FWA soon. In multiple markets (e.g., Austria, Australia, United Kingdom, Germany, Italy) by 2025, the 5G FWA household penetration rate reached 10% or higher. According to a survey report by Research Nester, the FWA market will exceed US$30.72 billion in 2023 and will reach US$2.32 trillion by the end of 2036, with a compound annual growth rate of about 39.5%.

FWA services include long video, gaming, web browsing, and downloading services. The service distribution varies according to FWA subscribers.
The FWA service has a high demand on network traffic, and the revenue per GB is less than 10% of the revenue per GB of the enhanced mobile broadband (eMBB) service. Therefore, carriers try to bundle packages with different traffic types to increase the ARPU. Since differentiated bandwidth, many operators begin to explore the FWA user layering and bundle differentiated service experience to launch packages of different levels to achieve premium. For example, the FWA game acceleration package during the Universiade provides differentiated latency experience for specific games and benefits for OTT members such as Disney and Xbox. The business is focused on the FWA market and 5G Business-to-Business (B2B) vertical, especially for young and dynamic demographics.

4.3 Differentiated Assurance for Key areas

4.3.1 Smart High-Speed Rail

In many countries, such as China, high-speed rail is a common choice for people to travel. According to the insight into high-speed rail users, the users are 30 to 39 years old and have a medium income level. They are mainly distributed in developed cities. They have a high consumption capability and willingness to spend.

High-speed rail users and operators have a high degree of overlap with high-value users. High-speed rail mainly carries business passengers and tourists. Voice, instant messaging, and videoconferencing are valuable services.

The pain point of high-value users in the high-speed railway scenario is poor user experience. According to the test results, the actual user experience rate is low, and the average user experience rate is lower than 4Mbit/s in the high-speed railway scenario. Short videos, such as TikTok and KuaiShou, are the main service mode of high-speed railways, consuming 58% of the network bandwidth. Video services occupy the bandwidth of high-value subscriber services. Therefore, the high-speed railway dedicated network must be capable of suppressing video services, providing differentiated guarantees for high-speed railway subscribers, and providing differentiated guarantees for high-speed railway services. Under the existing handover mechanism, common public network UEs access the high-speed railway dedicated network, occupying resources of the high-speed railway dedicated network, and affecting user experience. High-speed railway dedicated network UEs perform ping-pong handovers between the dedicated network and the public network, resulting in poor user experience.

China Mobile Guangdong proposes to introduce a profiling capability to accurately distinguish highspeed rail users from common public network users. In addition, the core network delivers different access, camping, and handover policies to different customers. For high-speed railway dedicated network users, the eNodeB preferentially accesses the high-speed railway dedicated network and dedicated frequency bands/carriers. Common users are preferentially connected to public network base stations. This feature prevents high speed railway UEs from accessing the public network and performing ping-pong handovers between the public network and the dedicated network.

4.3.2 Large Event Guarantee

Usually, carriers need to provide guarantees for high-value scenarios. The main features of large-scale events are:

— Firstly, the personnel are dense, large-scale sports events such as the Olympic Games, the World Cup, and so on; the live audience can reach tens of thousands or even hundreds of thousands of people. In addition to the spectators, there are many other users, including athletes, coaches, referees, security personnel, volunteers and so on.
— Secondly, the demand for data traffic is high, and audiences are keen to share their experience of watching the event and shooting the highlights of the game through social media platforms during the game. Some viewers may use mobile devices to watch live broadcasts or replays of the event to get different angles or review highlights. This has high requirements for network bandwidth, especially for HD or even 4K or 8K live broadcast, which consumes a large amount of data.
— Thirdly, communication timeliness and stability are high, and the event staff need to communicate in time to ensure the smooth progress of the event. For example, referees need to communicate the penalty in a timely manner through communication equipment, security personnel need to report the security situation in the venue in a timely manner, and athletes and coaches need to keep in touch for tactical arrangements. In case of an emergency, such as sudden illness and safety accident, on-site personnel need to quickly call medical emergency or related emergency department through the mobile network, which has strict requirements on timeliness of communication.

Large-scale events pose high requirements on mobile networks, requiring large bandwidth, low latency, and high reliability. However, due to limited air interface resources, cell congestion occurs when users are densely populated, and the bandwidth available to each user is low. As a result, user experience is severely affected because users cannot access the network. A new solution will be required, namely mobile networks providing preferential access to networks for users based on user types, such as security and high-value users, and preferentially allocate bandwidth resources to meet emergency communication requirements and network requirements of high-end users. Differentiated resource allocation is used to meet the requirements of special groups or services on the network. Operators can improve network resource utilization and obtain premiums from high-end users.

4.4 HD video Acceleration

Globally, the consumption of HD video is rapidly growing, with the proportion of content at 1080p and higher resolutions continuously increasing. Users' demand for better picture quality drives content upgrades, but it also leads to exponential growth in data traffic. This trend has placed platforms in a difficult situation regarding Content Delivery Network (CDN) bandwidth costs. CDN expenses account for 30%-40% of OTT operating costs, with egress bandwidth alone accounting for 70% of CDN costs. These costs are directly tied to the high bitrates of HD videos—1080p videos have bitrates ranging from 2500 to 4000 kbps, consuming over 1GB of data per hour, leading to a sharp increase in costs under high-frequency on-demand scenarios. To balance growth and cost, reducing bitrates has become a common industry choice. This compromise between picture quality and expenses has become a necessary measure for global mobile HD video platforms to cope with cost pressures.

In 2025, China Mobile Zhejiang introduced HD video acceleration capabilities, collaborating with TikTok to pre-mark popular videos during peak hours and distribute them via the core network for HD video caching. This approach reduced CDN bandwidth consumption while allowing users to watch HD videos. As the bitrate for video viewing increased, the operator's DOU also grew. This technology not only reduced CDN bandwidth costs but also boosted the operator's data traffic, creating new growth opportunities.

4.5 Mobile Home Assurance

Mobile Home is an innovative solution which integrates mobile and fixed networks based on the operator's network infrastructure to establish high-speed, low-latency channels. This allows users to access home devices while on the go, achieving a seamless experience. Currently, the global gaming console market is experiencing a period of rapid expansion, presenting a strategic opportunity for growth. The market size is growing rapidly, and consumer demand has shifted from traditional heavy experiences in the "living room scenario" to instant needs across all scenarios. Among these, Generation Z accounts for 67% of the user base, and their expectations for smooth operation of AAA-level content in mobile scenarios such as commuting and outdoor activities have significantly increased, leading to a sharp rise in demand for remote game streaming.
Currently, game streaming is mainly achieved through Session Traversal Utilities for NAT (STUN) traversal or Traversal Using Relays around NAT (TURN) relay. However, these methods suffer from low Network Address Translation (NAT) traversal success rates, limited internet bandwidth, and high latency due to multiple hops, resulting in unsatisfactory streaming experiences. With the Mobile Home solution, mobile devices can directly access home consoles for game streaming in just one hop, enabling smooth operation of AAA-level games and greatly enhances the gaming experience. Figure 4 shows a comparison between the current solution and the Mobile Home solution.

At the same time, as users' awareness of personal data protection continues to grow, the Mobile Home solution allows users to remotely access home cameras and Network Attached Storage (NAS) devices through the operator's internal network. This ensures both security and privacy while meeting users' needs for remote access.

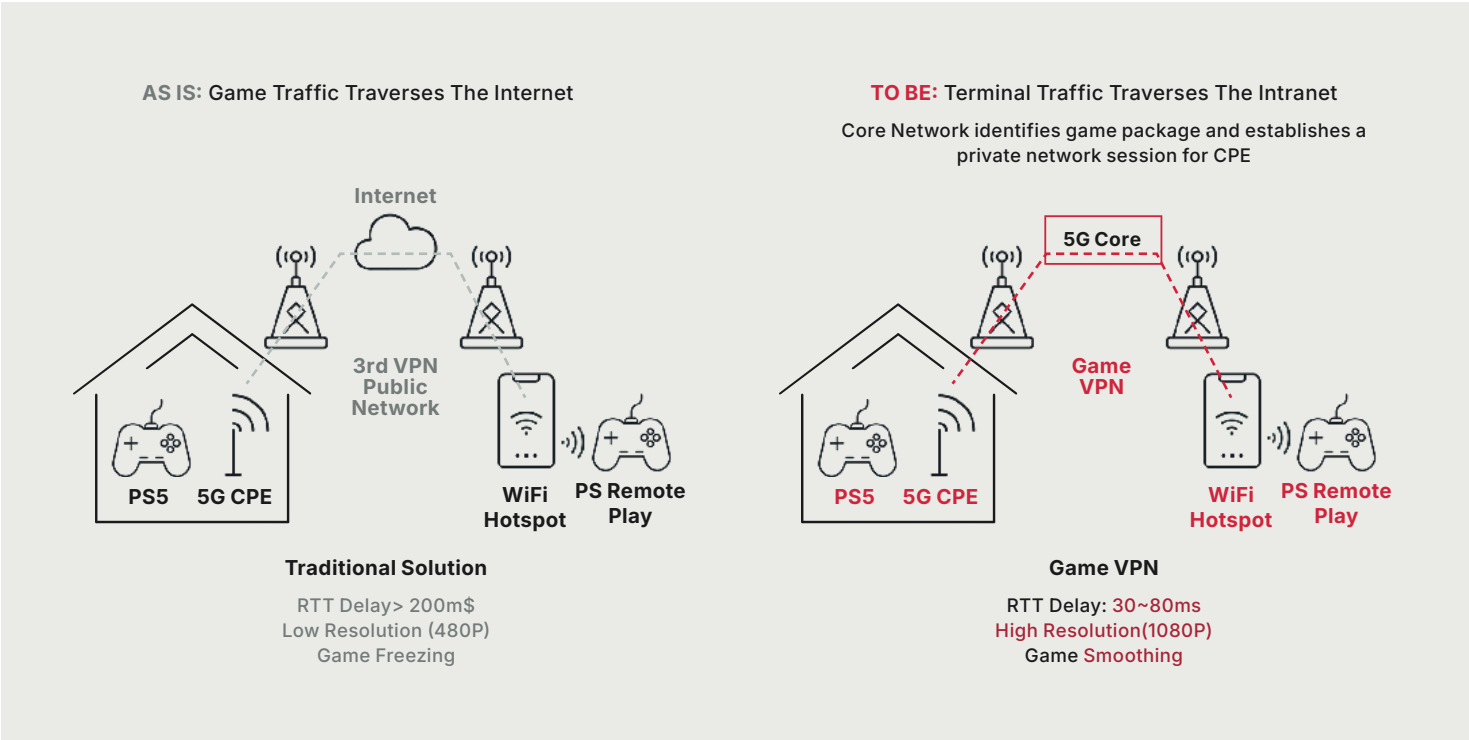


Figure 4, Mobile Home Solution Comparison.

5. Standardisation Progress

5.1 Overview of standardization activities.

This chapter describes the current standard progress in three aspects: network assurance, device awareness, content delivery Assurance and AI Agent digital identity, ensuring that mobile network services can better provide differentiated experiences and guarantees for users.

5.2 Network Assurance

3GPP R19 solves four related key issues in the direction of network assurance:

1. Policy Recommendation. The main solution for this KI includes: the NWDAF determines recommended QoS parameters based on candidate QoS parameters received from the PCF and input of target Quality of Experience (QoE), and uses these as new analytics. By leveraging data collection-based information, the NWDAF can assist the PCF in determining QoS to get accurate things in timely. The detailed procedure is shown in Figure 5
2. Signaling storm mitigation and prevention. If a large amount of Non-Access Stratum (NAS) signaling enters the NW within the same area and time, it may lead to a signaling storm. The NWDAF can predict potential signaling storms in the 5GC and prevent them in advance. The 3GPP R19 standard defines a new analytics method that predicts and prevents signaling storms by collecting internal signaling and Network Function (NF) status information within the 5GC.
3. Vertical Federated Learning (VFL). Due to privacy concerns, models/raw data may not be shared among network entities. VFL was introduced to perform training/inference without exchanging raw data/ models, thereby mitigating privacy issues. The R19 standard ultimately defines the VFL preparation, training, and inference processes between NWDAF(s) and/or AF(s).
4. AI Positioning. This KI is only for AI positioning on the LMF (Location Management Function) side. The LMF performs inference based on models provided by the NWDAF or locally trained models. The content and process of data collected by the LMF from the UE/gNB are discussed and defined by the 3GPP RAN WG.

3GPP R20 has initiated the project "Study on Core Network Enhanced Support for AL/ML - Phase 2"and will carry out the following work tasks (WTs):

- WT1: UP-based UE data collection. The research includes supporting OTT servers to request UE data through 5GC NFs; supporting the establishment of user plane connections between 5GC NFs and UEs; and addressing security and privacy issues related to the exposure of UE data to OTT servers via 5GC NFs.
- WT2: Enhanced support for user plane performance improvement by 5GC analysis. The research includes enhancing NWDAF to support user plane traffic analysis (e.g., traffic patterns, abnormal traffic, etc.) and assisting in user plane traffic processing to predict, mitigate, or eliminate performance degradation on the user plane or control plane caused by user plane traffic fluctuations.
- Other work tasks: studying other aspects of 5GS enhancements enabling AI over the air interface based on RAN requirements (e.g., UE data collection over Control Plane (CP), two-sided models); and exposing 5GC information (e.g., NWDAF analysis) to UEs (continuation of the R18 study).

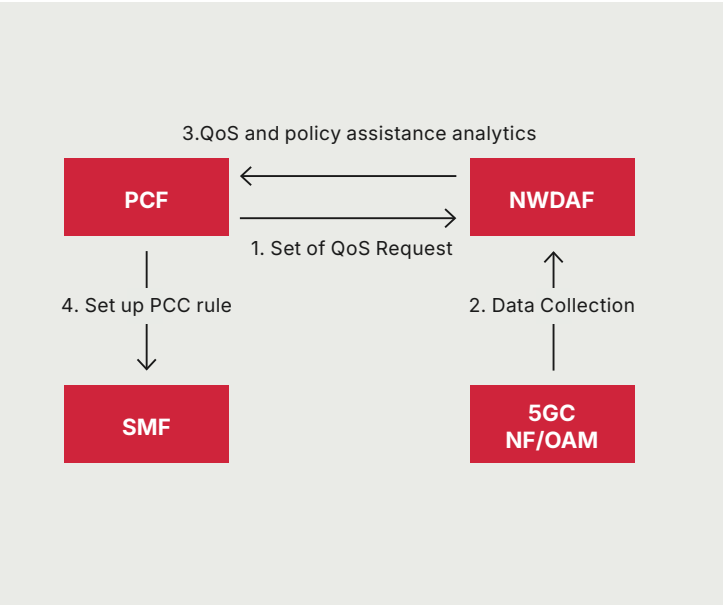


Figure 5, Policy Recommendation procedure.

5.3 Device Awareness

5.3.1 Dynamic operator's logo requirement

When a user's network experiences stuttering, the core network intelligently detects the network status, and based on the user's package consumption, provides real-time and precise package recommendations using dynamic operator's logo. It allows users to upgrade their packages with one click, thereby improving their network experience.

The network architecture is as follows Figure 6:

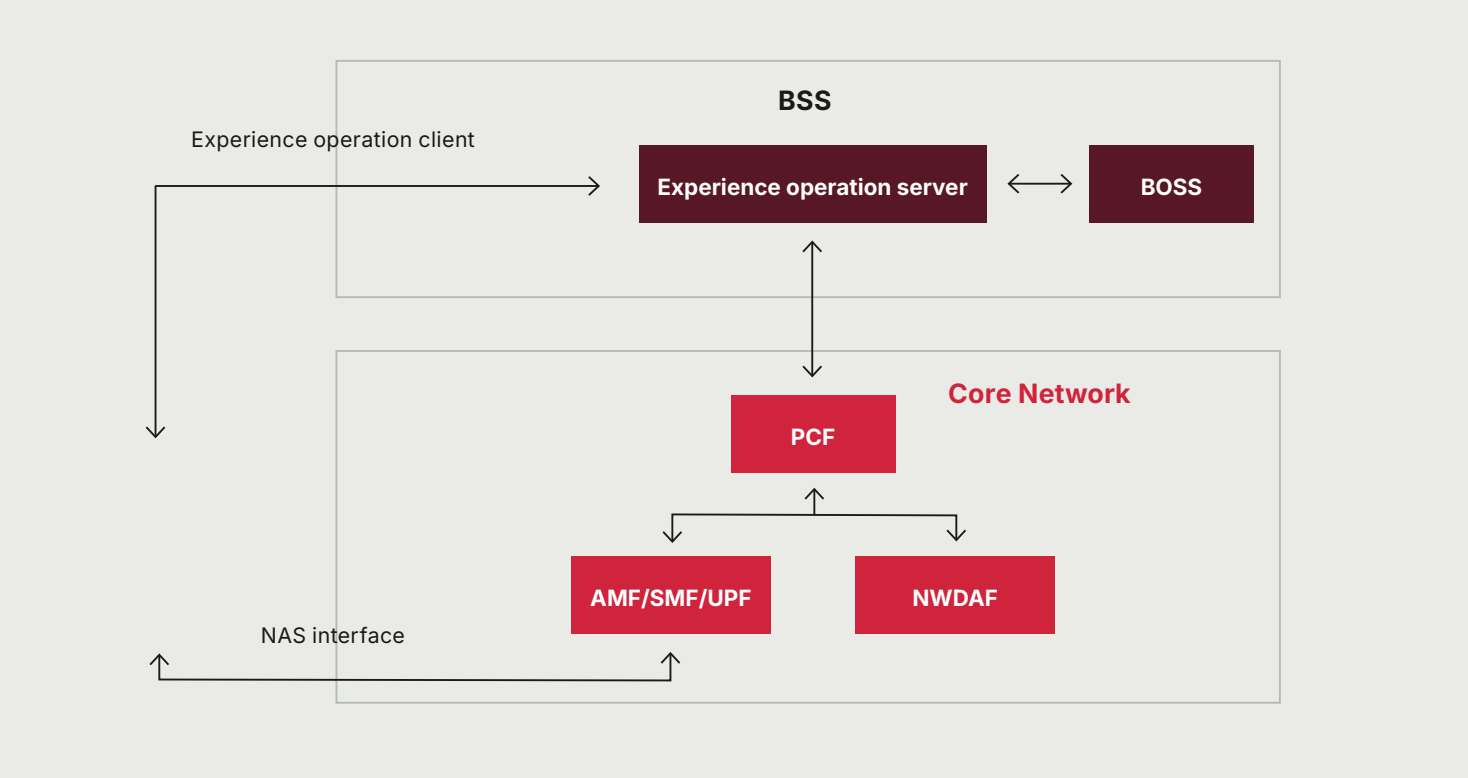


Figure 6, Network architecture for dynamic operator Logo.

- Experience operation Client: It can implement user login authentication securely, render and push the page to the terminal for display based on the server data template.
- Experience operation Server: Its function is to connect to the core network through the Nz interface, aggregate information such as main packages, recommended acceleration packages, and available rates, and then push this information to the experience management client.
- PCF: Its function is to establish a network-edge collaboration channel through the NAS interface; based on information obtained from the Business & Operation Support System (BOSS), terminals, and wireless networks, it combines with Business-domain recommended packages and delivers them to the experience management server.

Use case 1: Accurate Package Recommendation and Subscription for Users.
Based on user location or service, the network integrates mobile phone and network detection. When the network's quality is poor, the network will intelligently display a pop-up window to users according to their user level or existing subscription plans, offering different packages for users of different levels. After experiencing various network services, users can also share these experiences with their friends in real time.

Use case 2: Recommend services such as traffic acceleration to users in network congestion scenarios.
A user watches a live sports game on the subway, and the NWDAF in the core network detects that the live broadcast is not smooth. The dynamic operator logo on the user's phone will send a reminder to the user through the live

window on the phone; the core network will also deliver a recommended traffic acceleration package to the user via the phone interface. After the user subscribes to the traffic acceleration package, the operator logo on the phone interface will display the change in traffic acceleration status, and with the guarantee provided by the NWDAF, the user can watch the live broadcast smoothly.

5.3.2 Dynamic operator's logo Standard Process

After the UE is registered to the 5GC, the AMF is allowed to configure the Network Identity and Time Zone (NITZ) to the UE via UE Configuration Update (UCU) procedure as defined in 3GPP TS 23.502 [2]. However, 3GPP TS 22.042 [3] states that "The Network Operator may change the network identity at any time. However, the change of network identity need not force immediate transfer of information to the MS.". St the current time, the only way to update the network identity is by OAM via configuration in the AMF, which does not support the dynamic update of the NITZ at any time to the UE.

At the 3GPP TSG-SA2 Meeting #170 a new Work Item (WI) on Dynamic NITZ Update was initiated by China Mobile was approved. Supporting members include SK Telecom, China Unicom, CBN, HW, CATT, Tencent, Ericsson, Media Tek Inc, AT&T, Deutsche Telekom and ZTE.

The objective of the WI is to realize the ability of the 5GC to dynamically update the Network Identity to the AMF, i.e. the PCF updates the Network Identity based on operator policy, so that the AMF can then provide the NITZ to the UE by reusing the current UCU procedure.

5.4 Content delivery Assurance

The MoQ protocol is a media distribution protocol based on Quick UDP Internet Connections (QUIC), defined by the IETF. MOQ is a high-performance protocol that is suitable for low-latency, high-bandwidth scenarios, and applicable to various media transmission scenarios. The MoQ protocol includes three types of roles: Subscriber, MoQ Relay, and Publisher. Multiple subscribers can subscribe to media content from the same MoQ relay. After obtaining the media content from the publisher, the MoQ relay distributes the media content to each subscriber. During the media data transmission process based on the MoQ protocol, metadata information related to the media data is transmitted together with the media data. The metadata provides descriptive information about media data.

In 3GPP R19 standard, SA2 introduced the MoQ relay function into the UPF network element, aiming to address the issue of how the network can perceive media information in encrypted stream scenarios. With the implementation of the MoQ relay function, the UPF receives the metadata information sent along with the media data and maps this metadata information to PDU set information. The network architecture is as shown in Figure 7.

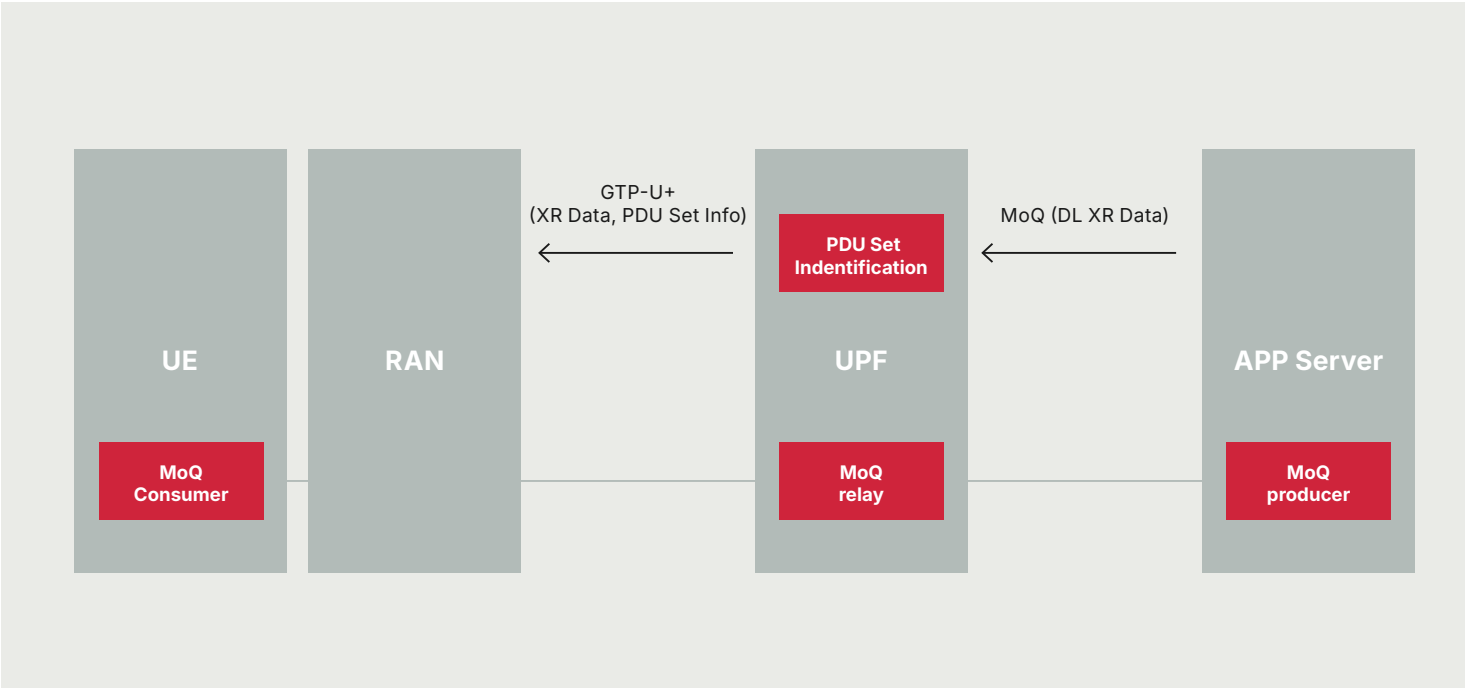


Figure 7, MoQ Relay Architecture

The process for a UE (mobile terminal) to access a media service is as follows:

1. The UE obtains the media server address through the Domain Name System (DNS) process. Currently, the UE sends a DNS request carrying the FQDN (Fully Qualified Domain Name) corresponding to the media service. This DNS request message is sent to the Edge Application Server Discovery Function (EASDF) network element in the network.
2. The EASDF network element sends the FQDN message in the DNS request to the SMF. The SMF confirms that, based on the configuration information, the media service corresponding to the FQDN needs to use the MoQ relay service. The SMF selects a UPF and obtains the MoQ relay address information integrated into this UPF. The SMF then instructs the EASDF to generate a DNS response message carrying the MoQ relay address information.
3. The UE obtains the MoQ relay address information through the DNS response message and then initiates a MoQ connection. The destination address of this connection is the MoQ relay address.
4. The UE subscribes to the media content from the MoQ relay. After receiving the subscription request, the MoQ relay obtains the media data from the application server.
5. The MoQ relay distributes the obtained media data to all UEs that have subscribed to the media content.

5.5 AI Agent digital identity

5.5.1 AI Agent digital identity Requirement

Trusted access for AI agents refers to providing secure, reliable, and seamless network access services for intelligent agents (such as home robots, smart devices, etc.) through mobile communication networks and digital identity technologies. It ensures that AI agents can achieve seamless handover and unified identification across different network environments (e.g., Wi-Fi, cellular networks), while also safeguarding the security and efficiency of data transmission.

By deeply integrating mobile communication networks with digital identity technologies, AI agents are provided with secure and efficient network connection services. In indoor scenarios, users can access robots at home anytime and anywhere through their smartphones, remotely controlling the robots, and viewing the home environment from a first-person perspective. The robots can collect and report training data (such as environmental modeling data) in real time, supporting subsequent intelligent upgrades.

In scenarios involving both indoor and outdoor environments, robots seamlessly switch between Wi-Fi and cellular networks, ensuring unified identification and secure, reliable connections without needing to bypass public networks. Users can remotely control robots via high-speed networks from any location, achieving a seamless experience.

5.5.2 AI Agent digital identity Standard process

In August 2024, the Digital Trust Technology Standards Promotion Committee (CCSA TC603) established the Future Network Digital Identity Application Working Group and released the white paper "Digital Identity System Supported by Future Networks: Industry and Technology Development Trends" [4]. The report analyzes the definition, concept, technological evolution directions, and industry development trends of digital identities. It emphasizes three core modules of digital identity: identity identification, identity attributes, and identity credentials based on the digital identity definition and study defined in ITU-T Recommendation Y.2720 [5], which together form the foundation of digital identity and ensures the correct registration, issuance, verification, and management of identities. The report also discusses innovative application trends of digital identities in scenarios such as digital human identity authentication, fine-grained authorization for AI agents, diversified applications of digital identities, and ubiquitous cross-industry trust.

3GPP SA1 introduced security requirements and related use cases at the September 2025 meeting. 3GPP TR 22.870 [1] which includes security-related content such as trust establishment, security management, and digital identity. A use case focuses on the digital asset container's functionality related to digital identity and proposes to expand the use cases related to the linkage with the 3GPP system. The benefit of establishing the identity of the operators is that the Subscriber Identity Module (SIM) has been selected in the past few years as a trust root to authenticate users and build secure connections for the customers. Operators can leverage the SIM identity as the root ID of user to associate the following digital identity of the user digital representative of AI Agent, e.g., robots, etc., and enable users to seamlessly access various services and resources of the Internet. Furthermore, SIM-based self-sovereign identity for authentication and associated attributes for authorization can be used to provide flexible access control of identity access control. Specifically, for the metaverse use case, 3GPP defines a digital asset container component, which is defined as a function to manage virtual currencies, Non-Fungible Tokens (NFTs), and digital identities. However, digital identities are not limited to the metaverse use case but can be used in many other use cases. The evolution of digital identities is shown in figure 8.

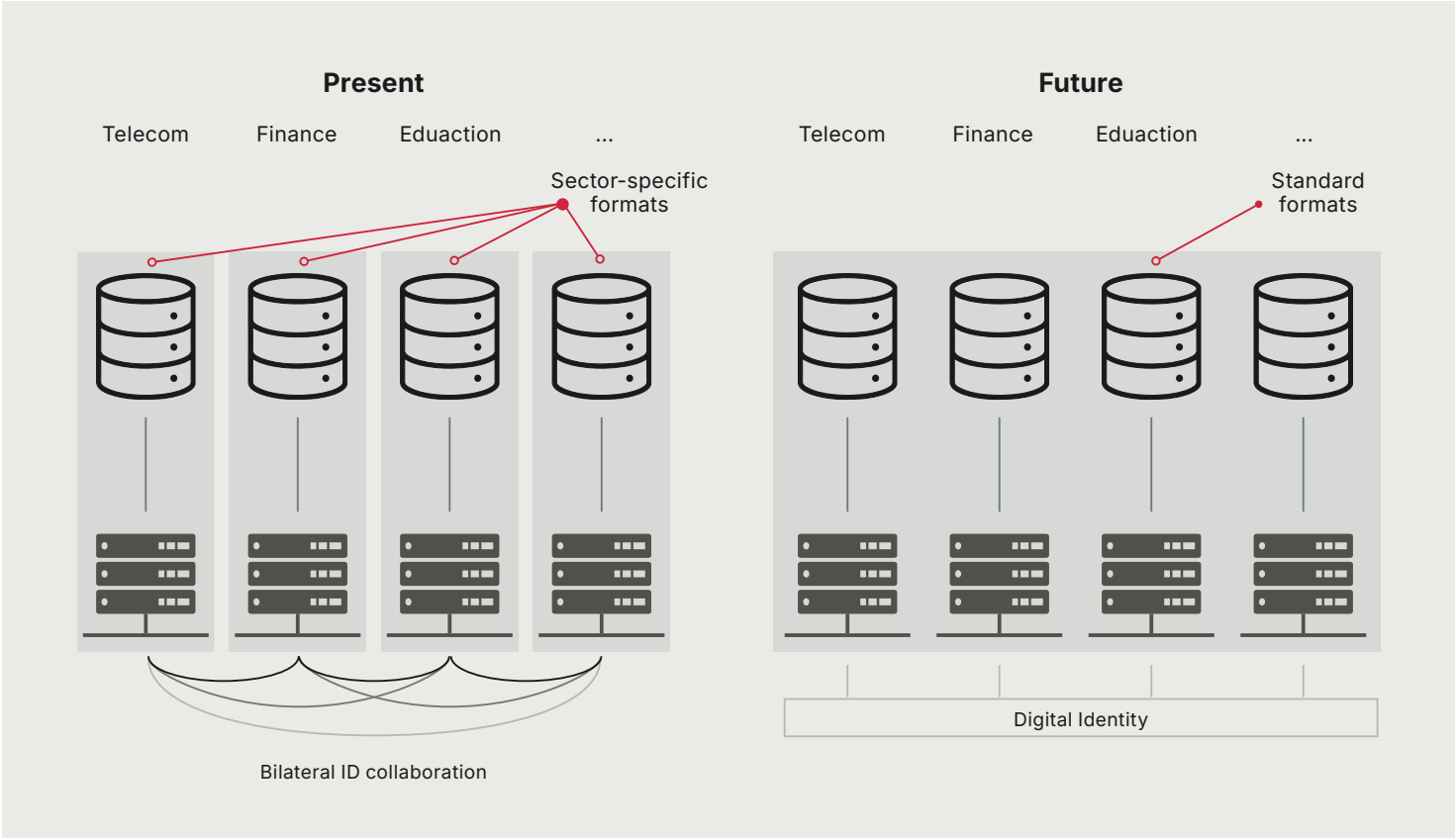


Figure 8, Evolution of Digital Identities

6. Intelligent Packet Core Evolution Readiness

The IPC initially integrates the NWDAF in the first phase to provide the analytics capabilities and take actions based on the analytics output. With the introduction of NWDAF, the packet core begins its intelligence transformation. However, this is only the starting point. To address challenges that basic analytics alone cannot solve such as identifying applications running over secure protocols or accurately measuring real user experiences (e.g., stalling, resolution, buffering time, etc.) the next phase of evolution involves adopting AI model technologies. These AI-driven enhancements will empower the packet core with deeper service awareness and improved experience awareness capabilities.

6.1 Evolution Phase 1

Intelligent Personalized Experience (IPE) frameworks provide comprehensive capabilities, including Experience Awareness, GBR QOS Decision, UE LOGO, Experience Report, and Instant Package Marketing. These features empower operators to carry out the experience of monetization strategy. Detail topology and function enable in phases as Figure 9 and Table 1.

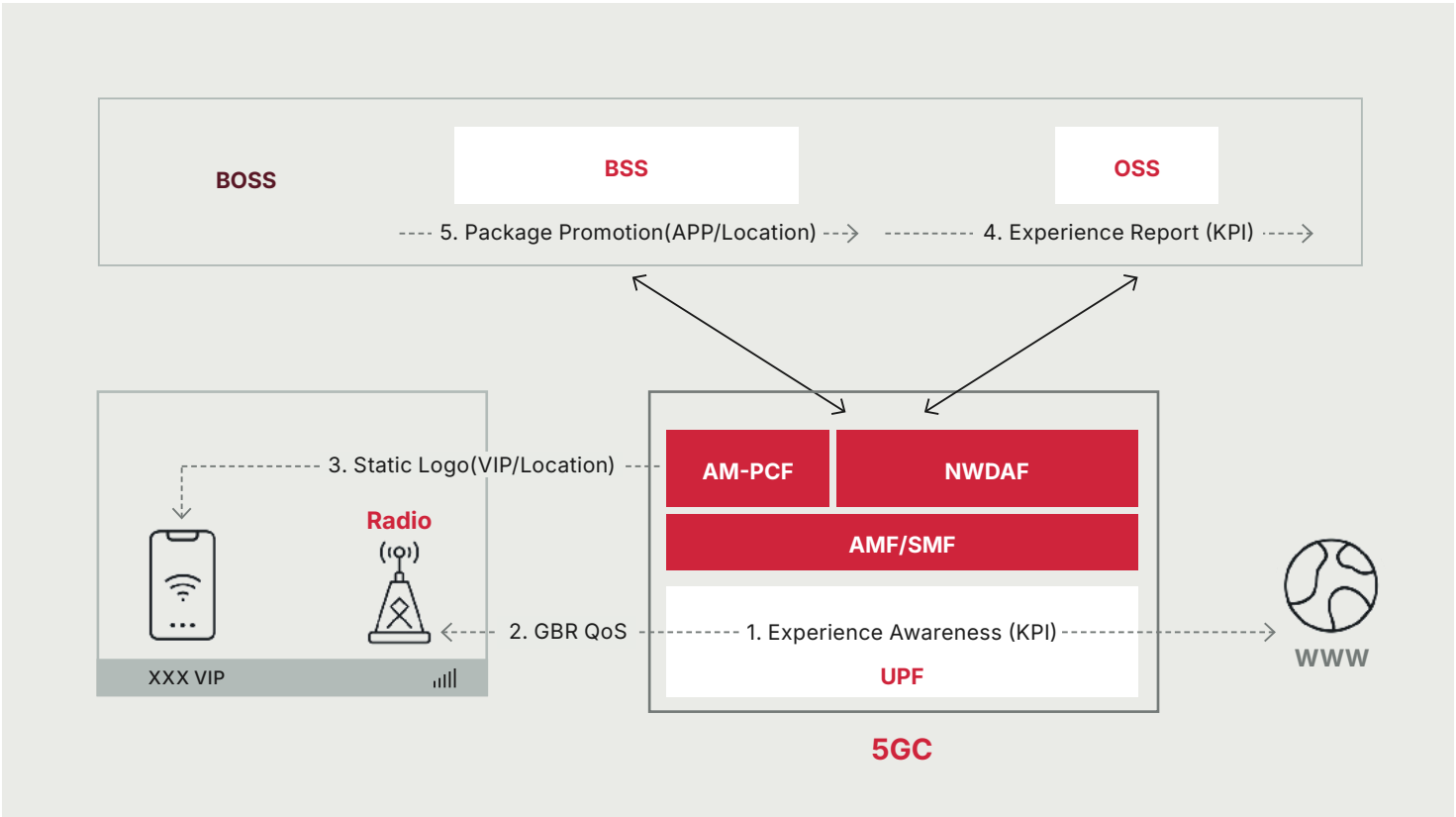
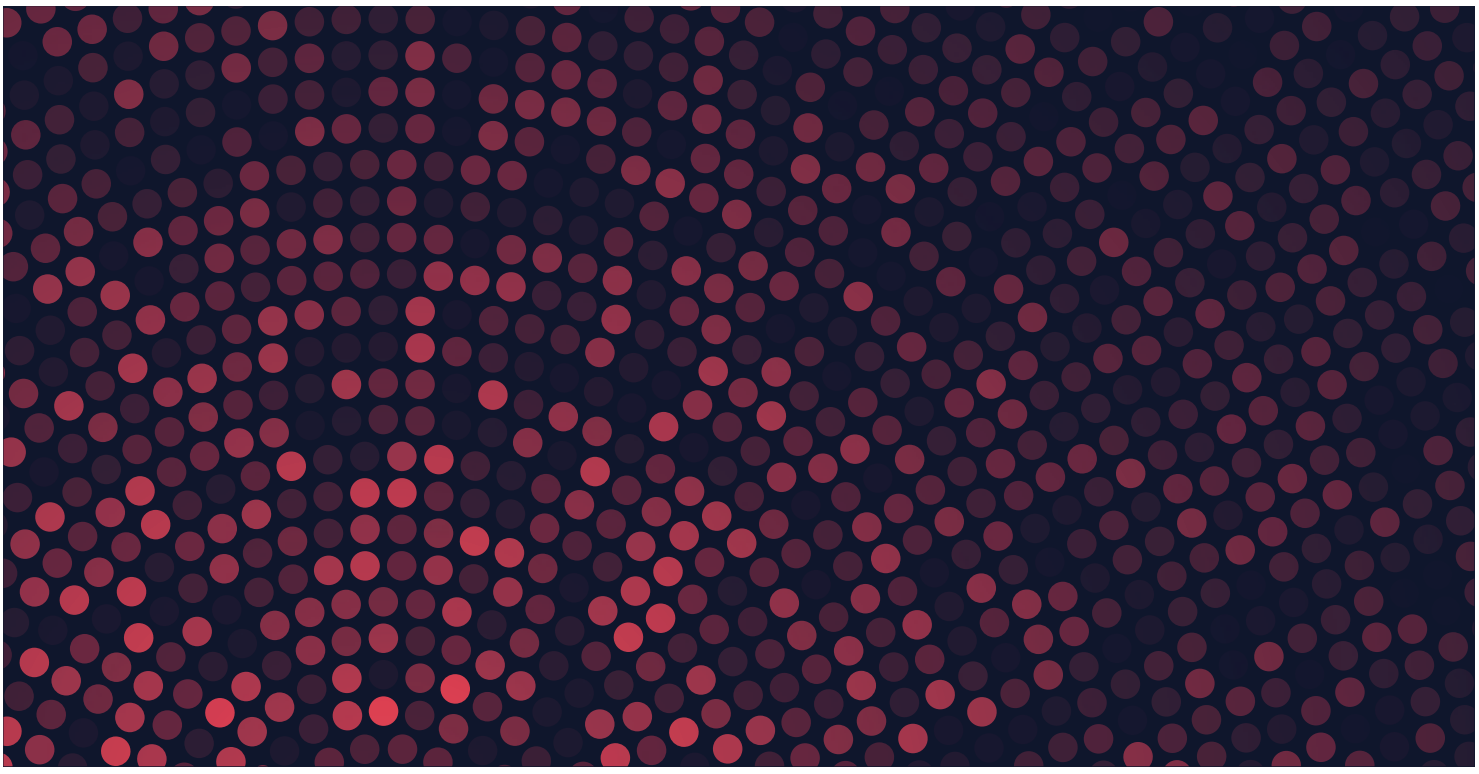


Figure 9, Phase 1 Network Topology

KEY CAPABILITIES	CAPABILITY DESCRIPTION
Experience Awareness (KPI)	IPE identifies the application and measure throughput/latency/packet loss of flows of application. Using a KPI threshold to classify the experience.
GBR QOS decision (APP)	IPE decides the GBR QoS parameters based on the APP differentiation according to demands.
Static Logo (VIP/Location)	IPE delivers a pre-defined logo to UE to display the privilege on top of the mobile screen. The privilege is differentiated according to the user's package subscription.
Experience Report (KPI)	IPE analyzes the experience results including pre-optimization and post-optimization, and offers graphical experience charts per app, user-group, location etc.
Instant Package Marketing (APP/Location)	IPE can perceive the experience of users and trigger an instant message towards BOSS informing BOSS that the users who are suffering poor experience, upon receiving message from IPE, BOSS can send SMS users promoting the application boosting packages.screen. The privilege is differentiated according to the user's package subscription.

Table 1, Phase 1 deployed function table



6.2 Evolution Phase 2 (AI Native)

The IPE solution evolves to an AI native architecture, enabling more accurate experience awareness, more accurate experience reports and more efficient package marketing pipeline. It also allows operators to identify the optimal moments for package promotion with higher precision. Detail topology and function enable in phase as Figure 10 and Table 2.

The detailed topology and phase-wise functional enablement are illustrated in Figure 10 and Table 2.

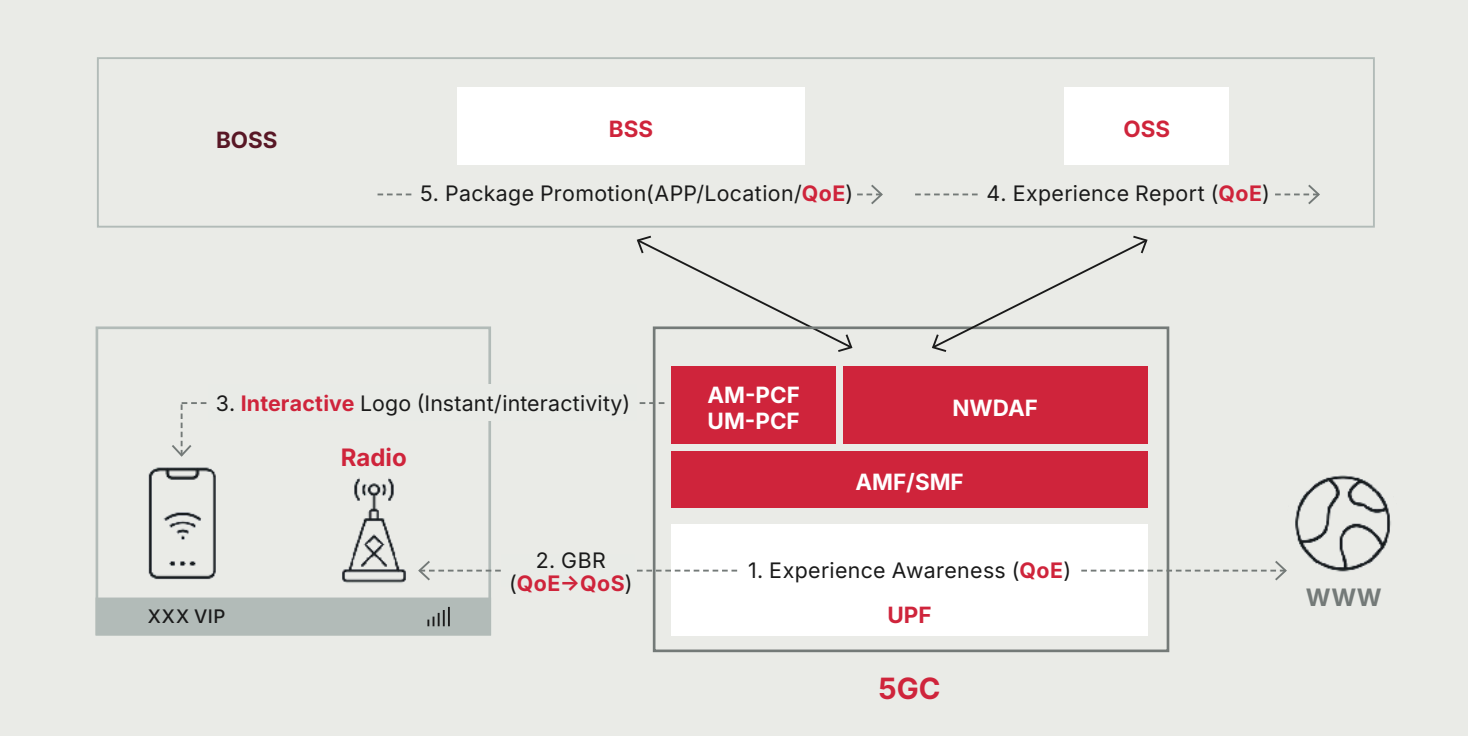


Figure 10, Phase 2 Network Topology

KEY CAPABILITIES	CAPABILITY DESCRIPTION
Experience Awareness (QoE)	IPE identifies the application and perceives the QoE application by AI QoE Large model. The AI QoE model can feed KPIs and various transfer statics of application, and output the QoE in term of Mean Opinion Score (MOS), Resolution, stalling etc. to measure the experience of application
GBR QoS (QOE->QoS)	IPE decides the GBR QoS parameters based on the combination with APP differentiation and target QoE differentiation. For instance, operators can define different target QoE for VIP and normal, both access the same application, IPE can decide different QoS according to the target QoE predefined. And the QoS parameters can ensure the target QoE is Achievable.
Interactive LOGO (instant interactivity)	IPE delivery logo to UE and coordinate with UE to display a clickable logo on top of UE screen. Users can click the logo; the mobile will pop up a window displaying package promotion information or some interesting information that users benefit from.
Experience Report (QoE)	IPE analyze the experience result including pre-optimization and post-optimization, and offer graphical experience charts per app, user-group, location etc. and with AI QoE model, the experience report will be enhanced by adding MOS, Resolution, Stalling etc.
Instant Package Marketing (APP/ location/QoE)	IPE can perceive the experience of users and trigger an instant message towards BOSS informing BOSS that the users who are suffering poor experience, upon receiving message from IPE, BOSS can send SMS users promoting the application boosting packages. The enhancement of phase 2 is using QoE to perceive the moment of poor experience and send package to users at the moment of suffering poor experience, which can be more attractive to users.

Table 1, Phase 1 deployed function table

7. Commercial Progress and POC Progress

7.1 CMCC

Amid the large-scale commercial use of 5G-A and the explosion of AI technologies, China Mobile has built the world's first large-scale pilot application of 5G-A intelligent networks in alignment with its forward-looking strategy. It continuously leads the intelligent innovation and business application of global 5G-A networks, ushering in a new era of digital and intelligent networks. Since the second half of 2024, China Mobile has been testing and piloting a series of intelligent guarantee scenarios. In 2025, several provincial branches of China Mobile launched commercial packages for intelligent guarantee. It is estimated that by the end of 2025, this capability will serve 50 million mobile users.

China leads the world in high-speed railway mileage, with Guangdong province having the most extensive high-speed railway network, which serves 30 million passengers per month. According to the survey, over 30% of these high-speed railway passengers are business travelers who demand high-speed network connectivity. Based on this, China Mobile Research Institute, China Mobile Group Guangdong Co., Ltd. (China Mobile Guangdong), and Huawei jointly initiated the incubation of the intelligent high-speed railway network acceleration solution in the second half of 2024. They developed the world's first AI model for core network high-speed railway user profiling, implementing AI analytics and precise guarantee for user operational status in high-speed railway scenarios. It achieves over 95% identification accuracy, less than 3 minutes delay, and 70% fewer public network user intrusions. In May 2025, China Mobile Guangdong launched the high-speed railway acceleration package throughout the province to announce the commercial use of the 5G-A high-speed railway VIP acceleration package. It also enables the display of the UE logo "China Mobile High-speed Railway VIP", enhancing user awareness. China Mobile Guangdong's intelligent guarantee service now covers 6 million users across the province and has provided customized UE logos for events like 2025 Provincial Fall Campus Freshman Orientation, 2025 China Mobile Partner Conference, and the National Games of China. See figure 11.

Figure 11, China Mobile Guangdong's high-speed railway 5G-A add-on package and UE Logo

China Mobile Group Henan Co., Ltd. (China Mobile Henan) has deployed 5G-A networks and the intelligent NF NWDAF in densely populated areas such as stadiums, and pioneered the "Try & Buy" service mode for the first time in China, offering a 2-hour trial use free of charge. Users can then choose to pay for the service if they are satisfied with the experience. This marks the transition of 5G-A from technical verification to business value exploration. After trial use, they can obtain an experience guarantee report, containing content like "The 5G-A network has offered you 26 minutes of exclusive guarantee within 2 hours, 6 accelerations, and a 206% increase in network access rate." Users who are satisfied with the service can purchase a monthly package via an SMS link. By November 2025, China Mobile Henan's NWDAF-guaranteed user base had grown to 1.7 million, comprising those who

use the GoTone 5G-A premium package, universal 100 GB package, and 5G-A network add-on package. For the universal 100 GB package, the number of users who upgraded their packages after the NWDAF was added increased by 2%, the ARPU increased by 31%, and the DOU increased by 55%. See figure 12.

Figure 12, China Mobile Henan's 5G-A add-on package and 5G-A premium package

On June 14, 2025, China Mobile Group Beijing Co., Ltd. (China Mobile Beijing) introduced a dedicated 5G-A experience for fans at Beijing Workers' Stadium as part of the GoTone & Speedup Package initiative. During the Chinese Super League matches, the company rolled out the "5G-A Workers' Stadium Speed Boost Package," offering fans an ultra-fast connection. For only 9.9 yuan, fans can enjoy 4 hours of exclusive network access, including high-speed connectivity of 10 GB of data, dedicated acceleration, and the "China Mobile GUOAN VIP" logo displayed in the phone's status bar. Following this, China Mobile Beijing has launched three 5G-A add-on packages, priced at 20 yuan, 40 yuan, and 60 yuan respectively, where users can subscribe to on a pay-per-use basis. In addition to delivering high speeds and generous data, these packages offer acceleration services for key applications, spanning dozens of essential apps across categories such as gaming, e-commerce and live streaming, instant messaging, video, and online meeting platforms. The VIP service of China Mobile is also highlighted through dynamic UE logos, available on both Android and Apple devices. Meanwhile, China Mobile Beijing has launched the "VVIP Package" for high-end users, with five membership plans priced between 199 and 999 yuan per month. In addition to standard communication services and benefits, these plans offer premium network features, including high-speed upload and download rates as well as accelerated access to key services. The details of these packages are provided in figure 13 below.

Behind this series of packages is an end-to-end intelligent assurance system: the packet core network NWDAF monitors user experience in real time, while the wireless network boosts high-speed services and dynamically optimizes key applications.

7.2 e& UAE

e& UAE stands at the forefront of advancing 5G/5G-A technology and adopting new technologies, particularly those powered by AI. New service offerings, including the Live Broadcast Package, allowing customers to experience real-time streaming experiences, even in challenging network conditions.

5G-A is a big step in 5G technology which brings more advanced capabilities and supports new use cases for different industries. 5G-A improves network performance using AI and machine learning and makes the network more energy-efficient. In the ever-changing world of telecommunications, e& UAE has always led, continuously setting and exceeding benchmarks for mobile broadband performance.

Currently, e& UAE is implementing a NWDAF solution for embedding intelligence in customer experience, and enhance operation capability for valued services. This marks the beginning of the 5G-A era for e& UAE with first commercialization of 5G-A NWDAF and Access and Mobility PCF (AM-PCF). The NWDAF integrates AI training and inference capabilities, can detect changes in user services and experience in real time and deliver customized policies to customers to ensure the Service Level Agreement (SLA) of users.

Based on the 5G-A experience acceleration capability, as part of its 5G-Advanced initiative, e& UAE plans to avail new experience boosting, via its 5G-Advanced capabilities. This new direction will focus on providing experiences acceleration service for two types of user scenarios:

— Accelerating experiences for OTT application used by high-end users: Applications such as YouTube, Twitter, Zoom, and Botim, which are related to video, live broadcast, and gaming, will receive enhanced performance.
— Accelerating user experience in key scenarios: Crowded areas such as tourist attractions and concert venues will benefit from improved service quality.

From a technical perspective, to support 5G-A experience monetization, NWDAF and network slicing can be flexibly applied. In Phase 1, based on NWDAF, dedicated bearer acceleration for subscribers is provided through service awareness and experience awareness. In Phase 2, as terminal slicing matures, NWDAF will be combined with slicing, using mechanisms such as hard slicing to enhance assurance effectiveness. Additionally, the capabilities of slicing will be leveraged to improve the visualization of experience assurance. The corresponding technical evolution is illustrated in figure 13.

Building Hierarchical Experience Assurance and providing 5G-A experience acceleration is just the first step toward 5G-A monetizing experiences. Looking ahead, e& also plans to leverage the powerful analytical capabilities of AI in 5G-A IPC to achieve precision marketing (precise awareness and precise promotion) through interactive UE Logos. Furthermore, e& will collaborate with capability open platforms and network slicing to support deterministic experiences and open experience capabilities monetization.

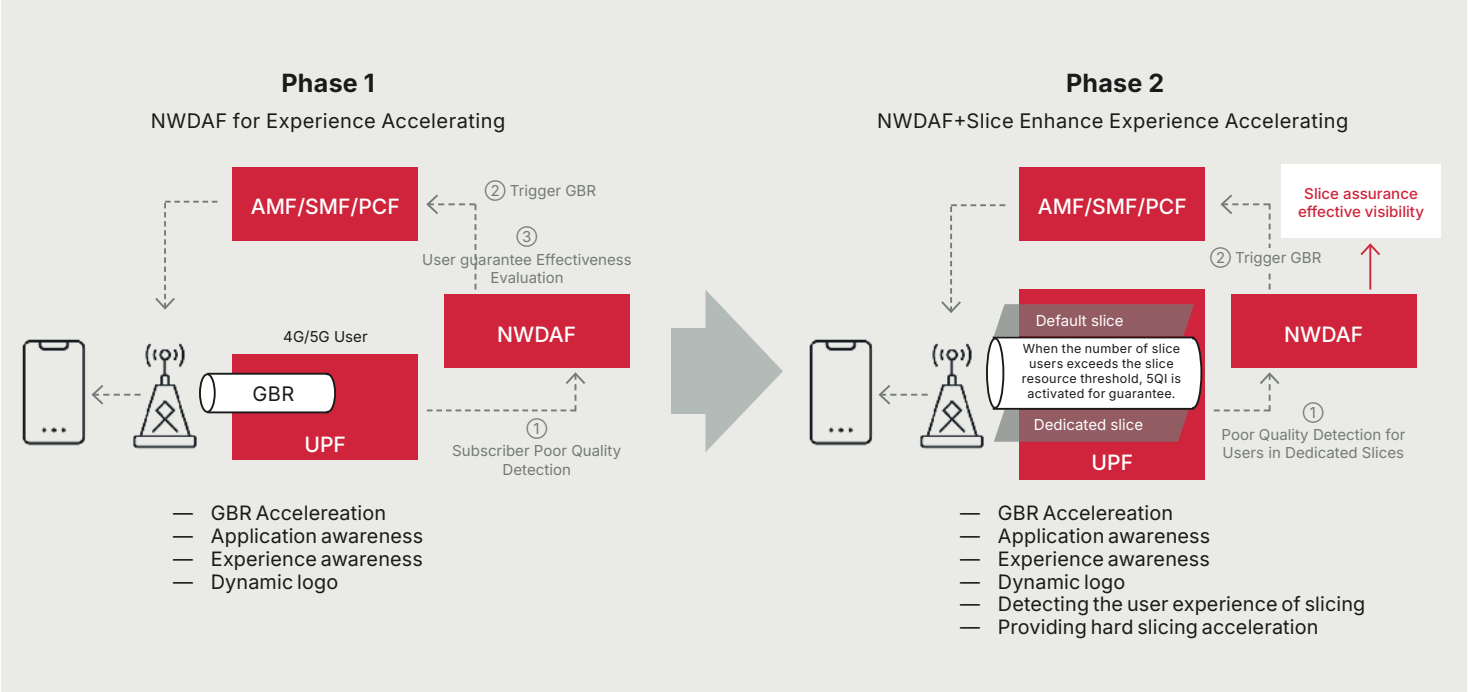


Figure 13, Experience Accelerated Architecture Evolution

7.3 Globe Telecom

Globe Telecom is the largest mobile telecommunications company in the Philippines, known for its strong focus on innovation and commitment to providing innovative and world-class services to its customers. Always ahead of the curve, Globe sees 5G as the next growth area in telco, expected to drive digital transformation by powering high-bandwidth activities and enabling lightening fast internet. Its uses range from high quality streaming and gaming to intelligent homes, virtual reality and a range of digital solutions for businesses.

As network capabilities become more mature and the devices become more affordable, consumers have more choices, making it increasingly important to figure out how to retain them, especially high-value users. Through long-term exploration, Globe has discovered that beyond traditional package offerings such as data volume, call duration, and SMS counts, enhanced network experiences have become a key factor in attracting consumers. Globe aims to fully unlock the potential of mobile networks, offering consumers with diverse network services, and achieving experience monetization by improving user network experiences and perceptions. On one hand, network experience privileges are added to the packages by configuring networks to offer faster speeds and better user experiences. On the other hand, Globe actively explores UE logos to enhance user perception, enabling consumers to more intuitively experience the differentiated benefits.

In terms of user packages, Globe offers enhanced network experiences for different groups through a combination of "main packages + add-on packages." For postpaid users, the upgraded network experience is included in the main package to improve user loyalty. For the prepaid users, consumers can flexibly subscribe to add-on packages that best suit their specific needs. Through this package combination approach, Globe is able to offer enhanced network experiences to more consumers who have the need and willingness to pay, thereby achieving business success.

Figure 14, Postpaid Package Publicize

The postpaid main package includes UNLI 5G and differentiated experience enhancements. The postpaid users can enjoy an upgraded network experience for all applications. See figure 14.

For prepaid users, add-on packages enhance the network experience based on application types and key areas to meet the diverse needs of different user groups. For example, Globe offers a high-definition video add-on package called GoWATCH for applications like YouTube and Netflix, improving the smoothness of watching HD videos. It also launched the Go5G UNLI50 package, enhancing the network experience for consumers in BGC (Bonifacio Global City). This is shown in figures 15 and 16.

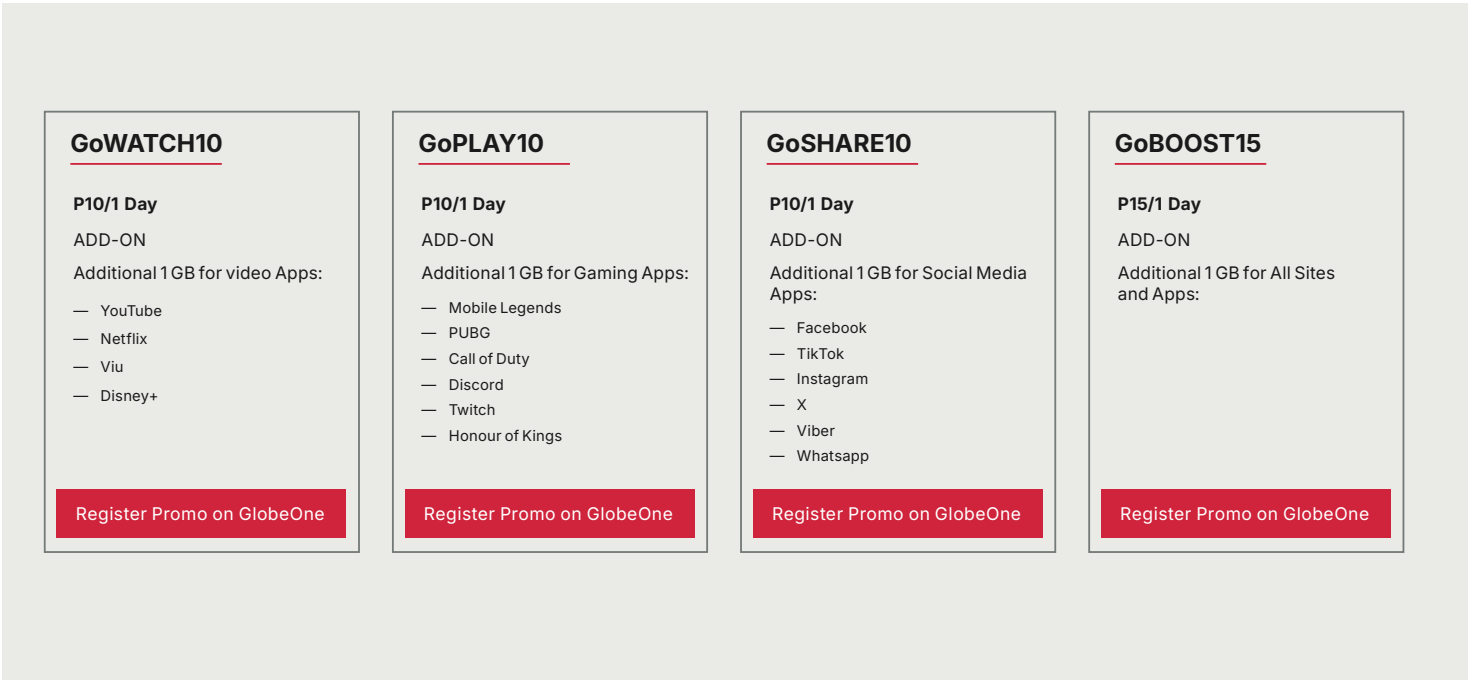
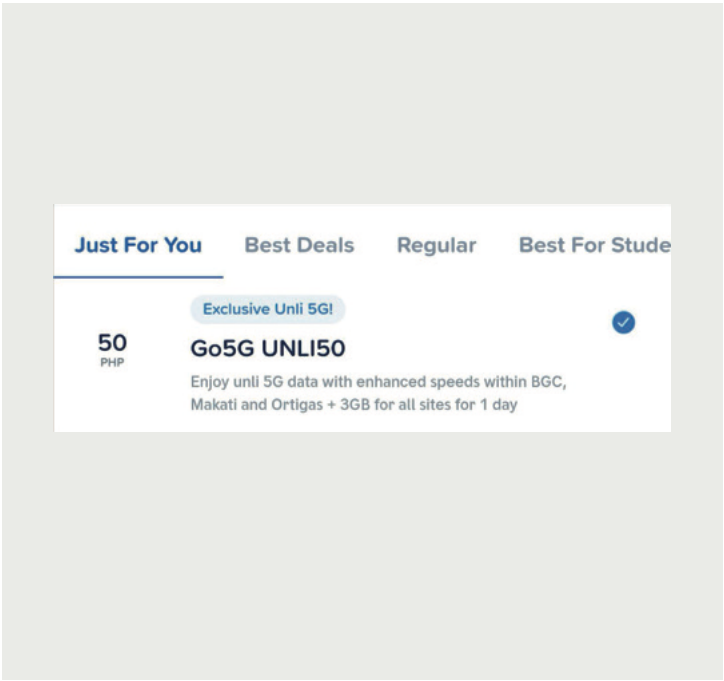


Figure 15, GO BOOSTERS Add-on Packages



These packages are configured through a combination of QoS configuration such as QoS Class Identifier (QCI), Allocation and Retention Priority (ARP), and RAN weight on the network side to provide consumers with differentiated user experiences as shown in figure 17.

Figure 16, Go5G UNLI50 Add-on Package

	QCI	ARP	RAN Weight	NORMAL	CONGESTED	USER EXPERIENCE
Tier 1		Highest		Fastest and top priority	Most gauranteed access and speed	VIP level speed and access on all conditions
Tier 1		Middle		Balanced performance	High admission priority	Reliable access with strong balance of speed and priority
Tier 1		Lower		Moderate speed	Low admission priority	Entry level performance with minimal network priority
Tier 1		Best effort		Best effort only	Lowest admission priority	Basic service, lowest access and speed priority across all conditions

Figure 17, Differentiated User Experience

In terms of enhancing user perception, the differentiated display of UE logos clearly conveys to consumers the unique network service capabilities, constantly reminding users that they are enjoying upgraded network services. Globe has already completed the design of its UE logo solution based on 5G SA/5G NSA/4G networks, and network deployment is underway. It is expected to launch a commercial trial soon. See figure 18.

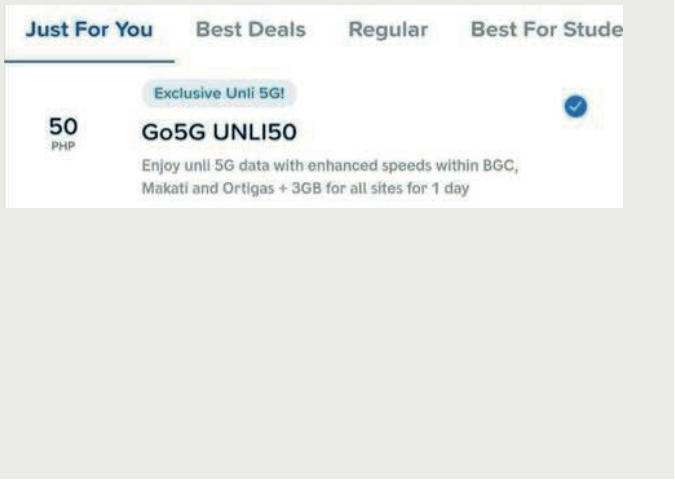


Figure 18, Differentiated UE Logo for VIP Users

Currently, Globe primarily focuses on providing differentiated user-level experiences based on static rules and static UE logos. In the future, AI technology will be considered to enable dynamic rule-based experience assurance and interactive dynamic UE logos, offering consumers smarter and more precise experience upgrades.

7.4 KT

With the advent of 5G-A and the forthcoming 6G era, users increasingly expect personalized and differentiated service experiences beyond simple high-speed connectivity. To address these expectations, KT introduced "Customer-Centric Operation with AI" as a core paradigm for the future networks in a previous white paper. This strategy aims to enhance both operational efficiency and service quality through the seamless integration of AI and Machine Learning (ML) across core and radio networks.

In 2025, KT strengthened its end-to-end data collection and analytics framework across network infrastructure and conducted several pilot implementations to validate operational automation and intelligent network management. Key cases are summarized below:

Case 1 : Enhanced AI Analytics for the Core Networks

a. NF Load Balancing Based on Traffic Variations

Previously, detecting subtle quality degradation during the early stages of faults was difficult, often resulting in prolonged customer impact. KT addressed this issue by embedding standalone data collection and analytics module into the 5GC SMF to collect, learn, and infer system metrics, enabling automated session distribution.

This approach isolates abnormal NFs and redirects traffic to alternative NFs, enabling corrective actions within one minute — a reduction of approximately 80% compared to manual intervention.

b. Root Cause Analysis for Wireless Call Drops

Following the introduction of Voice over New Radio (VoNR) services, new call drop causes emerged that were not observed in VoLTE. Traditional analysis required manual data collection from IMS, core, and OSS systems, followed by expert review, resulting in significant time and resource consumption. KT developed an integrated data collection framework and applied AI/ML-based classification and analysis to streamline this process. This approach enabled faster detection of problematic segments and clearer identification of root causes, reducing per-case analysis time by around 80% and significantly improving diagnostic accuracy.

- Case 2 : AI-Driven Network Operations Automation

a. Automated Validity Checks for Wireless Core Switch Firmware Upgrades

Large-scale switch software upgrades are often required due to aging firmware. Previously, these upgrades involved repetitive manual command execution and result verification during pre- and post-upgrade checks, increasing time consumption and the risk of human error. KT introduced an AI-driven automation process for switch validation, enabling automated checks before and after firmware upgrades. This minimized human error and reduced operational time by more than 68%.

b. Automated NF Software Upgrade Testing

NF software upgrades are becoming increasingly frequent, necessitating extensive pre-deployment testing in testbed environments. To ensure high reliability, maximizing test coverage is essential. KT implemented an AI-based automated testing framework that executes NF software tests and compares results autonomously. This increased test coverage by approximately tenfold, improved reliability, and enabled closed-loop validation for highly accurate outcome prediction.

These case studies KT approached reaffirm the importance of network data collection and analytics. Moving forward, KT will continue to expand its analytics-driven foundation to support emerging 5G-Advanced and 6G networks.

7.5 Turkcell

Turkcell is a converged telecommunication and technology services provider, founded and headquartered in Türkiye. Mobile communication in Türkiye began when Turkcell commenced operations in February 1994. Turkcell's target has been to become an integrated communication and technology services player in the region, operating a converged mobile and fixed network platform and offering a wide range of innovative products and services. Turkcell believes that it is important to offer our consumer and corporate customers the full range of our mobile, fixed and broadband services to meet their expectations.

This year, as the commercialization of 5G approaches, Turkcell has made substantial preparations for its official launch. Although 5G has not yet been officially rolled out in Türkiye, Turkcell has already been providing 5G service in selected areas for quite some time. For over two years, Turkcell has offered 5G service at Istanbul Airport, and this year, it took another step forward by bringing the 5G experience to customers in some football stadiums. In September 27, 2025, Turkcell broke new ground in the Kaçkar by UTMB section of the event, completing a 5G field test at an altitude of 1,250 meters, proving that it is ready for 5G technology in challenging natural conditions and major sporting events.

In the 5G spectrum auction held on October 16, Turkcell got the widest frequency band with a total bid of 160 MHz and Dr. Ali Taha Koç emphasized their continued leadership in 5G, which will be available starting April 1, 2026. At the Turkcell 5G Press Conference held at Zorlu PSM on October 17, Turkcell successfully completed demo presentations of:

- 5G Speedtest (More than 2.8 Gbps)
- Remote Machinery Control with 5G with very low latencies
- Augmented Reality (AR) Training with 5G

As a key component of the first commercial deployment of 5G, Turkcell has already initiated preparations for deploying an IPC network. As an early adopter, Turkcell has started its cloudification journey in 2017, has already virtualized nearly all of its network functions and has started implementing a container-based architecture. By adding new functions and AI capabilities, it is taking another step toward the target of an intelligent core network. See figure 19.

Turkcell is actively exploring the potential of the NWDAF within a 5G Standalone (SA) core network. NWDAF collects performance, mobility, and network metrics from core network functions and exposes analytics insights through standardized interfaces. By combining AI with these real-time insights, Turkcell can evaluate data-driven automation, proactive network management, and intelligent orchestration, unlocking new opportunities for intelligent, customer-centric services.

At the same time, Turkcell is exploring the capabilities of the Network Exposure Function (NEF) through OpenGW and API-based ecosystems. The NEF enables secure and standardized exposure of network capabilities and events to third-party applications, external platforms, and internal systems. Leveraging the NEF via APIs allows Turkcell to create new service opportunities, enhance network interoperability, and accelerate the delivery of digital services, while maintaining security, compliance, and operational efficiency.

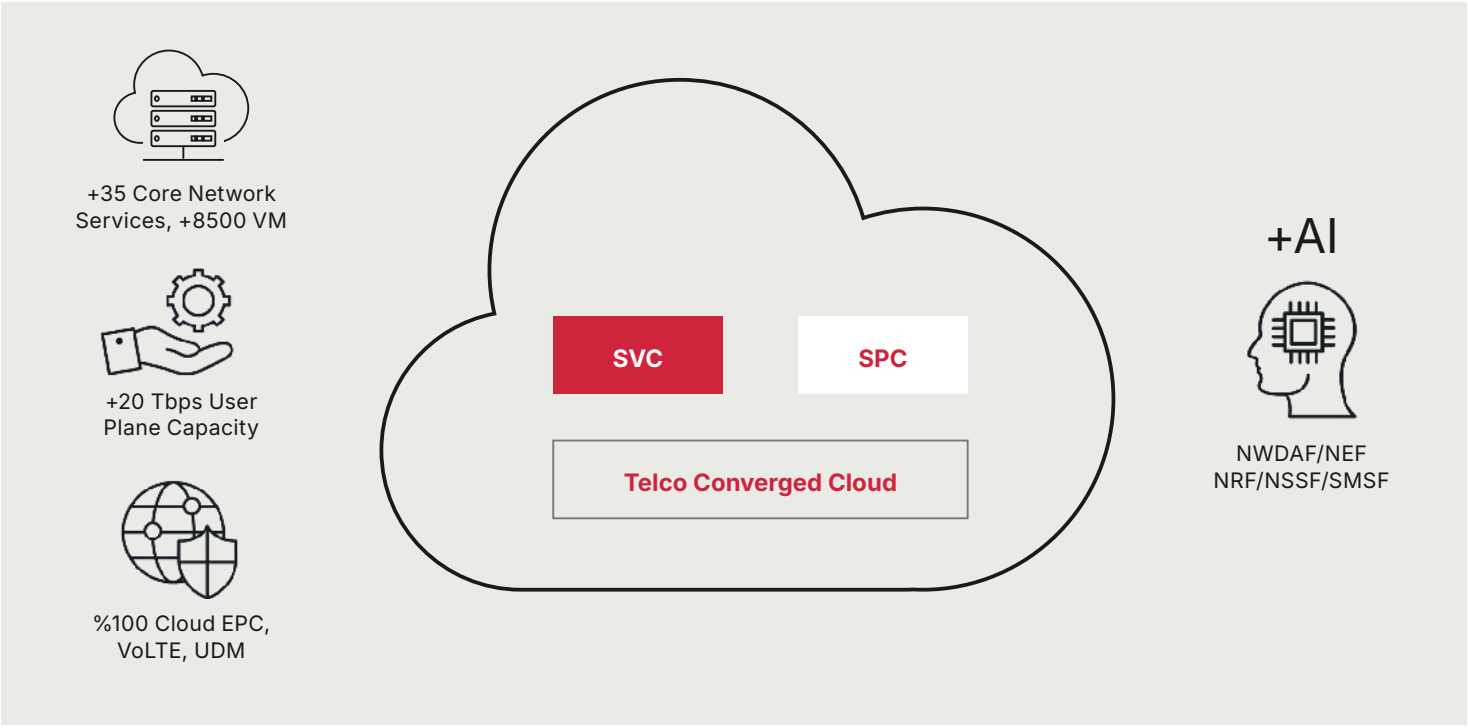


Figure 19, Turkcell 5G Core Network Empowered by Cloud and AI

By combining NWDAF and NEF, Turkcell is leveraging the power of AI and network intelligence together, enabling data-driven insights to inform service exposure and orchestration. This integrated approach allows Turkcell to proactively optimize network performance, unlock innovative service possibilities, and deliver highly personalized, intelligent experiences across its 5G ecosystem, reinforcing its commitment to superior user experience and digital transformation. See figure 20.

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This approach not only enables intelligent, personalized experiences for subscribers but also supports quality on demand, allowing the network to dynamically adapt resources and service parameters based on real-time analytics and user needs. By leveraging NWDAF and NEF together, Turkcell can anticipate demand, optimize performance, and deliver tailored services that respond instantly to evolving conditions, ensuring both high satisfaction and efficient network utilization.

Looking ahead, Turkcell is also exploring cutting-edge technologies for the future, including Non-Terrestrial Networks, AI-native architectures, AI agents, and autonomous networks. The goal is to expand the range of innovative products and services, delivering the fastest, most powerful, and most comprehensive mobile experience in Türkiye.

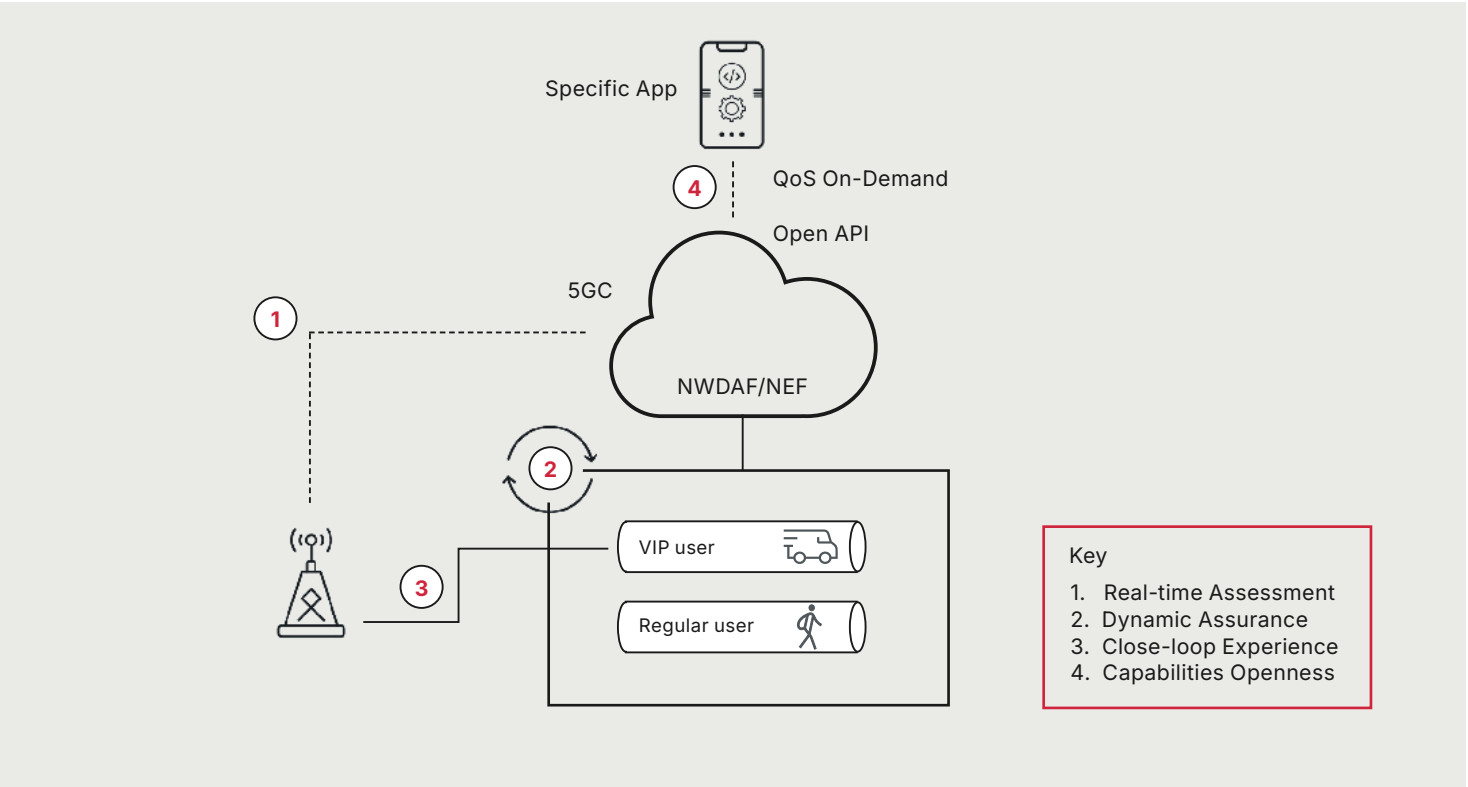

Figure 20, Quality on Demand, Intelligent Personalized Experience

8. Conclusions

With the rapid deployment of global artificial intelligence, mobile networks are also accelerating their adoption of AI capabilities. Since 2024, some leading operators have initiated commercialization of 5G experience monetization by deploying NWDAF and AM-PCF with built-in AI. Currently, world-leading operators such as China Mobile, e& UAE, Globe, KT and Turkcell have already completed commercial deployment or trial of experience acceleration services, providing best practices and references for commercial success for other operators. By 2025, some operators will also begin exploring newer 5G/5G-A monetization scenarios, such as collaborating with OTT, deploying a UPF integrated with MOQ Relay to provide mobile HD video acceleration services and deploying an enhanced UPF to provide Mobile Home Assurance. Operators are accelerating their exploration of 5G/5G-A commercialization.

At the same time, there are still many tasks in the process of exploring network intelligence to support Operators' 5G/5G-A monetization. This needs the whole industry to collectively push forward and solve. Such tasks include:

— Strengthening end-to-end collaboration across industries to jointly enhance consumer service experiences, e.g. by improving the dynamic display experience of UE logos on terminals to enable user aware user experience changes in real time. The future-oriented terminal may also use AI inference information and/or models provided by the network to optimize communication, services, and performance, to enhance network selection, application/service data transmission time and path selection, and energy saving.
— Continuing to explore new scenarios and business opportunities for network intelligence in order to incubate and explore new network intelligence monetization scenarios such as open network intelligence as a service with Open APIs for monetization to combine packet core network intelligence with network slicing to offer experience monetization of segmented services.
— Accelerating the exploration and implementation of new monetization scenarios for 5G/5G-A and collaborating with local OTT providers to explore ways to increase the proportion of mobile HD video based on MOQ Relay to enhance user experience, and offer HD video acceleration services. Dependent on the development of local smart home devices, launch the Mobile Home Assurance service at an appropriate time.

Glossary

Term	Description
1080p	HD video standard with 1920 pixels horizontally and 1080 pixels vertically (1920x1080), for a sharp, detailed image with a 16:9 widescreen aspect ratio
3GPP	Third Generation Partnership Project
4G	4th Generation (of Mobile Technology)
5G	5th Generation (of Mobile Technology)
5G-A	5G - Advanced
5GC	5G Core (Network)
AAA-level	The highest standard of quality or accessibility
AI	Artificial Intelligence
AMF	Access & Mobility Management Function (part of 5GC)
AM-PCF	Access and Mobility PCF
API	Application Programming Interface
APP	Application
AR	Augmented Reality
ARP	Allocation and Retention Priority
ARPU	Average Revenue Per User
B2B	Business to Business
BOSS	Business & Operations Support Systems
BSS	Business Support Systems
CAGR	Compound Annual Growth Rate
CCSA TC603	China Communications Standards Association – Technical Committee 603
CDN	Content Delivery Network
CMCC	China Mobile Communications Corporation

Term	Description
CP	Control Plane
DCCF	Data Collection Coordination Function
DL	Downlink
DNS	Domain Name System
DOU	Data Of Usage i.e. Average handset data traffic per month (MB/user/month)
E2E	End-to-End
EASDF	Edge Application Server Discovery Function
eMBB	Enhanced Mobile Broadband
eNodeB	Evolved Node B (4G RAN)
EPC	Evolved Packet Core (4G Core)s
ETSI	European Telecoms Standards Institute
FQDN	Fully Qualified Domain Name
FWA	Fixed Wireless Access
Gbps	Giga bits per second
GB	Giga Bytes
GBR	Guaranteed Bit Rate
GMV	Gross Merchandising Volume
gNodeB	Next Generation Node B (5G RAN)
GSMA	GSM Association
GSM	Global System for Mobile (Communication)
HD	High Definition
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IPC	Intelligent Packet Core

Term	Description
IPE	Intelligent Personalized Experience
ITU-T	International Telecommunications Union (Telecommunications)
KPI	Key Perfomance Indicators
KQI	Key Quality Indicator
KT	Korea Telecom
LMF	Location Management Function (5GC)
MB	Megabytes
Mbps	Megabits per second
ML	Machine Learning
MNO	Mobile Network Operator
MOU	Minutes Of Usage
MOQ	Media over QUIC
MOS	Mean Opinion Score
ms	Milleseconds
NAS	Network Attached Storage
NAS	Non-Access Stratum
NAT	Network Address Translation
NE	Network Element
NEF	Network Exposure Function
NF	Network Function
NFT	Non-Fungible Tokens
NITZ	Network Identity and Time Zone
NSA	Non-Standalone
NWDAF	Network Data Analytics Function (5GC)

Term	Description
OAM	Operations, Administration and Management
OTT	Over The Top
PCC	Policy & Charging Control
PCF	Policy Control Function (5GC)
PDU	Packet Data Unit
PoC	Proof of Concept
PRB	Physical Resource Block
QCI	QoS Class Identifier
QoD	Quality on Demand
QoE	Quality of Experience
QoS	Quality of Service
QUIC	Quick UDP Internet Connections
RAN	Radio Access Network
SA	Standalone
SA1	Service and System Aspects WG1 (part of 3GPP)
SA2	Service and System Aspects WG2 (part of 3GPP)
SIM	Subscriber Identity Module
SLA	Service Level Agreement
SMF	Session Management Function (part of 5GC)
SMS	Short Messaging Service
SMSF	SMS Function (5GC)
STUN	Session Traversal Utilities for NAT
TR	Technical Report
TSG	Terminal Steering Group (a GSMA WG)

Term	Description
TURN	Traversal Using Relays around NAT
UAE	United Arab Emirates
UCU	UE Configuration Update
UDP	User Datagram Protocol
UE	User Equipment
UN	United Nations
UPF	User Plane Function (part of 5GC)
USA	United Stated of America
USD	United States Dollars
V2X	Vehicle-to-everything
VFL	Vertical Federated Learning
VIP	Very Important Person
VoNR	Voice over New Radio
VR	Virtual Reality
VVIP	Very Very Important Person
WG	Working Group
WI	Work Item
Wi-Fi	Wireless Fidelity
WT	Work Task
WWW	World Wide Web
ZB	Zettabytes (1021 bytes)

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