

Unlock 5G Potential: How Intelligent Packet Core Drives 5G Monetization



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- Zain KSA

The above are listed in alphabetical order and does not represent any other ranking.



1. Executive Summary

With Global large-scale deployment of 5G networks in the past few years, the growth rate of 5G users has slowed down recently. At the same time, the introduction of new video coding algorithm and the peak MOU of mobile users in some areas lead to a slow growth of mobile network traffic. As a result, carriers begin to face slow revenue growth pressure and start to explore from traffic monetization to experience monetization transformation.

5G deployment enhances operators' capabilities to provide differentiated services. The Network Data Analytics Function (NWDAF), which integrates Artificial Intelligence (AI) capabilities, solves key difficulties in experience operation, such as accurate identification of users and services, accurate service experience, and dynamic and timely assurance of user experience. It is a key help for carriers to transform from traffic to experience monetization.

AI-enabled Intelligent Packet Core (IPC) network has a wide range of business scenarios: such as Cloud Gaming, Video Conference, and Live Broadcast assurance, and can also provide Smart High-Speed Rail Experience Upgrade. In addition, it can be used for Large Events assurance and vertical industries such as manufacturing, Transportation in the future.

The NWDAF, a key Network Element (NE) for experience operation, has been defined in 3GPP specifications. The NWDAF is introduced in 3GPP Release 15 to provide differentiated services and is continuously enhanced in R16 to R19. The dynamic UE logo that enhances user experience has been defined in the GSMA TSG WG. Here is still no unified global standard for service experience evaluation, which needs to be jointly developed by the industry together.

Carriers need to enable intelligent packet core networks step by step. First enable basic network intelligence capabilities and build a closed-loop system for real-time and dynamic user experience. then Introduce native AI to form a closed-loop system for experience operation.

World-leading operators have started to explore the business monetization of Intelligent Packet Core. Such as AIS, CMCC, e& UAE, Globe, Vodafone, Zain KSA, KT has started commercial use, trial, and PoC (Proof of Concept).

In order to let the IPC fully unleash the potential of 5G and monetize 5G, there is a need to continue to cooperate with the industry to solve the following issues:

- Enhance device and network collaboration to improve service experience;
- Build a global unified experience evaluation system and have a unified measurement standard for experience;
- Continue to explore new scenarios and business opportunities for network intelligence.

2. Introduction

With the large-scale deployment of 5G around the world, operators are facing a transformation from traffic monetization to experience monetization.

In this context, how to monetize 5G networks has become the carriers' one major task. This white paper focuses on how Artificial Intelligence (AI) enabled Intelligent Packet Core (IPC) helps carriers experience operation during the transformation. Experience operation include not only Service Experience Assurance, but also vertical scenarios such as Smart High-Speed Rail Potential etc.

Recently, leading operators have started commercial and trial based on 3GPP standards and their scenario exploration, with this exploration, the industry has formed a common network readiness proposal. This provides valuable practical considerations for global carriers. Of course, in the future, there are still many issues that need to be promoted by the whole industry, including enhance ecosystem cooperation and continue scenario exploration.



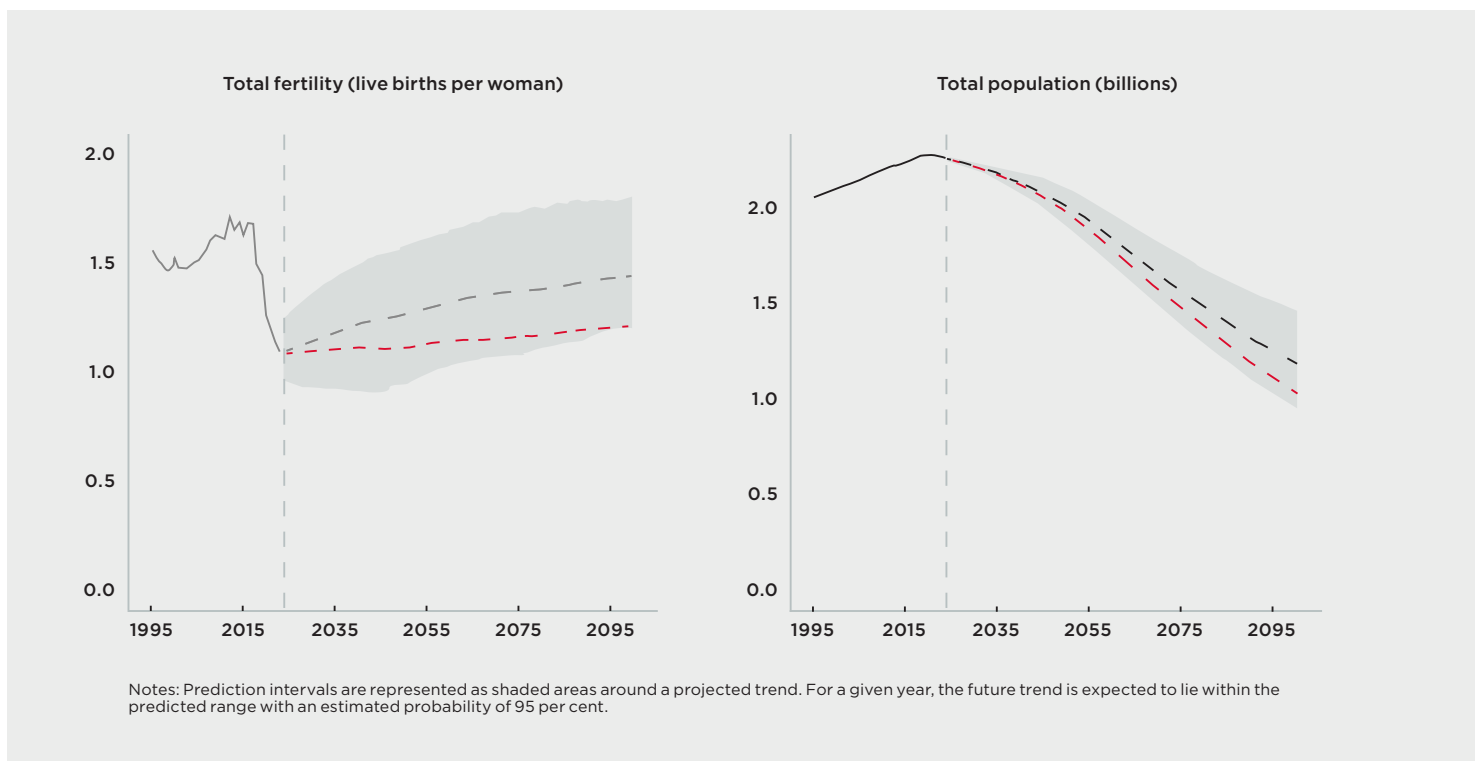
3. Transformation from traffic monetization to experience monetization

3.1. 5G Consumer Market - Challenges

The 5G consumer market faces the challenge of weak growth due to the connection growth from the demographic dividend having faded away. Based on forecast¹ 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 is the level required for a population to maintain a constant size in the long run without migration, with each generation followed by another of roughly equal size. The detail forecast you can refer to below Figure 1.

Most of the countries where 5G has been deployed on a large scale face the problem of insufficient fertility. As a result, these operators can hardly rely on the connection growth brought by the demographic dividend. This means that the migration rate of 5G has started to slow down, and that the migration dividends are further weakened.

Since 2020, after several years of rapid development of 5G, the growth rate of 5G users has begun to decline, and the transition from 2G, 3G, and 4G users to 5G users has entered a stable period. According to the statistics² of GSMA, the annual growth rate of 5G subscribers will decrease from 63% in 2024 to 31% in 2025 and to 21% in 2027. As time goes on, the value of Average Revenue Per User (ARPU) growth brought by 5G migration will gradually decrease. This is illustrated in figure 2.



Source: United Nations (2024a)

Figure 1, World Population Trend.

1 World Population Prospects 2024, UN

2 GSMA Mobile Data Deck, Q3 2024

Global Mobile Connection forecast by GSMA (2020 ~ 2030)

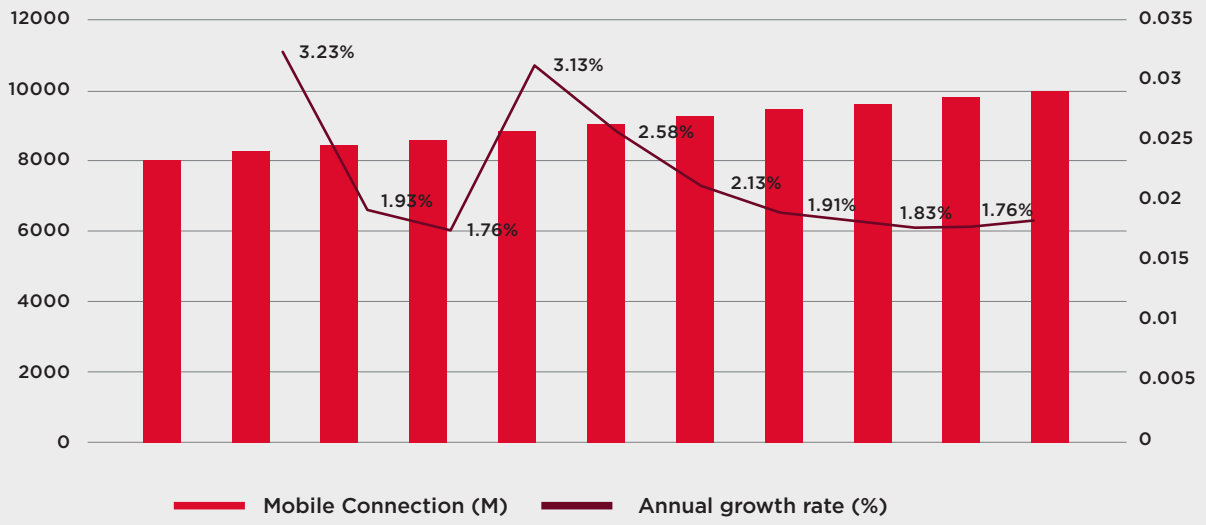
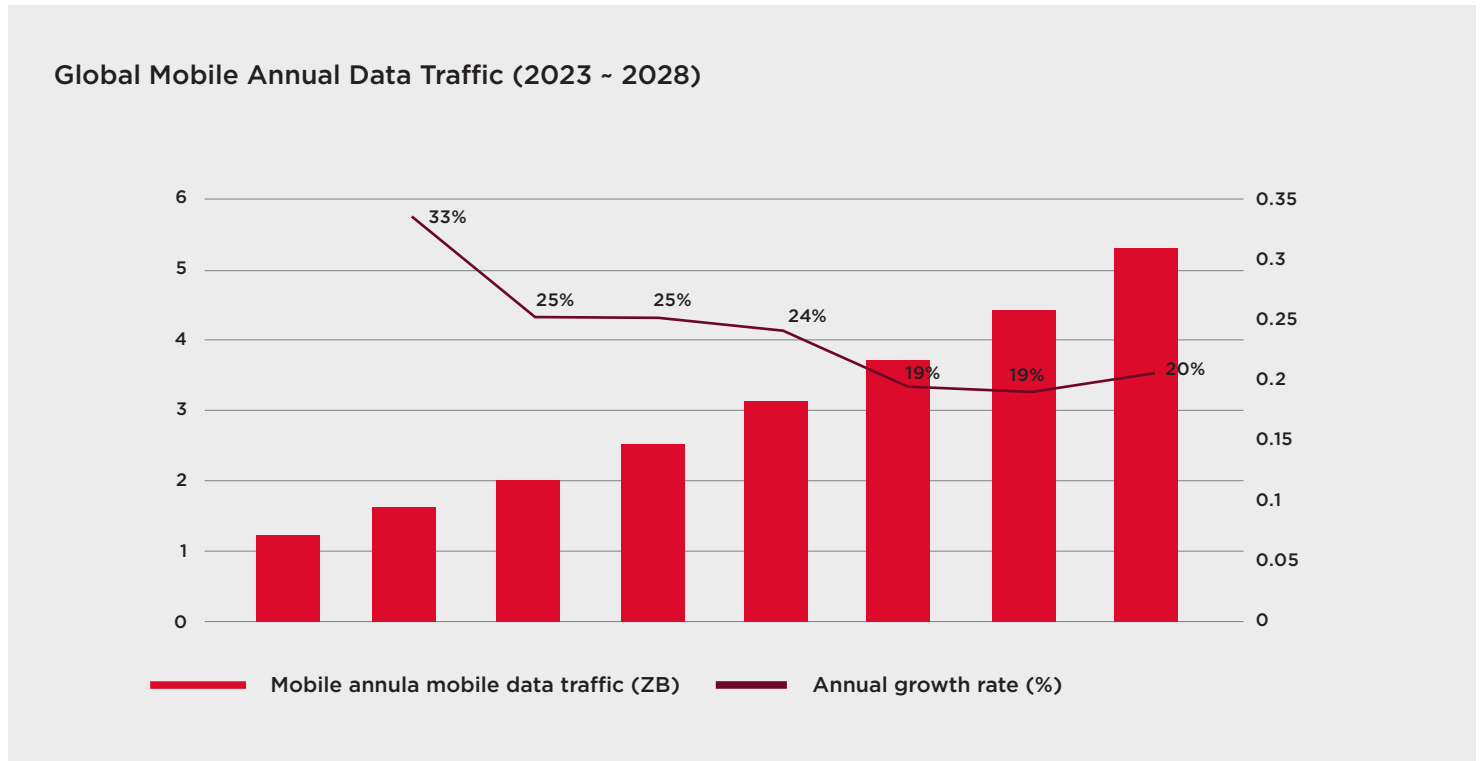


Figure 2, Global Mobile Connection forecast



In addition, 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 3 illustrates the overall trend.



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

Figure 3, Global Mobile Annual Data traffic forecast.

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. According to GSMA’s statistics in 2023, global mobile video traffic has accounted for 70% of mobile traffic. Five years later, i.e. in 2028, it will increase to 80%. This means that depending on increasing the proportion of video traffic cannot bring rapid traffic growth.
- The Time of Mobile network usage for each user has reached the peak. With the rapid development of mobile Internet in the past decade, the Mobile Minutes of Usage (MOU) of most countries has reached the top, i.e. the user usage duration has been stable and basically stopped increasing. Taking China as an example, according to CNNIC statistics, excluding the usage time growth caused by COVID-19 pandemic, the duration of users’ use of the mobile Internet has stabilized to 26 hours per week and is no longer increasing. This is illustrated in figure 4.
- The introduction of new video encoding technology such as H.265 is also a key factor that weakens the growth of mobile traffic. Based on recent statistics, the number of H.265-based mobile videos in OTT traffic has exceeded 50%, and 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. As an example, Virtual Reality (VR) currently accounts for less than 1% of mobile networks and still has not become the engine of traffic growth.

China mobile internet usage per week (hours)

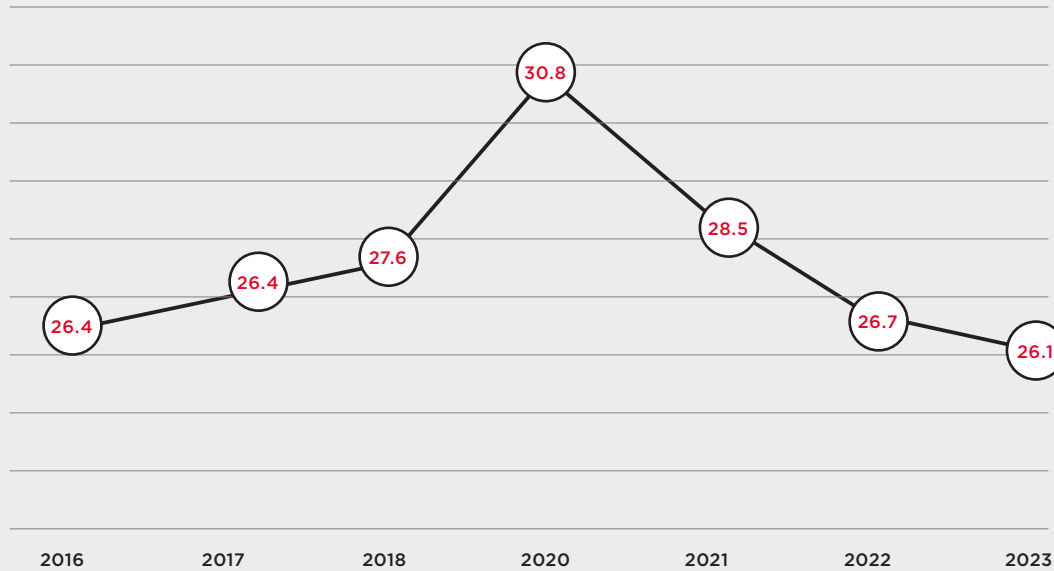


Figure 4, China User internet Usage per week

3.2 Acceleration of Service Differentiation due to 5G Deployment

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 operation.

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. Scenarios such as manufacturing automation, smart city, medical surveillance, and agriculture have been developing rapidly in the world. With the rapid development of electric vehicles and self-driving this year, the provision of low-latency and highly reliable links to support self-driving has become a key requirement of 5G. For home users, with the large-scale deployment of 5G Fixed Wireless Access (FWA), in addition to providing higher bandwidth than 4G FWA, the provision of differentiated latency experience for home entertainment, especially games, has become a widespread requirement.

According to the survey³ 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. For example, customized identity tags. See Figure 5.

³ GSMAi 2022 Survey "Consumer 5G: how much users would pay for mmWave"

Willingness to pay (WTP) for a 5G enhanced service

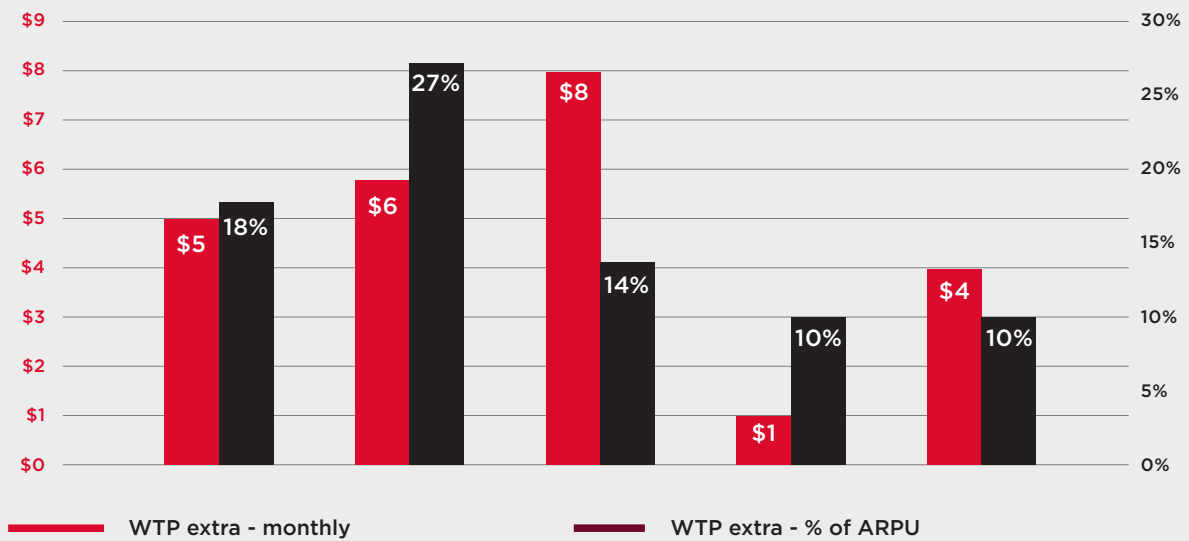


Figure 5, WTP for a 5G enhanced service

3.3. New Growth Curves via Provision of Differentiated Experience

In order to address the challenges described in section 3.1, the provision of differentiated experience is a way for Operators to open up a new growth curve.

5G development lays a foundation for differentiated operation of users, services, and networks. Operators can develop network capabilities based on different requirements of users and different service experiences to meet different requirements of users at different levels and different services of the same user. High-priority customers should enjoy better network service quality and in specific areas, users can automatically obtain specific service capabilities.

The satisfaction of user requirements directly affects user experience. The network provides differentiated capabilities, establishes the association between users and experience, and enables users to perceive the differentiated capabilities provided by the network through explicit methods such as assurance reminders and evaluation reports and perceive the value of differentiated assurance. This can further encourage high-end users to maintain loyalty, and can also guide

mid-range and low-end users to upgrade. Operators use experience monetization to implement close-loop management 5G network technology improve and end-user service experience benefit.

In a word, experience-based operation means that operators provide targeted assurance based on different network requirements of different services. Based on the differences in user experience perception degree, operators prioritize different types of services and preferentially guarantee the experience of services with high user experience. Carriers can provide different experience assurance packages based on differentiated capabilities, subscribers, services, and scenarios.

Users can select appropriate packages based on their differentiated SLA requirements. The network monitors user experience changes in real time and automatically triggers assurance when user experience deteriorates. The assurance report is sent to users in a timely manner, improving user experience and satisfaction.

In addition to providing new packages, carriers can add additional network assurance privileges, such as by time and by duration. Through the combination of the preceding methods, the experience operation business model is established to help carriers effectively start or accelerate business transformation and bring new growth.

3.4 Differentiated Experience Monetization

3.4.1 Challenges

In addition to the lack of network resources, differentiated operation has always faced the following four problems:

- It is difficult to classify users and identify services.
 - Differentiated assurance is based on user classification and real-time service identification. Currently, mobile network's capability of identifying user categories and service identification still have some problems. In this case, accurate user experience assurance cannot be implemented. Different user categories have different requirements for different user experiences. The same user is also classified in different scenarios and requires different services. Static subscription information on the network cannot support the preceding fine-grained user differentiation. In addition, encryption affects service identification precision. As a result, existing service identification methods cannot accurately and quickly identify services. If the above problems cannot be solved, it is difficult for the network to know which users need experience assurance and which potential customers are available, this restricts the development of experience operation.
- Cannot gain awareness of user service experience.
 - Different applications have different experience requirements, and network congestion and packet loss have different impacts on different service's experience. These KPIs indirectly affect user experience. Therefore, it is not intuitive to judge user experience based on network KPIs such as delay and packet loss. It's not accurate either. How to find out whether the data packets of a certain user or service meet experience expectations from massive mobile network traffic data involves a lot of analysis work, such as massive data analysis, context comparison, and experience expectation judgment. Taking video as an example, there are many factors that affect video viewing experience, including the rate, packet loss rate, and packet length. The correlation between these factors and video experience is non-linear and cannot be expressed by simple and stable formulas. Applications are diverse and complex. As a result, the traditional fixed formula calculation or traditional manual analysis is almost impossible to achieve.
- Unable to ensure efficient guarantee
 - The Quality of Service (QoS) of the current network is usually based on the users' level and does not distinguish different services of the same user. All services of a user will share same network resource. This implementation occupies unnecessary network resources and limits the number of guaranteed users supported. In this case, it is difficult to adopt the GBR-based guarantee, and only the non-GBR priority measures can be adopted. The guaranteed effect is limited. In addition, on traditional networks, post-event statistics and static analysis are performed. User experience can only be analyzed when services have already finished. Whether the delivered rules are valid or not cannot be determined in real time. In addition, the current network cannot dynamically enable guarantee, and the network resource status changes in real time. The existing mobile network traffic statistics are reported with a delay of more than 10 minutes. Their evaluation is thus delayed. On the other hand, radio air interface resources change dramatically. According to network statistics, when the number of physical resource blocks (PRBs) occupied exceeds 20%, the network is lightly loaded. However, second-level bursts may occur, and service experience may fluctuate. In addition, the current assurance mode is fragmented and isolated. The Radio Access Network (RAN), core network, and transmission network are separately guaranteed, which makes end-to-end coordination difficult and cannot ensure resource coordination in a timely manner.

- Users are unaware of experience assurance.
 - The basis of experience operation is that users can perceive the effect of experience assurance. On traditional networks, subscribers cannot perceive network assurance. This is because carriers' networks do not understand subscriber requirements and only deliver policies based on subscription information. On the other hand, subscribers do not know whether the network can provide differentiated assurance or user experience status. In other words, users cannot associate the good experience of using applications with the assurance provided by the network. Positive feedback cannot be established, and users cannot pay for experience. As a result, the promotion of new business models cannot be sustained.

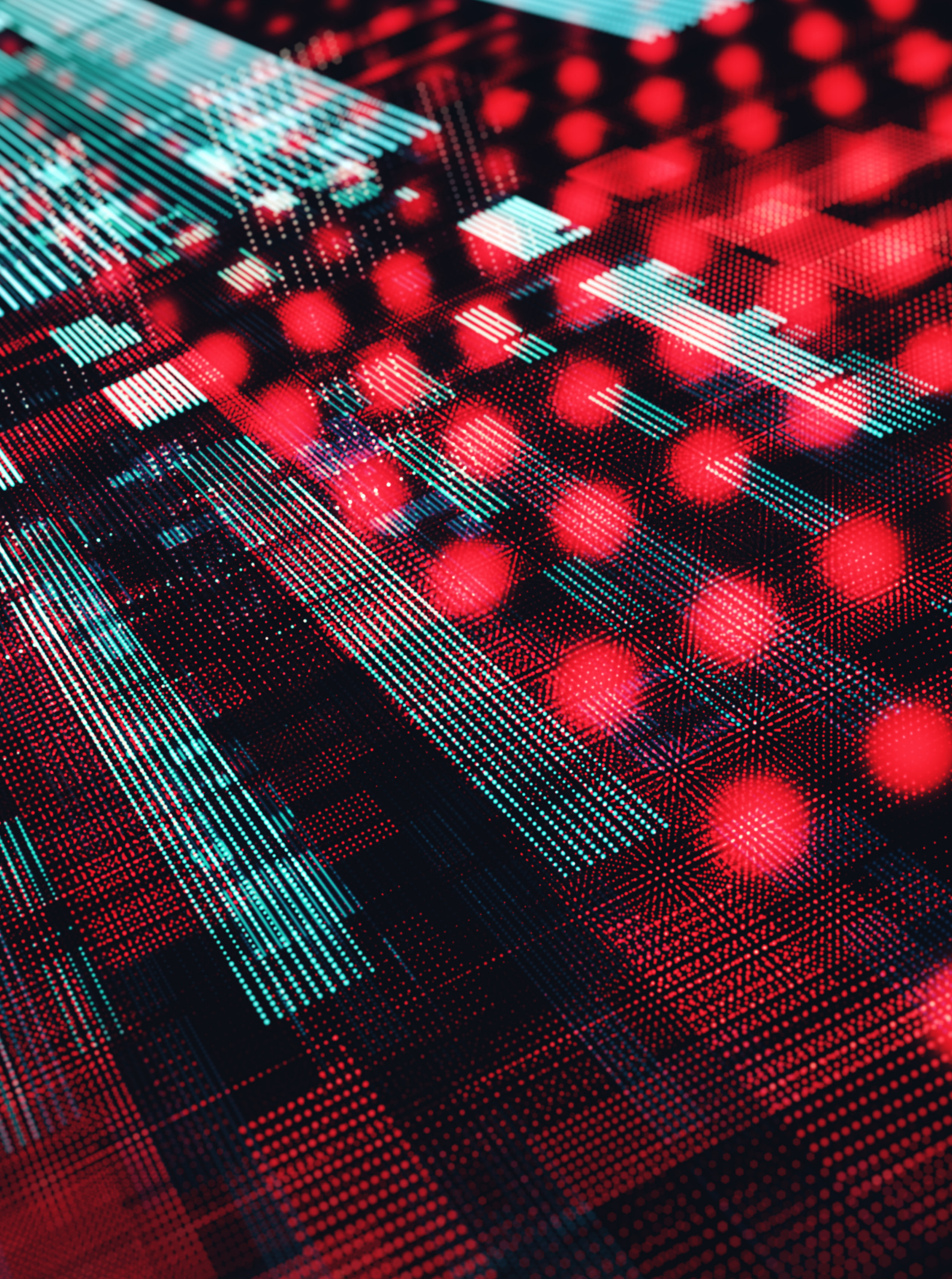
3.4.2 Enablers for Differentiated Experience Monetization

To address the preceding problems, 3GPP R16 and later has enhanced the network architecture, established a closed-loop feedback mechanism from the user plane to the control plane, enhanced data collection, analysis, and inference capabilities, and enhanced network awareness of services and experience. The Network Data Analytics Function (NWDAF) was introduced to implement data awareness and analysis. The NWDAF collects data from the radio access network and 5G core (5GC) network. After training and reasoning, the NWDAF get service types and actual experience. The NWDAF then adjusts network resource allocation based on the above result to improve and guarantee user experience and implement a closed loop from perception to optimization and then to perception. Finally, the network can provide analysis reports, which provide basic reports for analyzing network status and user-defined reports for specific scenarios. The NWDAF addresses the lack of application and service analysis capabilities in the network architecture, as well as the collection and analysis of policy execution results. However, it only defines the basic framework. The core competencies required are analysis and reasoning, which require the use of

intelligent technologies. This is because the mobile core network is characterized by a large amount of user data and a large amount of data traffic. In addition, the radio network status changes rapidly. The RAN allocates resources in a minimum scheduling unit of 1/32 ms to 1 ms. Traditional predefined rules cannot effectively cope with such a complex model and cannot accurately determine services and experience on a network that changes in real time. However, this is addressed via usage of AI and other technical improvements:-

- **AI has a significant advantage in processing massive amounts of data, effectively improving NWDAF's analysis and reasoning capabilities.**

- AI is naturally able to fulfill the needs of massive data analysis, reasoning, and prediction. Large models, typically built from deep neural networks, have billions or even hundreds of billions of parameters and can handle more complex tasks and data. Large models also can generalize and fine-tune, and can correctly understand and predict new, unseen data when faced with it. Fine Tune is performed based on a given pre-trained model. Compared with Training a model from scratch, fine tuning can save a large amount of computing resources and time, improve computing efficiency, and even improve accuracy. With the generalization and fine-tuning capabilities of the large model, it can be applied to the mobile network to identify users and service types in real time, identify service experience changes, and predict network resource status and service requirements, making the mobile network intelligent.



- **Combine AI with mobile core network technologies to build network intelligence and streamline the breakpoints of experience operation.**

- The network intelligence of the mobile core network is the convergence of network technologies and AI. Network intelligence technologies play a critical role in addressing challenges such as difficult user identification, inaccurate service identification, and delayed service assurance, and improve overall network performance by enhancing network awareness and analytics, which in turn enables operators to develop innovative business models and succeed in operations.

- **Precise identification of user's category**

- In terms of user identification, intelligent technologies can be used to establish a precise user profile solution based on user behaviour (such as moving tracks and camping locations) and features to automatically build a comprehensive user model. The intelligent user profile solution has advantages in massive data analysis and real-time result output. It can also be used to analyze user's characteristics, area distribution, and movement trends, predict user behaviour changes, and predict the impact on networks. Finally, it provides intelligent support and management in terms of network resource scheduling and user experience assurance and effectively assists carriers in data package business design and marketing.

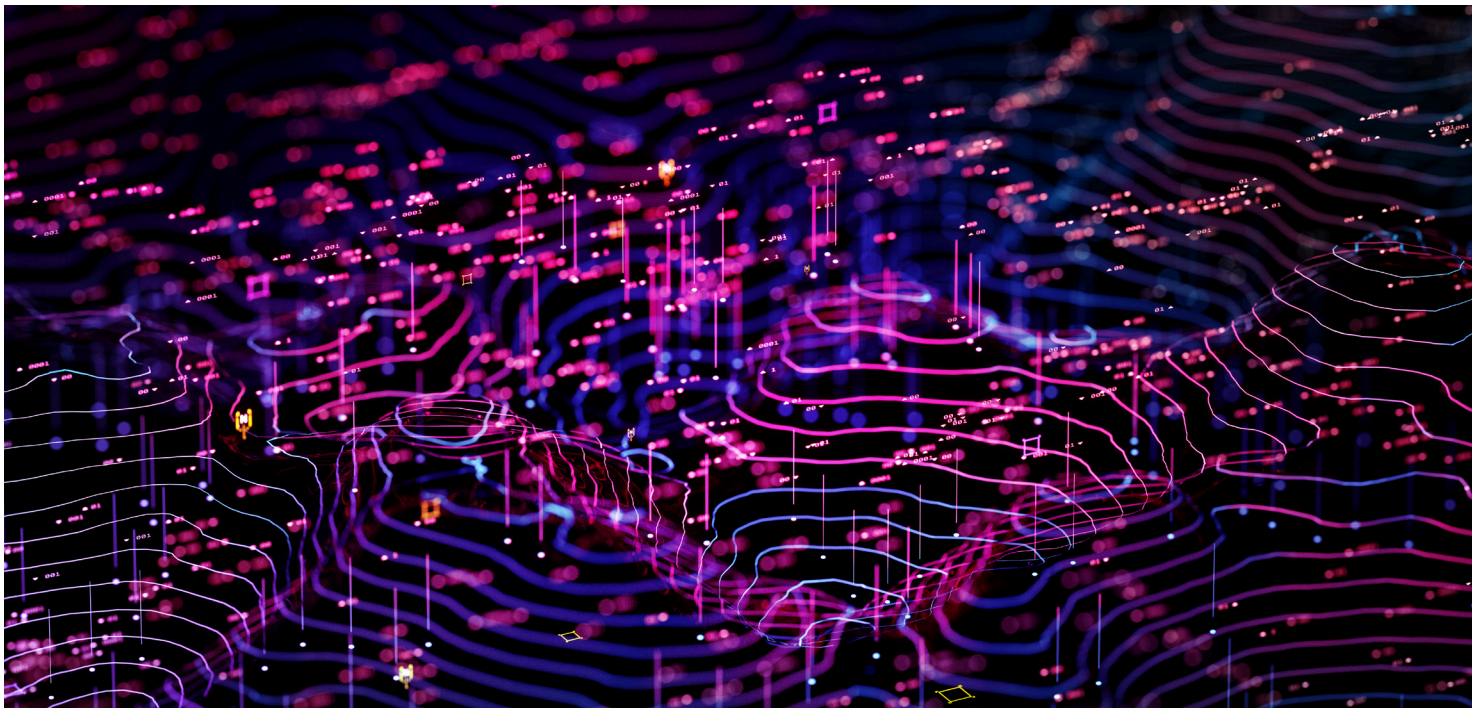
- **Precise service identification**

- In terms of service identification, AI technologies are used, especially the intelligent service identification large model constructed based on deep learning. A small number of data samples (such as feature information and

service tags) are used to pre-train the large model in advance, and then the trained model is deployed on the user plane Network Elements (NEs) on the live network. When user's service traffic passes through mobile network, the large model automatically infers and identifies service-specific feature information based on flow characteristics (such as packet length sequence and flow characteristics). Compared with fixed rules, the large model can also identify service-specific feature information based on the feedback mechanism. The service signature database is updated based on the learned application features, which enhances the original identification engine and continuously updates the service signature database. Based on the above technology, a generalized application identification capability can be implemented, including fast identification capability iteration, and a high identification rate can be maintained.

- **Real-time service experience awareness**

- After constructing a differentiated experience evaluation large model and understanding users' differentiated experience requirements, the deep learning model is deployed on the user plane to automatically identify changes in Key Performance Indicators (KPIs) such as bandwidth, delay, jitter, and packet loss of users and services. By correlating and analyzing these KPIs and actual service requirements, users' or services' experience results are obtained, and the results are reported to the NWDAF. The NWDAF has a global perspective and combines data from multiple parties to obtain a comprehensive user experience curve. The result can accurately reflect the real user



- experience, support second-level analysis of quality of experience (QoE) and experience monetization.
- Real time and effective experience assurance
 - The NWDAF collects real-time resource usage data from the User Plane Function (UPF) and RAN and uses advanced modelling technologies to analyze and process network data online to predict future mobile network performance. Based on second-level speed experience evaluation and reporting, the NWDAF automatically triggers assurance in a timely manner based on the current network status when detecting that service experience is poor. During the assurance process, the NWDAF monitors network resource fluctuation in a timely manner. When network congestion occurs, the NWDAF automatically withdraws the assurance to mitigate the impact of other services on User Equipment (UEs) that require performance assurance. Various experience assurance methods can be used. Dynamic GBR and advanced 5G network slicing technologies can be used to automatically calculate and reserve E2E isolated network resources based on Service Level Agreement (SLA) requirements of specific services, providing flexible and refined assurance.
- **Multiple methods to improve user experience in real time and enable closed loop of experience payment**
 - After key network intelligence capabilities are introduced, users can get the assurance process and results in different ways based on real-time experience awareness and dynamic experience assurance. For example, the network can customize UE's dedicated tags in a timely manner during user assurance. For example, the carrier ID can be changed on the phone to display that the user is in VIP assurance, or reminders, cares, and greetings information can be pushed. Through these methods, users can know when to be guaranteed and how effective the guarantee is. In this way, users' perception of the satisfaction of their differentiated requirements is improved, customer satisfaction and loyalty are improved, and carriers can better build experience benefits based on the guarantee and create packages based on the benefits to monetize.

The cited Network Intelligence streamlines key breakpoints and enables Differentiated Experience Monetization.

4. Use Cases

4.1 Service Assurance

The following subsections describe a number of user cases related to Service Assurance.

4.1.1 Live Broadcast Assurance

Live broadcast has become a mainstream service around the world. In China, the number of live broadcast e-commerce users reached 540 million in 2023, a year-on-year increase of 14.16 percent. In 2024, the number is expected to reach 590 million. Southeast Asia is one of the most active regions for overseas live broadcast with goods and has become a new blue ocean for live e-commerce. Tik Tok Shop's total market share in Southeast Asia rose to 13.2 percent in 2023, with Gross Merchandise Volume (GMV) reaching \$16.3 billion, a nearly fourfold increase from 2022. 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, Jeffree 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. The number of accessed users, cell congestion, radio signal strength, and core network gateway and transport network element congestion all affect the user experience.

With the 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 QoS levels, setting up dedicated bearers, delivering GBR guarantees, and dynamic slicing, to optimize user experience.

China Mobile started living broadcast service assurance in Hangzhou in June 2023. In a real network environment, 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 successfully 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 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 ARPU and DOU. The package includes 90 Gbit/s to 150 Gbit/s traffic, 150 Mbit/s to 200 Mbit/s upstream rate, and distinguished VVIP guarantee. See Table 1.

GRADE	PRICE (RMB)	RIGHTS AND INTERESTS		
		Traffic	Experience assurance	
VIP	199	90 GB	150 Mbit/s	10 times, or 10 hours
VVIP	299	100 GB	150 Mbit/s	20 times, or 20 hours
VVVIP	399	250 GB	200 Mbit/s	30 times, or 30 hours

Table 1, Example
Customer Packages for
streaming

In 2023, AIS Thailand launched a 5G Live Mode add-on package, which costs \$1.38 USD 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 increases 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 to deliver business models and increase revenue.

4.1.2 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 distance education and has 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 the market growth. In addition, the network has higher requirements, high-speed and stable connections, and videoconferencing has higher requirements on 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. In May 2024, the marketing department of China Mobile released the User-Oriented Hierarchical Network Assurance Service Specification, which specifies the assurance scope of experience operation and ensures video sessions as typical applications. Currently, China Mobile Guangdong is actively verifying videoconferencing assurance technologies in high-speed rail business travel scenarios.

4.1.3 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 light-weight 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 operation requirements. Therefore, the response delay must be within 100 ms. In the worst case, the response delay should not exceed 150 ms. The shooting class of games have higher operating precision requirements as the game needs to control the response delay to 60 ms 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 also \$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.

China Mobile Shanghai has focused on improving the experience assurance for applications requiring high bandwidth. It takes the lead in network construction based on 5G-A standards. It started in July 2013 and completed a Proof of Concept (POC) verification in June 2024. Based on the wireless 3CC CA technology, the peak rate of a single UE is verified to exceed 5 Gbit/s on the live network, providing resources for differentiated experience assurance. Test results show that the cloud game Black Myth-Goku can provide a stable rate of 100+ Mbit/s.

4.1.4 WA 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 will reach 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, which 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 B2B vertical, especially for young and dynamic demographics.





4.2 Smart High-Speed Rail Experience Upgrade

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 and travel. Voice, instant messaging, and videoconferencing are valuable services.

The pain points of high-value users in the high-speed railway scenario are poor user experience. According to the test results, the actual user experience rate is low, and the average user experience rate is lower than 4 Mbit/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. High-speed rail mainly carries business and travel. Voice, instant messaging, and videoconferencing are valuable services. 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 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 high-speed 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.

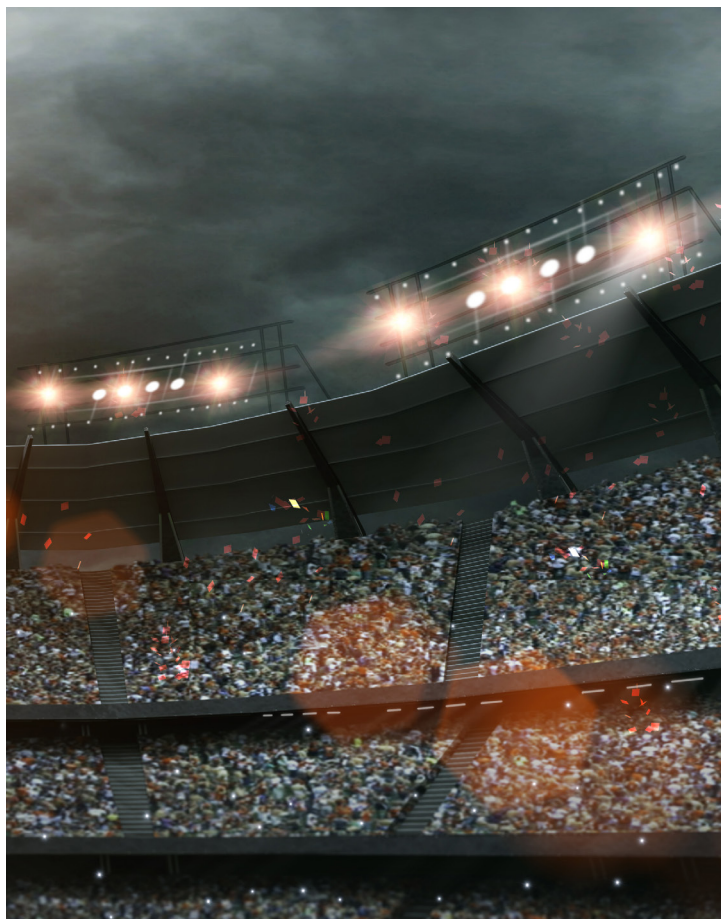
4.3 Large Event Guarantee

Large-scale events, such as sports events and concerts, usually occur in high-value scenarios and need to be guaranteed by carriers. 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 on 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. That is, mobile networks can provide 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 Potential End User Excavation

Operators possess vast amounts of user data, encompassing traffic usage patterns, network preferences, geographic location details, and more. This wealth of information reveals intricate user behaviour patterns and potential demands, making it an invaluable resource for identifying prospective customers. By developing sophisticated recommendation models and algorithms, operators can efficiently sift through their extensive user base to pinpoint potential customers, thereby enhancing marketing effectiveness and bolstering their competitive stance in the market.

Machine learning and data mining algorithms, serving as foundational technologies, have found widespread application in the realm of potential end-user excavation. For example, classification models are harnessed to forecast customer subscriptions to specific products or packages, facilitating precise push notifications. Clustering algorithms categorize customers into distinct groups based on shared characteristics, empowering operators to devise more tailored customer engagement strategies. Leveraging these algorithms, operators can distill valuable insights from extensive user data, offering strong support for prospect identification and mining. This technology enables:-

- Intelligent data analysis and personalized service:
 - Operators use machine learning and artificial intelligence technology to process large amounts of user data by deploying advanced analysis platforms. For example, Verizon uses AI to predict customer churn and take measures to improve customer satisfaction. By building detailed user profiles, operators can identify user groups with high consumption potential or interest in specific services. AT&T has launched a content recommendation system customized based on user behavior patterns.
- New Business Promotion:
 - By harnessing intelligent algorithms, personalized business recommendations can be achieved, significantly boosting the conversion rate of new service promotions. This algorithm meticulously builds user profiles through the collection and analysis of historical user data. It then predicts users' likelihood of

accepting and purchasing new services, tailoring personalized recommendation strategies to precisely target potential users with relevant offerings. For instance, when an operator introduces a new home broadband service, the algorithm can pinpoint home users requiring high-speed internet through data mining. By accurately promoting the service to these users, the operator can substantially enhance the promotion's conversion rate.

- User Upgrade and Retention Scenarios:
 - By continuously monitoring and analyzing user behaviour data, operators can promptly detect trends in changes in user usage habits and take corresponding measures to improve user satisfaction and loyalty. For potential churn customers, operators have constructed early warning models to predict customers' churn probability in real-time and take proactive intervention measures, such as offering discounted packages or free data, to reduce churn rates. Meanwhile, for customers who may upgrade their packages or services, operators provide personalized upgrade recommendation schemes through prospect mining algorithms, such as recommending higher data packages based on users' data usage or recommending related value-added services based on users' APP usage preferences.

4.5 Vertical Case

5G networks not only enrich personal life but also serve as a platform technology to lay a solid foundation for industry digitalization, especially in the ToB field. Various industries, including manufacturing, transportation and storage, supply of electricity/gas/steam/air conditioning, human health and social work activities, art/entertainment/cultural activities, are actively exploring digital transformation of the industry, compared with previous IEEE 802.11 wireless technologies. In addition, 5G has improved key connection capability indicators such as rate, delay, reliability, and number of connections. These improvements in technical capabilities will enable industries to gain higher capabilities in applications that already use wireless technologies. For example, in vision-based AI detection scenarios in the industrial manufacturing field, such applications use industrial cameras to collect a large amount of data in real time, process the data in real time with AI and big data technologies, and deliver instructions with a certain delay and reliability assurance based on the data processing results. In this service flow, high bandwidth and low latency are required for network transmission. 5G networks are the core requirements for scenarios that require high transmission bandwidth, low latency, and high reliability. Example service scenarios and performance requirements are shown in Table 2.

Combining intelligent technologies with 5G network technologies and intelligent differentiated assurance, different network resources are allocated to different types of services. For example, for industrial control services with deterministic latency requirements, dedicated delay assurance threshold PDBs are delivered. The wireless network, core network, and transport network coordinate end-to-end delay allocation to ensure time delay stability..

SCENARIO	HEALTHCARE	POWER GRID	SMART CITY	V2X IOV	MANUFACTURE
Service	Remote diagnosis Remote surgery	Feeder automation Intelligent power distribution	Video surveillance parking, streetlamps, and traffic lights etc.	Platooning Remote driving Automatic driving	Industrial Control Remote Control
Bandwidth(bps)	>100M	>30M	>100M	>100M	>20M
Latency	<5ms deterministic delay	<10ms deterministic delay	<50ms	<10ms	<10ms
Reliability	Reliability >6*9 UP bandwidth scheduling	Reliability >6*9 Precise control	Massive connections	Reliability >6*9 Platooning management	Reliability >6*9 deterministic delay

Table 2, Example Service Scenarios & Performance Requirements



5. Standardization Progress

5.1 Overview of standardization activities.

As described in the section 3.4.1, differentiated experience monetization faces different challenges. If Operators are unable to ensure efficient guarantee and users are unaware of experience assurance. How to effectively solve the challenges faced by the current differentiated experience is also a problem that needs to be solved by the standards. The following sections describe the standards progress related to network assurance, device awareness, and experience evaluation for differentiated experience assurance.

5.2 Differentiated experience assurance- network assurance

With the support of 5G for more complex communication scenarios and its high data exchange and processing capabilities, the need to optimize service experience for end users and enhance network efficiency in an automated, real-time, and flexible manner has become critical. To address this, 3GPP has established a standardized network automation architecture as illustrated in figure 6. This framework has garnered significant attention across the industry and driven the development of valuable use cases and achieved remarkable progress in network optimization.

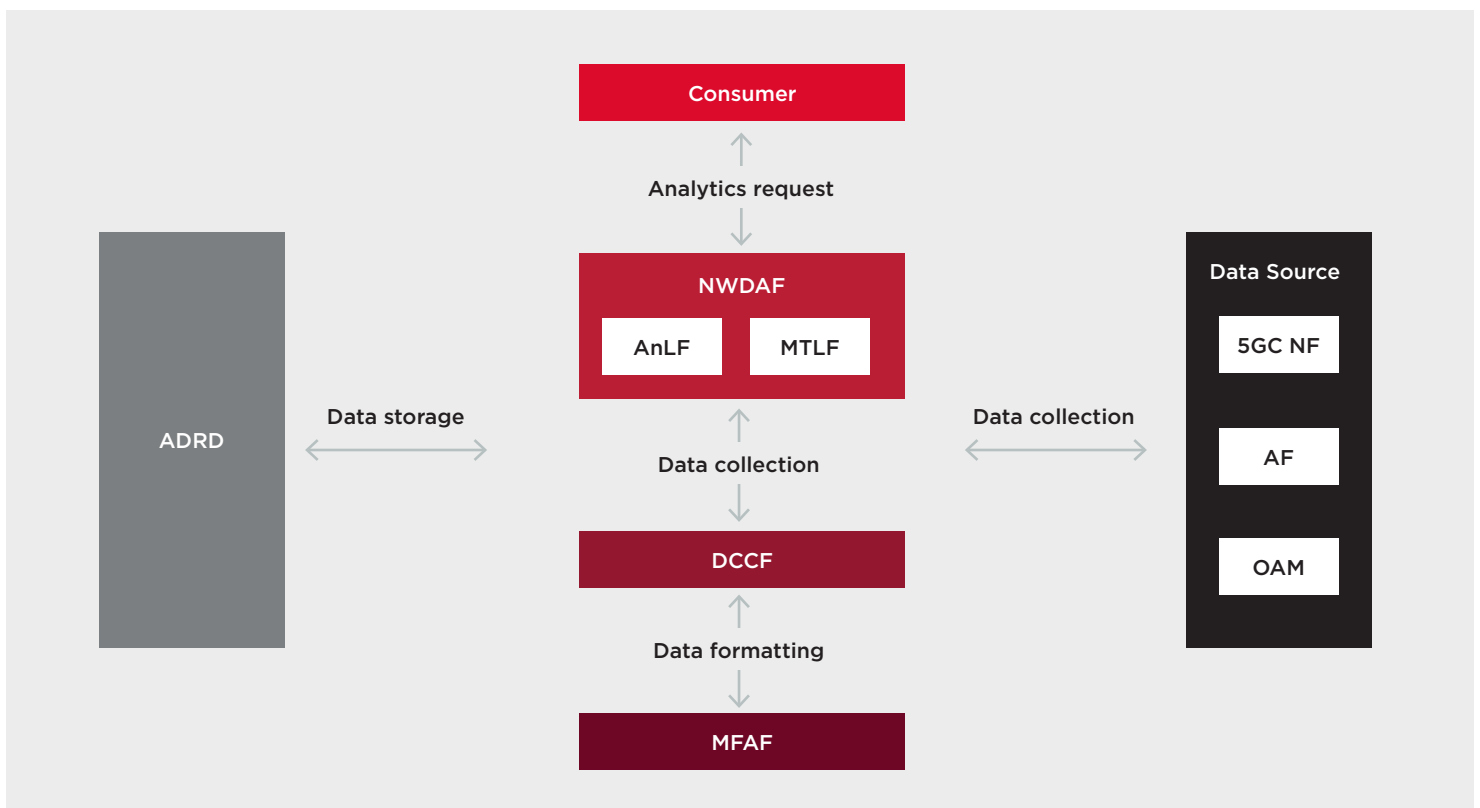


Figure 6, Network automation architecture

3GPP introduced the Network Data Analytics Function (NWDAF) in Rel-15, to manage and analyze complex network data effectively. When an analytics request is received from the consumer, the NWDAF collects relevant network data, service data, management data and/or UE performance data from dedicated data sources accordingly, and then processes the collected data to generate the requested analytics information, providing actionable insights that help the consumer achieve their objectives, such as enhancing user experience and optimizing network performance.

3GPP Release 16 enhanced the intelligent network architecture by expanding the capabilities of the NWDAF. The NWDAF now supports collecting different data types from additional data sources through subscriptions to events provided by 5GC Network Functions. The valuable use cases were further enriched in this release by including the Observed Service Experience analytics which provides statistics or predictions about user-perceived service quality to assist in enhancing user experiences and Abnormal UE behaviour analytics which may be used to block communication of the hijacked UE, etc.

In 3GPP Release 17, the architecture and use cases were further refined to enhance ML model training and improve data collection efficiency. The NWDAF was decoupled into Model Training Logical Function (MTLF) and Analytics Logical Function (AnLF), enabling distributed Data analytics tasks, and analytics results are aggregated to handle large-scale data analysis and inference more effectively. The support of transferring the subscriptions and analytics context information in NWDAF reselection scenarios significantly enhances the data analytics efficiency in handover scenarios. The Data Collection Coordination Function (DCCF), Message Framework Adaptor Function (Messaging Framework Adaptor Function), and Analytics Data Repository Function (ADRF) were introduced to improve the efficiency of data collection, data processing, and data storage. The Data Collection Application Function was introduced to facilitate the collection of terminal application data. In terms of valuable scenarios, the Data Network (DN) performance analytics provide insights into the DN performance enabling consumers to select the most suitable DN Access Identifier (DNAI) for the UE. Additionally, Session Management Congestion Control Experience analytics supports the analysis of PDU session congestion on DNs or network slices.

Release 18 focused on addressing the accuracy challenges of NWDAF analytics results and models and defining the accuracy measurement mechanism. This enhancement enables NWDAF to support accuracy monitoring and dynamic adjustment. The introduction of a machine learning method of Horizontal Federated learning, that trains a ML Models across multiple decentralized NWDAF instances without exchanging and sharing the local data set in each NWDAF, was introduced into the model training of the NWDAF to improve the model training efficiency.

In addition, the use cases were expanded and refined., e.g., the Packet Flow Description (PFD) Determination leverages the existing PFD information and User-Plane traffic and provides the analytics in the form of new or updated PFDs to the analytics consumer for more effective traffic management and optimization.

3GPP Release 19 builds upon the network automation architecture with further enhancements and a broader range of use cases. The AI-assisted positioning enhancement introduces solutions for the Location Management Function (LMF) to support Direct AI/ML based positioning, improving accuracy and efficiency. The release also introduces NWDAF-based and Application Function (AF) based Vertical Federated learning enabling the Machine Learning (ML) model training and analytics inference to be performed without exchanging the local datasets. Additionally, NWDAF-assisted policy control and QoS enhancement provide QoS recommendations to further assist the Policy Control Function (PCF) for policy decisions. A significant new capability is the enhancement of NWDAF to support the prediction, detection, prevention, and mitigation of network abnormalities such as signaling storms, further strengthening network reliability and stability.

5.3 Differentiated experience assurance- device awareness

5.3.1 GSMA TSG for Service Experience

In July 2018, the GSMA published PRD TS.44 [2]. This document outlines simple requirements to ensure customers consistently have access to the operator's name and network connection status.

The Operator Name Display (OND) SHALL use the "Mobile Network Name" or the "Abbreviated Mobile Network Name" typically derived from the Network Broadcast (NITZ), SIM Fields or Abbreviated Mobile Network Name as defined in GSMA PRD TS.25 [3]. This information is available from the TS.25 [3] Database , although the device vendors may agree directly with operators on exceptions.

5.3.2 UE Logo – Dynamic Network Identity

The following use cases are applicable:-

- Use case1 - Local service notification:
 - When a terminal is in a specific location, the PCF sends a customized Network Identifier (NI) to the user to present the local personalized service, for example, China Mobile to Grand Hyatt.
- Use case 2 - Subscribed User status notification:
 - When a UE is in a specified state, the PCF sends a customized NI to enhance the Subscribed User experience. If a user is in the assurance process, China Mobile can send a tailored notification to inform the user about the status or provide updates relevant to the process, improving overall customer experience.

The Access & Mobility Management Function (AMF) can determine the NITZ and send the UE Logo via UE Configuration Update procedure, as described in 3GPP TS 23.502 [4]. This decision regarding UE Logo is made by the AMF based on local policies but lacks dynamic and flexible updating mechanism. The new standard plan introduces a more flexible approach for updating the UE Logo, enhancing the original 3GPP standard solution. In this updated plan the UE Logo can be dynamically updated based on user-level policy decision capability provided by the PCF and delivered to the AMF. This improvement allows for more dynamic and user-specific updates.

(Key Quality Indicator [KQI] evaluation). Subjective evaluation is a comprehensive evaluation of network quality based on users' real service experience. In contrast, Objective evaluation is to evaluate the network quality based on several quality indicators that impact user experience.

Currently, there is no unified global standard for service experience evaluation, and the overall experience evaluation framework system needs to be further developed to ensure consistency and comprehensive assessment across networks.

5.4 Differentiated experience assurance- experience evaluation system

With the development and widespread adoption of various mobile Internet services, users are increasingly focused on the quality of their service experiences. To ensure the mobile networks can bring better user experience, network quality evaluation from the user's perspective experience has gained significant attention. Network quality evaluation can be classified into two categories subjective evaluation (QoE evaluation) and objective evaluation

6. IPC – Network Readiness

For the enablement of IPC networks to support experience monetization early, it is recommended that the deployment be divided into two phases.

- Phase 1: Enable basic network intelligence capabilities and build a closed-loop system for ensuring real-time and dynamic user experience. It is recommended that carriers select the solution based on factors such as network conditions, 4G/5G deployment, and terminal ecosystem.
- Phase 2: Introduce native AI and collaborate with the Business Support Systems (BSS) to enable precision marketing and data openness capabilities, from experience assurance closed-loop to experience operation closed-loop.

6.1 Phase 1

The intelligent packet core network forms an E2E solution based on user experience. The objective of the solution is to achieve a complete closed-loop solution that can perceive experience, guarantee poor quality, evaluate the network, and effect awareness:

- Experience awareness: The intelligent packet core network evaluates user experience based on network data and performs closed-loop processing based on user experience.
- Poor-quality assurance: The IPC evaluates user experience in real time and detects whether poor-quality services occur. If poor-quality services occur, the IPC triggers GBR for dedicated bearer to ensure user experience.
- Network evaluability: Before enabling network

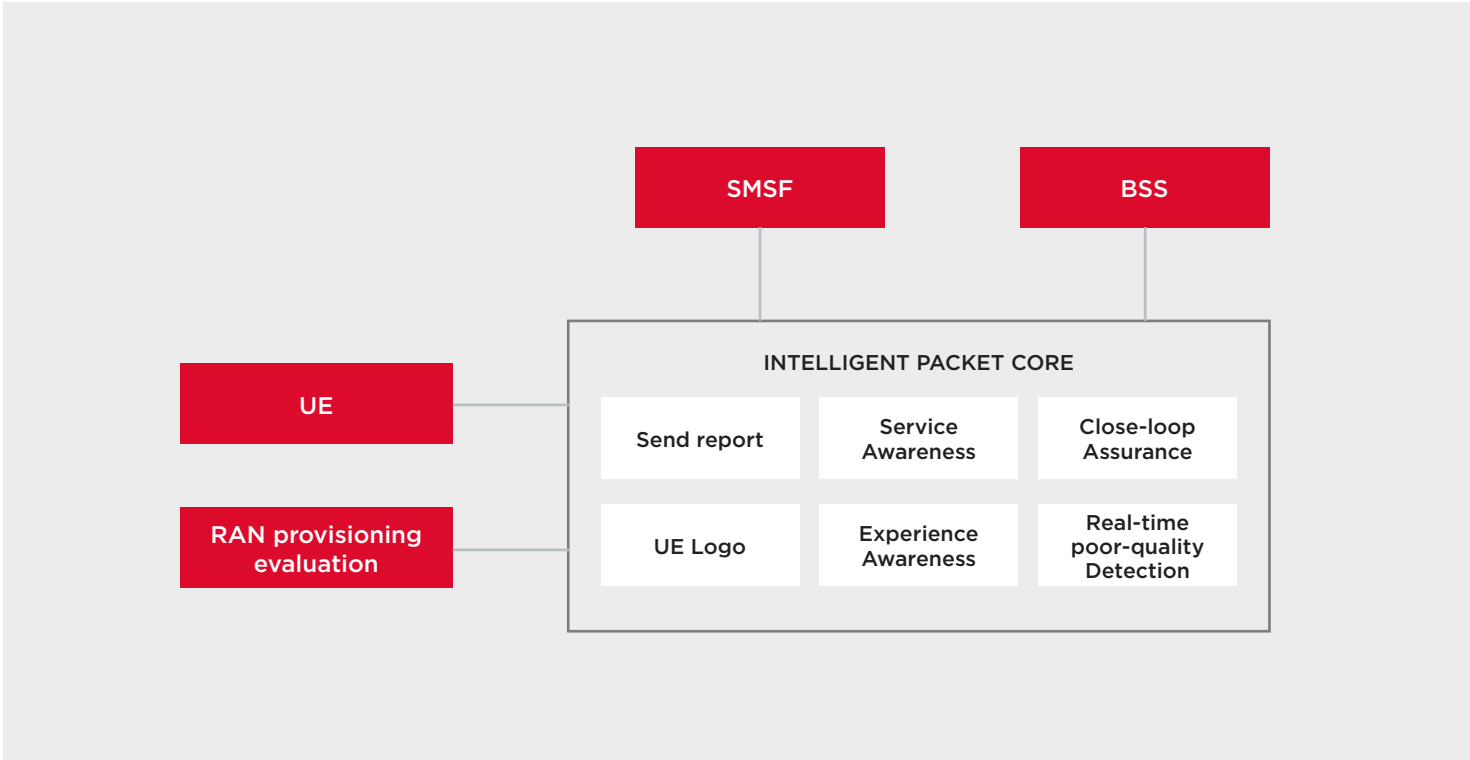


Figure 7, Phase 1 Network architecture

- assurance, plan assurance policies based on network status information to prevent network environment deterioration.
- Assurance effect awareness: After service assurance, the service experience improvement effect report can be sent to users through Short Message Service (SMS) messages.

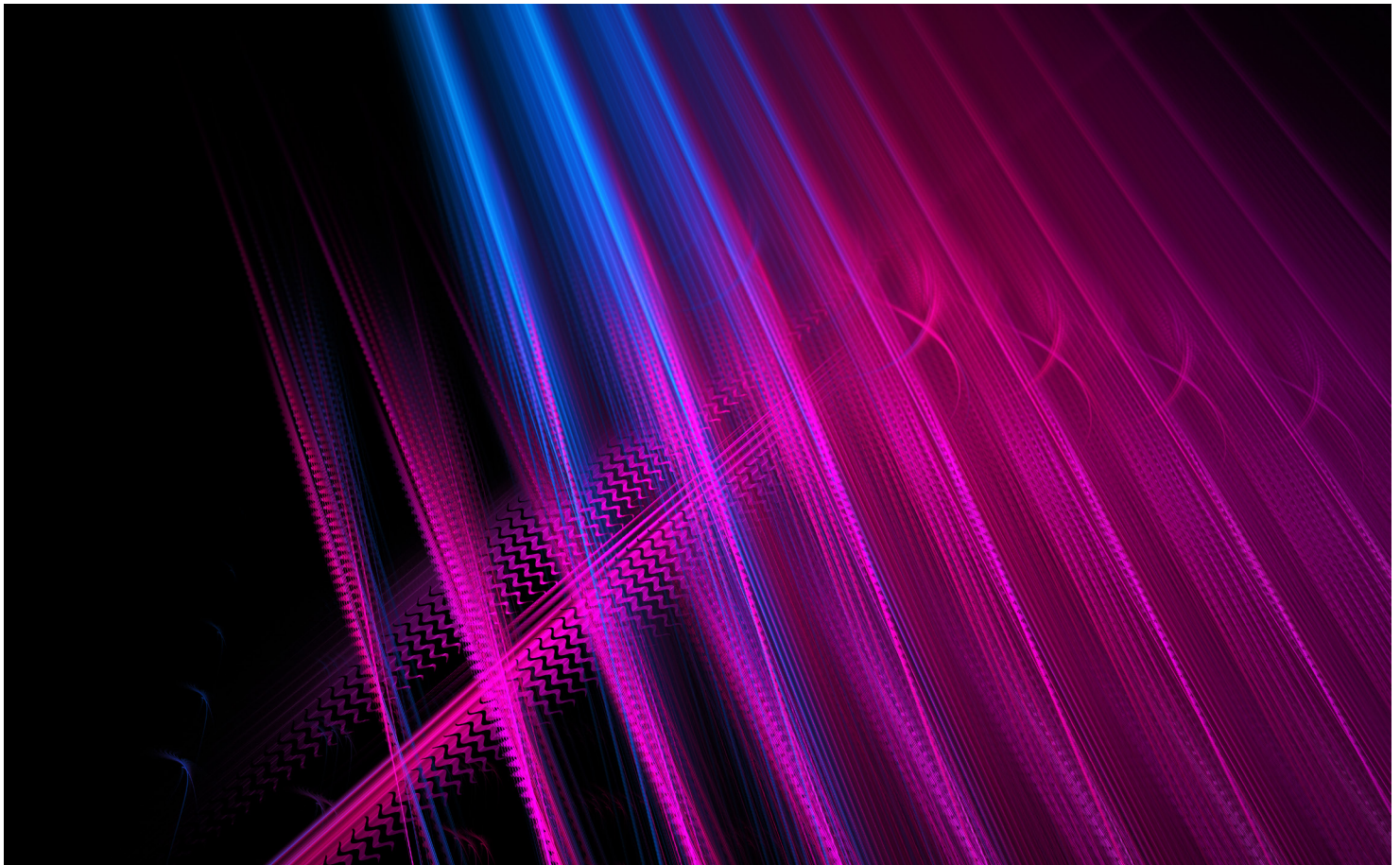
The entire solution consists of multiple functional modules in the intelligent core network and wireless network as illustrated in Figure 7. Considering the deployment difficulty and requirements in different deployment phases, it is recommended that various functional modules be flexibly deployed according to the following categories:-

- **Mandatory Function:-** Consisting of the following five functional modules. It is recommended that these modules be deployed at the initial stage to support the closed-loop management of basic experience assurance
 - Service awareness,
 - Experience awareness,
 - Real-time poor-quality detection,
 - Real-time closed-loop assurance,
 - Assurance effect awareness,
- **Optional Function:** Consisting of the following two functional modules (and recommended that that carrier use this feature based on the live network status and UE conditions):
 - Dynamic UE logo: It is recommended that dynamic UE logos be promoted based on the UEs on the live network that support dynamic UE logos.

- Wireless provisioning evaluation capability: This capability is optional at the initial stage of user development. After the number of users increases to a certain extent, it is recommended that wireless vendors provide provisioning evaluation capabilities to guide wireless network construction and package provisioning.

To accelerate dynamic UE Logo deployment, it is recommended that core network NEs such as the NWDAF be provided by the same vendor as the PCF. If different vendors are inevitable, adaptation is required. For operators who have deployed 5G Standalone (SA), it is recommended that SA UEs be preferentially enabled to accelerate user migration to 5G SA and increase ARPU.

For operators who have not deployed 5G SA, it is recommended that network intelligence technologies be introduced in 4G/5G non-Standalone (NSA) to preferentially develop high-end users and improve high-end user loyalty or increase ARPU.



6.2 Phase 2

In the second phase, native AI capabilities are introduced to refine user groups awareness, more refined experience evaluation, and more accurate package marketing as illustrated in Figure 8, which enables:-

- Collaboration with the BSS domain to carry out experience marketing,
- Open intelligent analysis of data and upgrading data value.

6.3 Suggestion on BOSS collaboration

Experience acceleration package provisioning is supported to implement the first-hop operation based on user experience. The NWDAF obtains user experience data to implement post-event effect analysis.

The NWDAF obtains user experience data in real time, quickly locates high-value users, and pushes packages through SMS messages to implement precision marketing.

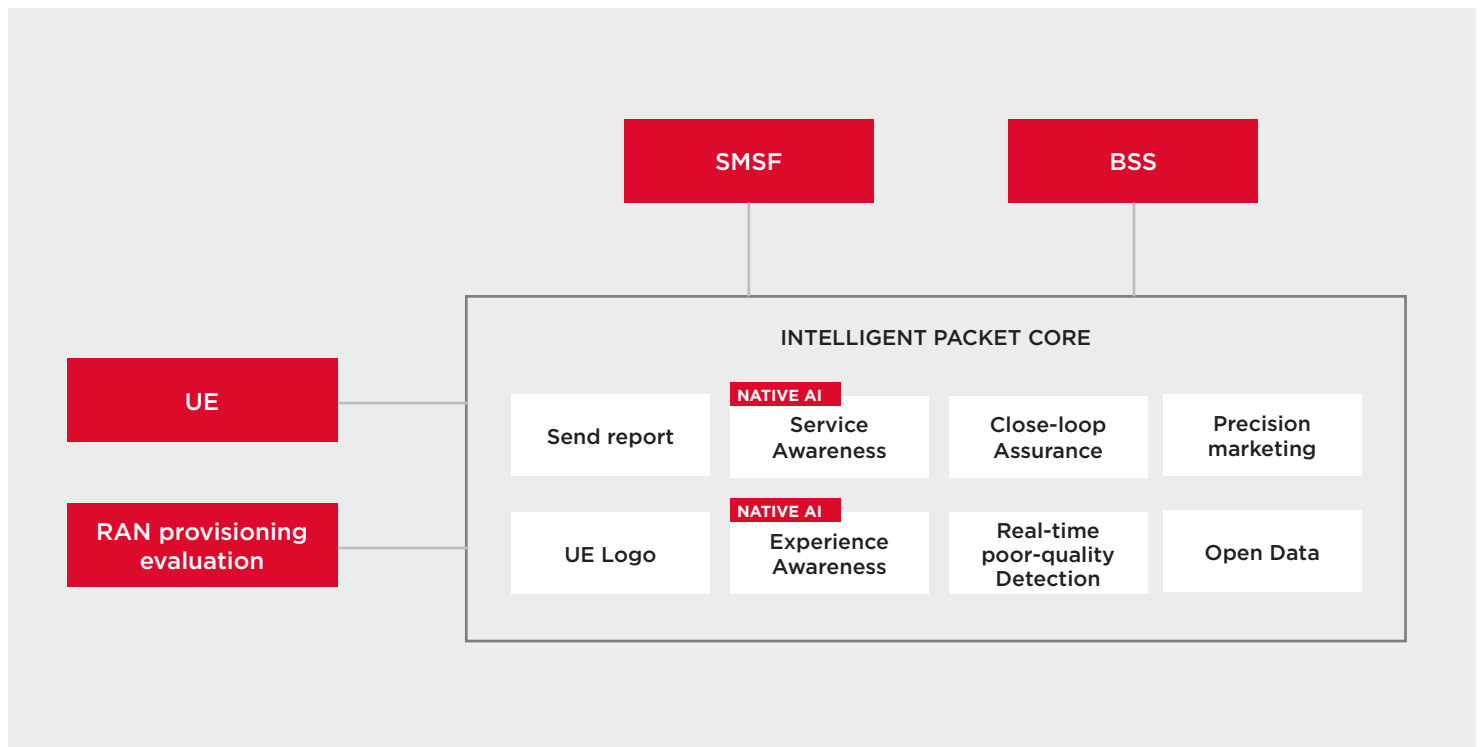


Figure 8, Phase 2
Network architecture

7. Commercial Progress

This section describes commercial progress and trials carried out by a number of different Operators.

7.1 AIS Thailand

Advanced Info Service (AIS), the largest mobile operator in Thailand, has launched the country's first "Living Network". The move is part of the company's efforts to become a cognitive technology company, aiming to elevate the capabilities of its intelligent 5G infrastructure, the Living Network that allows a degree of micro-segmentation of users that was not previously possible. Today, AIS 5G subscribers can access their myAIS application portal, select the MyNetwork option, and then enable "5G Mode". This mode allows the user to evaluate different usage modes. Once they select the one that best suits their requirements, they can choose from available packages. Currently, there are three primary 5G Mode options available as illustrated in Figure 9.

Boost Mode:

Offers high-speed 5G data throughput in "built-up areas", or, in other words, areas with significant congestion and heavy load of simultaneous users.

Game Mode:

offers mobile: gamers an enhanced and more importantly, stable data connection to maintain a consistent user experience.

Live Mode:

enables users to maintain a consistent experience level for "live streaming" events.

Once the user selects the usage mode that best suits their specific requirement at that time and location, they are then presented with package options that, once activated, will enable the differentiated network capabilities that deliver on the experience they seek. "The Living Network would not affect the network quality for other customers in the same area because the company caps the number of adoptions in terms of the coverage radius of each cell site to maintain network quality for all," said Saran Phaloprakarn (Head of Mobile and Consumer Products).

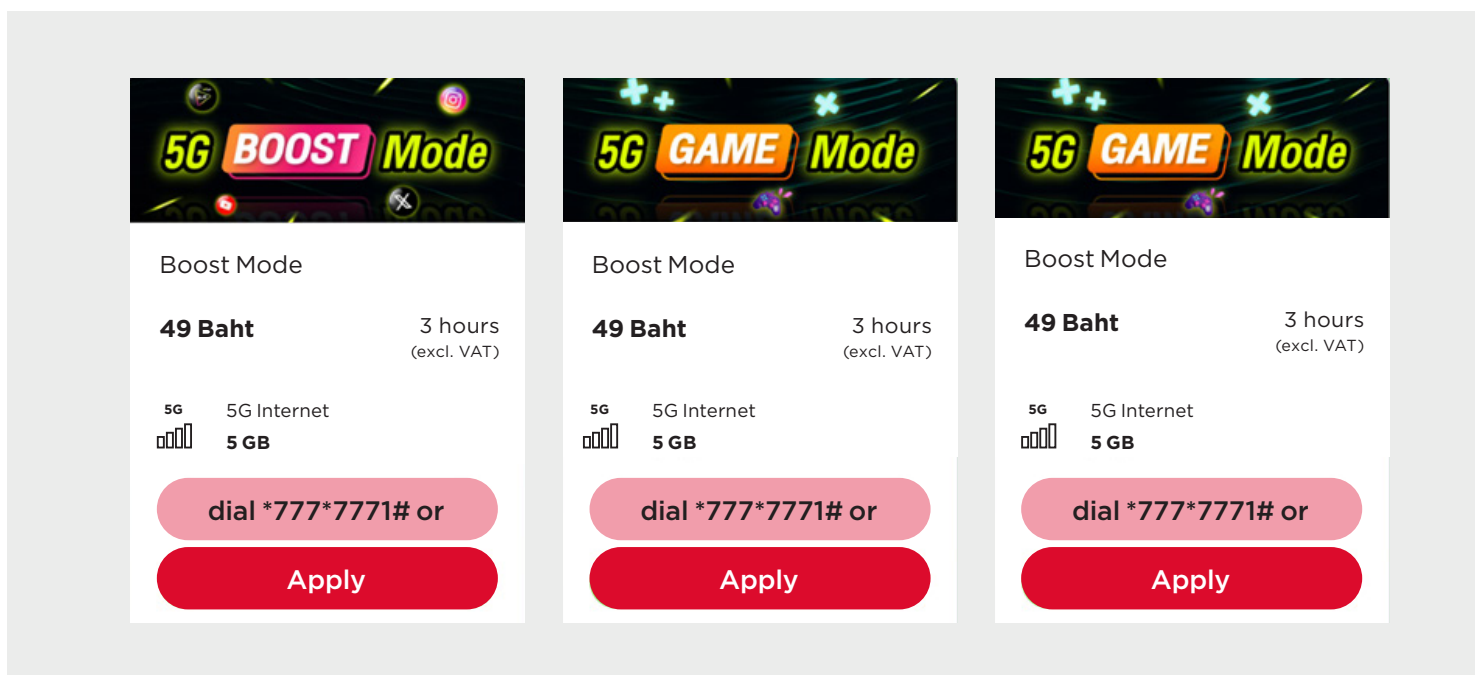


Figure 9, AIS Living Network data package

The key decision that has allowed AIS Thailand to put all their building blocks in place was the deployment of their 5G Intelligent Packet Core, or their 5G Core solution. This product developed by Huawei, not only offered AIS advanced policy controls and management capabilities, but it also taps into levels of intelligence about the underlying network that were previously not possible. The Intelligent Packet Core acquires this level of intelligence by tapping into the 5G network's Network Data Analytics Function, or NWDAF. The NWDAF was a new standard introduced by the 3GPP. 3GPP defined a new 5G Core architecture with their Release 15 standard, with preliminary functional interfaces defined.

After the launch of the Living Network package, AIS will keep exploring and working on new technology to bring better and deterministic experience to subscribers based on the industry's leading 5G network. Meanwhile, AIS also aims to explore and provide other new 5G services to subscribers to unleash the full potential of the network capability.

7.2 CMCC

As the first carrier to commercially deploy 5G-Advanced globally, CMCC continues to lead the innovation and commercial use of monetizing 5G-A networks' intelligent acceleration experiences around the world. CMCC has started tests and pilots for some key scenarios since 2023, and some leading CMCC branches have launched experience acceleration packages in 2024.

From June 2023 to March 2024, China Mobile Group's Zhejiang Company Limited, along with China Mobile Research Institute and Huawei, have jointly conducted a trial and POC for live broadcast over 5G. In July 2023, they began to verify the mainstream live broadcast acceleration effect. The key service acceleration solution deployed by China Mobile Group's Zhejiang Company Limited is based on Intelligent Packet Core with NWDAF. For users who have subscribed to key 5G services, such as live broadcast, the key service acceleration solution can detect the service experience of these users. When the service experience is poor, the key service acceleration solution implements precise and dynamic acceleration and resource utilization based on the subscribed packages and the radio cell resource status. In the case of live sporting events, a typical scenario is frozen frames caused by buffering. With the new solution, VIP users will not be impacted by frozen frames, and common users will receive an option for a "Back to Live" link once their streams are restored. Figure 10 shows the detailed effect observed on UEs, that provide the downlink live TV playback of common and VIP users.

Effect: After a common user freezes several times, the image delay occurs. The VIP user's score is 33:29, and the common user's score is still 33:28

Effect: When a common user enters the playback mode after several delays, the "Back to Live" link is displayed on the page.



Figure 10, Trial Result of China Mobile Group's Zhejiang Company Limited

On December 8, 2024, China Mobile Group's Beijing Company Limited held a GoTone customer sharing meeting to showcase the charm of leading communications technologies for customers. In addition, the world's first commercial use of the NWDAF of China Mobile Group's Beijing Company Limited was launched at this sharing meeting, and four differentiated experience packages were released, as shown in the Figure 11 below. This will provide a smarter and more efficient network experience for GoTone users. As the first to commercialize differentiated experience based on NWDAF-centered Intelligent Packet Core solution, China Mobile Group's Beijing Company Limited makes a major breakthrough for China Mobile in the 5G era and sets a new benchmark for the industry.

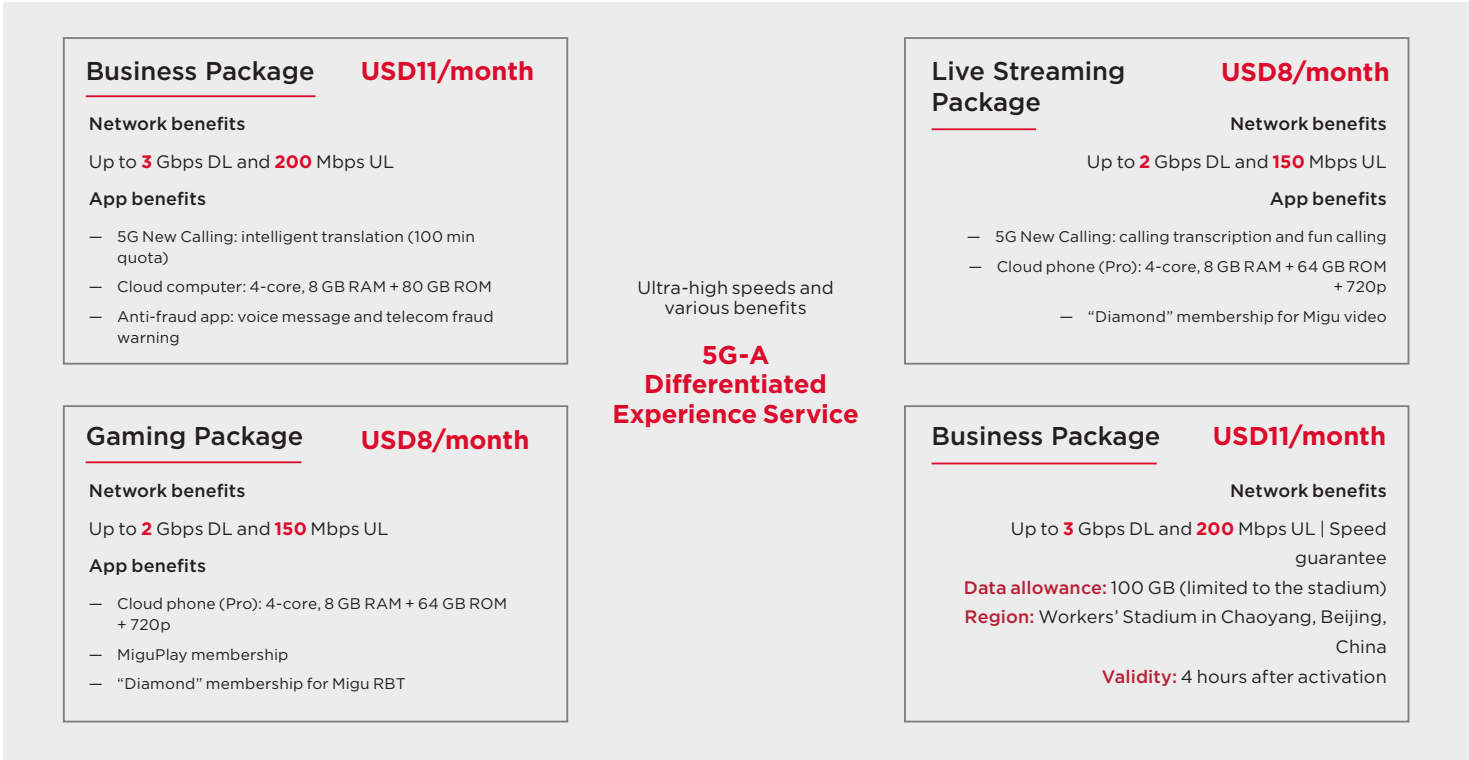


Figure 11, Four differentiated experience packages of China Mobile Group's Beijing Company Limited



Along with the official deployment of 5G-A network intelligence in 2024 after large-scale 5G construction, China Mobile Group's Henan Company Limited launched three new tariff packages for high-end GoTone users at the end of December 2024. These packages are crafted based on a tiered guarantee-based segmentation of their consumer base. They offer experience acceleration, superior service awareness, and a wealth of benefits and

applications, satisfying customers' various needs and increasing the ARPU. Table 3 below shows an example of these new tariff packages, with a focus on enhanced uplink features to suit specific usage profiles. In the concert scenario (the service upgrade in Table 3), users with these packages have a superior user experience, compared with common users.

Package	Communications Privilege			Smart Network Privilege		Other Privilege	
	Calling Duration in China (Min)	Data (GB)	Call Duration for International Roaming (Min)	Gigabit 5G-A Mobile Network			...
				Speed Upgrade	Service Upgrade		
First class A	2,200	250	200	1 Gbps DL up to 150 Mbps UL	1. Key service/scenario guarantee 2. Dedicated network channel 3. Customized UE symbol	...	
First class B	2,500	300	400	2 Gbps DL, up to 150 Mbps UL		...	
First class C	3,000	400	400	3 Gbps DL, up to 200 Mbps UL		...	

Table 3, Examples of Tariff Packages

In the second half of 2024, China Mobile Group's Guangdong Company Limited and Huawei trialled the first intelligent 5G-A core network experience acceleration solution along the Guangzhou-Shantou high-speed railway, marking a milestone in experience monetization for specific scenarios. The NWDAF-based intelligent user profile awareness technology is applied to high-speed rail scenarios, aiming to accurately identify high-speed rail passengers based on the sequence clustering of user tracks from base stations. Based on the intelligent awareness of high-speed rail passenger profiles, differentiated frequency selection policies are delivered to UEs to ensure that they preferentially access proper frequency bands. As such, high-speed rail passengers' UEs will preferentially access a high-speed railway dedicated network. If these UEs accidentally access the public network, the base station uses the policies from the intelligent packet core network to instruct the UEs to switch back to the frequency band of the high-speed railway dedicated network. Separating public and private network users not only improves the call quality and data transmission rate but also optimizes the utilization of network resources.

As illustrated in Figure 12, after the high-speed railway user awareness algorithm is enabled, the network side can identify intrusive users except railway users at an accuracy of 90% and migrate them out. Thanks to the intelligent capabilities of the NDWAF, the intelligent packet core network utilizes two new technologies to enable high-speed rail passengers to have a smooth network transmission of pictures, texts, and videos even when they are moving rapidly, enhancing the high-speed rail travel experience.

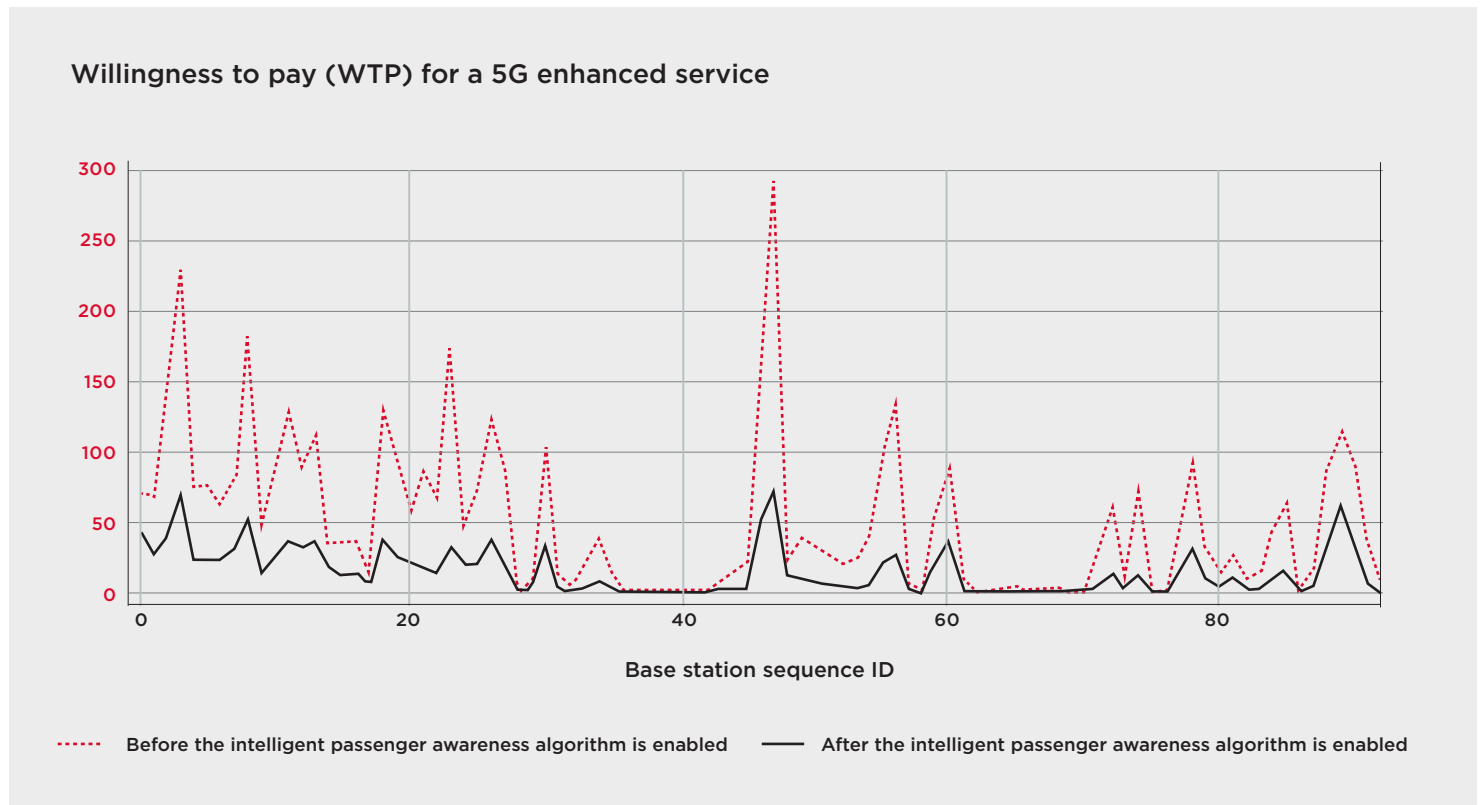


Figure 12, High-speed railway user experience improvement trial result of China Mobile Group's Guangdong Company Limited

7.3 e& UAE

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

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

Currently, vTapping is used for some functions, such as non-real-time service experience awareness. With the introduction of 5G-A intelligence that follows 3GPP standards, with the overall solution needing an update to NWDAF based solution.

In July 2024 the first release of 5G-Advanced the 3rd Generation Partnership Project (3GPP) standards (3GPP) Release 18 (R18) was implemented. This marks the beginning of the 5G-A era for e& UAE with first regional proof of concept of 5G-A NWDAF, followed by commercial deployment targeted for the first half of 2025. The NWDAF integrates AI training and inference capabilities and it can detect changes in user services and experience in real time and deliver customised policies to customers to ensure the SLA of users. Currently, preliminary verification has been performed in the lab. This solution ensures network bandwidth and latency for users in different environments and can provide personalized and dedicated logos for users to highlight VIP user identities and improve their user experience. During the assurance, user experience is stable and no frame freezing occurs. After the assurance is complete, the experience report is sent to the customer through a SMS. The report contains the optimization time and the specific rate increase value. The whole plan is illustrated in Figure 13.

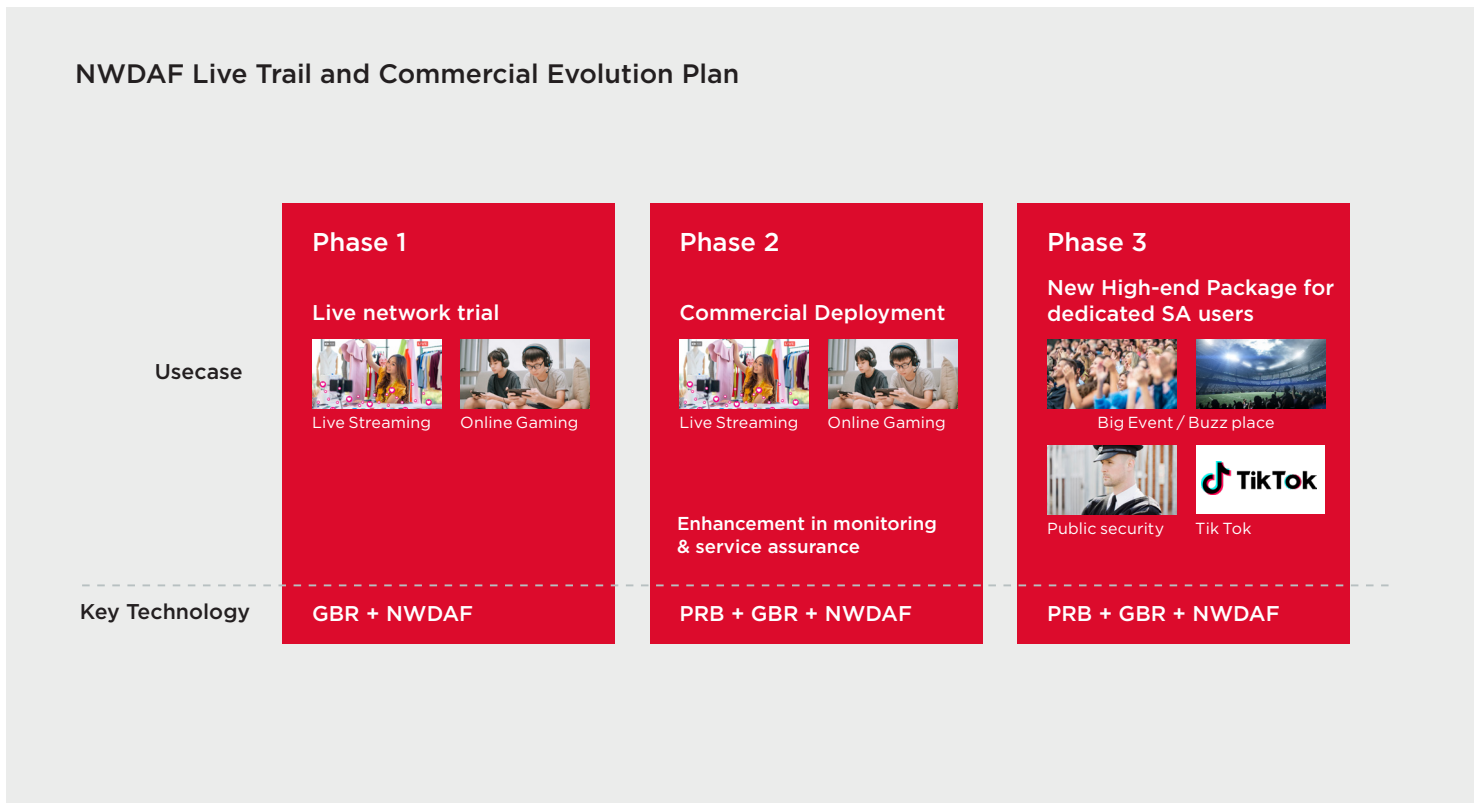


Figure 13, e& whole experience monetization plan

7.4 Globe

Globe Telecom is one of the largest telecommunications companies 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 lightning fast internet. Its uses range from high quality streaming and gaming to intelligent homes, virtual reality and a range of digital solutions for businesses.

Globe is currently working with partners to further explore 5G use cases and achieve market firsts.

Globe has embarked on trials of 5G SA technology through the Intelligent Personalized Experience (IPE) solution. This technology uses multi-modal data to intelligently sense and predict network applications and user experiences. Based on real-time user status, services, spatiotemporal factors, and network conditions, the IPE solution optimizes the technology, ensuring personalized customer experience while enhancing network performance and efficiency. It helps carriers transition customers to a more refined operational experience.

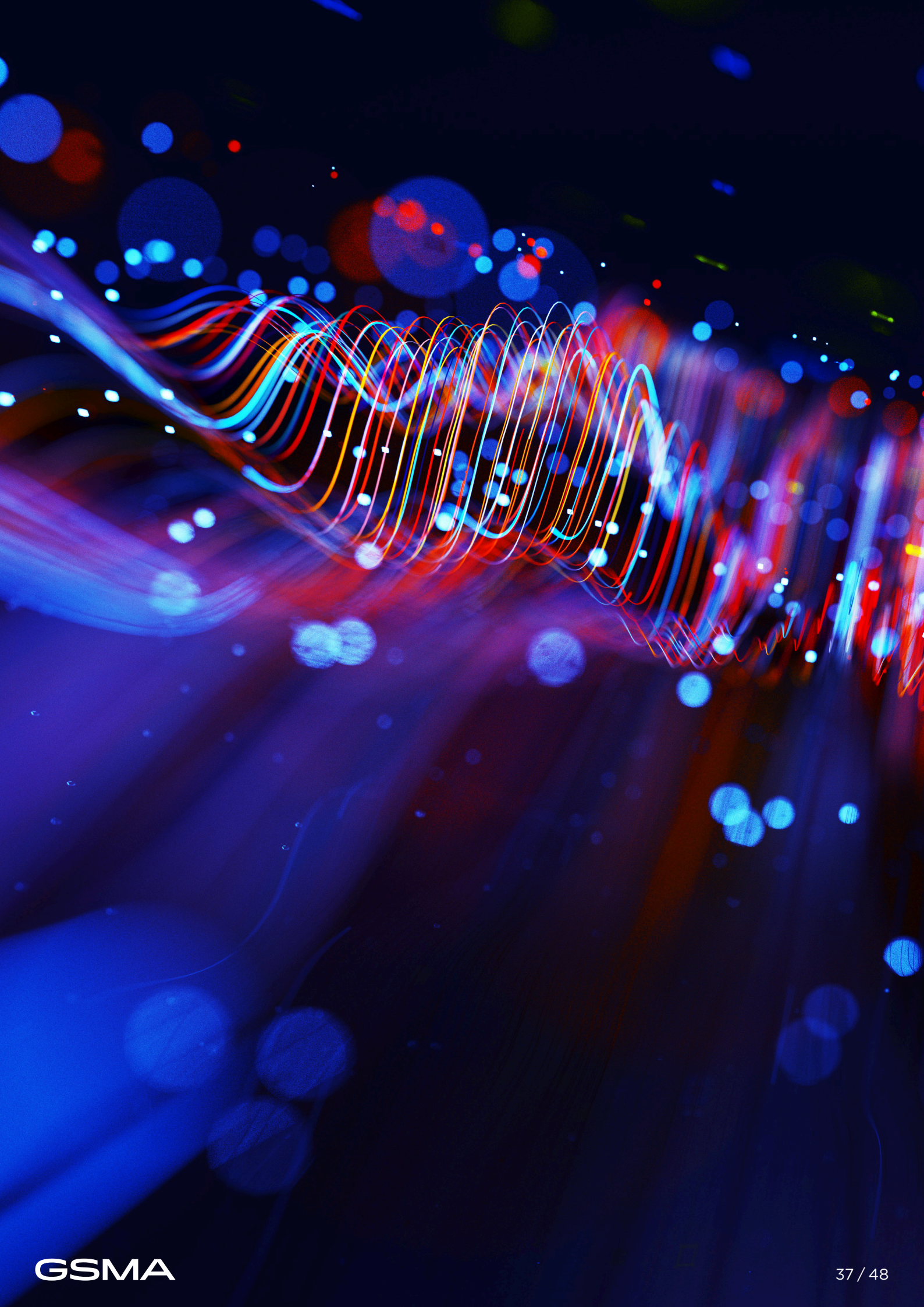
In the Philippines, mobile live streaming has become an increasingly popular way for young people to earn money. Mobile live streamers generate high traffic, thus generating a high upstream bandwidth demand. To service this high-bandwidth activity, Globe is working to innovate and build three key capabilities

based on the IPE solution: real-time experience perception, dynamic optimization assurance, and closed-loop reporting for mobile live streaming experience monetization. This technology detects poor live streaming experience in real time and triggers the offer of an acceleration promo package to the user. Once the user purchases the package, the user's resource usage priority is increased, significantly improving the streaming experience. When the user finishes the live stream, the intelligent core network sends an improvement and optimization assurance report to the user.

As of 2024, there were about 30 million mobile game users in the Philippines according to official estimates, and the number is growing rapidly. This translates to higher demand for better connectivity, particularly a low-latency experience. For gamers to have a good experience, mobile gaming latency is typically required to be under 100ms. However, the mobile network often faces unstable latency issues. This prompts them to pay extra for better service. To address this problem, Globe will focus on improving its intelligent packet core network and reducing latency among non-roaming mobile users in the Philippines for popular games such as Mobile Legends and PUBG. Through the intelligent user plane, Globe will be able to monitor mobile game users' latency in real-time and offer the promo package once high gaming latency is detected.

Through these solutions, Globe hopes to improve customer experience while also boosting monetization of 5G technology. When the user finishes the live stream, the intelligent core network sends an improvement and optimization assurance report to the user.





7.5 Vodafone

The integration of 5G intelligent core network into mobile networks offers transformative benefits, such as reducing energy costs, improving operational efficiency and enhancing customer experiences. Some key areas where Vodafone is working on to apply network intelligence are as follows:

- **Energy Efficiency (reducing the carbon footprint of mobile networks)**
 - Dynamic Network Resource Management: Network intelligence system and AI algorithms optimize the allocation of network resources like power and spectrum based on real-time traffic demands, reducing unnecessary energy consumption.
 - Sleep Mode Optimization: Network intelligence system predicts periods of low network traffic and selectively deactivate base stations or components to save energy without compromising service quality.
 - Predictive Maintenance: Network intelligence system with data analytics identify potential failures in network equipment, allowing proactive maintenance that prevents energy wastage due to inefficiencies.
 - Operational Efficiency: Network intelligence system reduces the need for manual intervention by automating complex tasks such as configuration, monitoring, and troubleshooting.
- **Quality of Service (QoS) Prediction and Enhancement**
 - Customer Experience Monitoring: Network intelligence system analyzes user data and network performance metrics to predict QoS for individual users and adjust network configurations dynamically.
 - Proactive QoS Management: By identifying potential bottlenecks and network issues in advance, network intelligence system ensures smoother service delivery, for instance, for latency-sensitive applications.
 - Application Based Traffic Prediction: Network intelligence system forecasts data traffic patterns, enabling proper scaling of network resources to maintain QoS during peak periods.

7.6 Zain

Zain KSA is a pioneer in Saudi Arabia's telecommunications sector, renowned for its innovation and dedication to shaping the future of digital connectivity. By harnessing advanced technologies like 5G, AI, and IoT, Zain KSA consistently elevates customer experiences, setting new standards for excellence and adapting to the evolving demands of a digital world.

According to statistics, Saudi Gamers account for 60% of the total population, and around 55% of them are willing to pay for games. At the same time, with the fast development of e-commerce and football in Saudi Arabia, the number of live broadcast users is also growing rapidly. Ensuring a high-quality experience for these users has become a key focus, unlocking significant potential for experience monetization.

With the fast development of global AI, the convergence of 5G networks and AI is also accelerating, particularly in Packet Core Networks, enabling operators to monetize user experiences in order to support more privatized and diversified innovative services, Zain KSA initiated an experience

assurance POC. In Dec 2024, Zain KSA and Huawei successfully completed experience assurance test for the PUBG video game, leveraging NWDAF-enabled dynamic experience assurance to reduce game latency.

The detailed results of this PoC test are as follows:

- For PUBG users with IPE intelligent experience assurance enabled, latency remains relatively stable during gameplay.
- During network congestion, their latency is significantly lower compared to users without IPE enabled intelligent experience assurance.
- PUBG users without IPE experience assurance face a sharp increase in latency, often resulting in noticeable game freezes during congestion.

Zain plans to commercial intelligent experience assurance for games soon. However, achieving full implementation will require a phased approach. Initial steps include enabling basic NWDAF functions, such as experience awareness, dynamic assurance, and experience reporting. Future plans will focus on advanced features like intelligent customer recommendations.

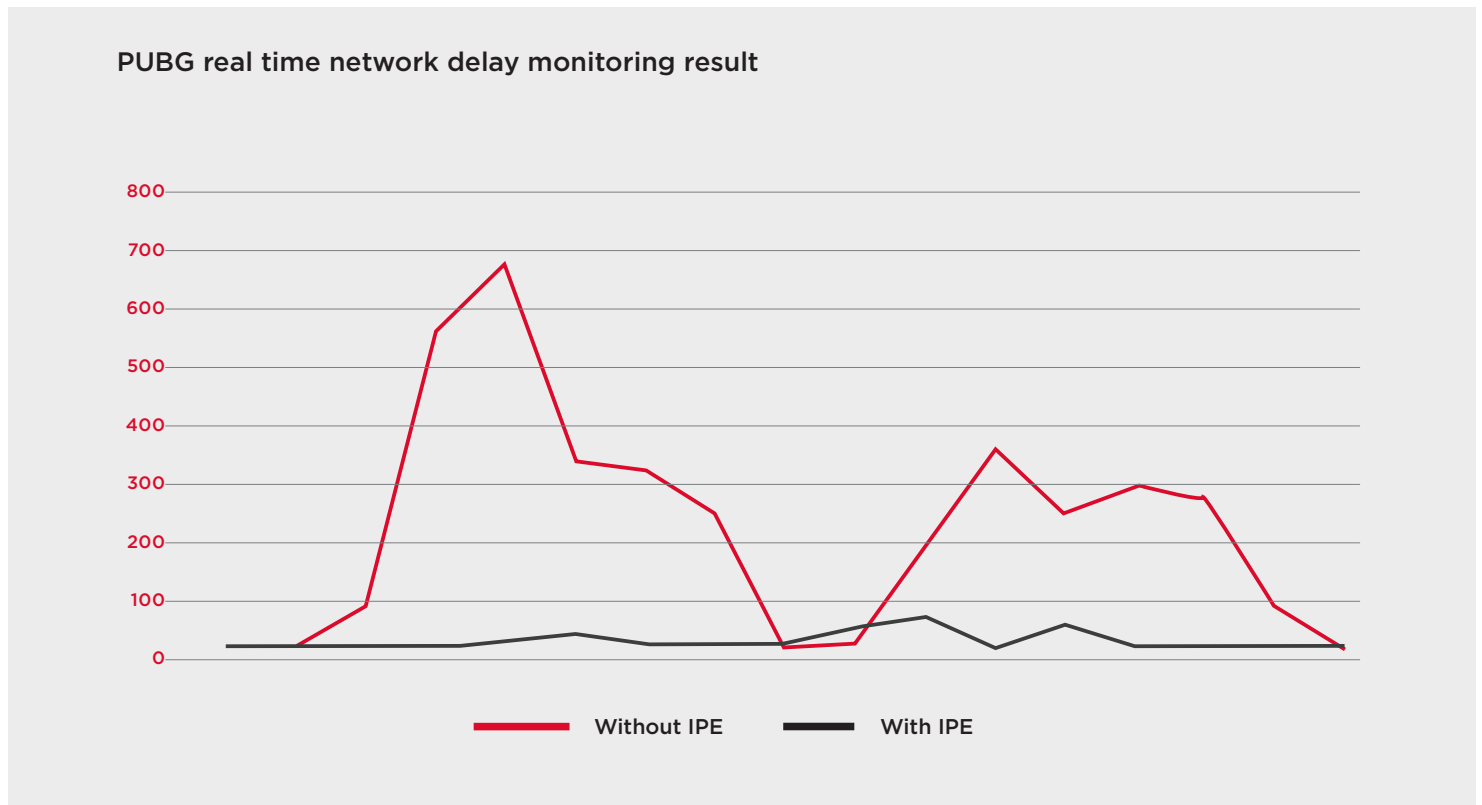


Figure 16, PUBG delay statistic result

7.7 KT

KT, the largest telecommunications company in South Korea, initiated the world's first 5G NSA commercialization in 2019 and successfully launched the country's first 5G SA commercialization in 2021, thereby providing 5G services. However, when considering the comprehensive aspects of differentiated customer service provision, network optimization and operation, network modernization, monetization and security, there are inherent limitations to the basic Core Network Function, which is operated based on standardized subscriber policies. Through the NWDAF, AI can be applied to the network to achieve a higher level of intelligence. Consequently, the introduction of IPC in B5G/6G is essential.

Based on its 5G commercialization experience, KT is comprehensively analyzing and reviewing the direction of future B5G/6G networks along with the current 5G network, with the goal of achieving "Customer Centric Operation (with AI)." To this end, KT is pursuing research and PoC on the application of AI to end-to-end future networks by obtaining intelligence levels through the Analytics Function of Radio Access Network (RAN Intelligent Controller [RIC]), and Core Network (NWDAF) based on the openness of Network Function. Additionally, KT is actively promoting collaboration between global telecommunications companies through Application Programming Interface (API) technology research and standardization work in GSMA's Open Gateway and CAMARA. Efforts are being made to secure vendor compatibility and reflect it in the actual network by discovering the openness of the Network Exposure Function (NEF) and Open Gateway API. Open Gateway API offers different service experiences with intelligent core network functions.

The PoC and activities currently being conducted by KT include the following use cases:

- **Packet Processing AI Optimization:** Analyzing network information such as User Equipment (UE), base stations, and core through AI to provide efficient packet processing of traffic within densely populated cells, thereby improving the Quality of Experience (QoE) for customers receiving lower throughput services.
- **Paging AI Optimization:** Analyzing users' movement paths through AI to optimize paging, thereby enhancing network management efficiency and improving customers' communication quality (reducing call and data transmission/reception time).
- **Anti-Fraud API Provision:** Providing APIs such as SIM SWAP API, One Time Password API, Device Status API, and Number Verification API to determine abnormal phone usage through SIM card change history or roaming status. This is utilized to prevent financial crimes such as SIM swapping.
- **QoD (Quality on Demand) API Provision:** Providing functions to immediately improve communication quality as desired by customers, which can be applied to remote driving of Unmanned Aerial Vehicles (UAVs) or shared taxis in the future.



Conclusions

With the rapid AI deployment in the world, mobile networks are also accelerating integrated AI capabilities. In addition, mobile operators need to resolve the problem of increasing traffic operations without increasing revenue. Some leading operators have been exploring experience monetization since 2024. Their goal is to continuously increase revenue by improving service experience. In this context, the mobile core network with intelligent capabilities has become a key enabler for operators' business transformation. World-leading operators, such as AIS, CMCC, e& UAE, Globe, STC, Zain, have completed tests or commercial launched experience acceleration service, providing best practices and business success references for other operators.

At the same time, there are still many tasks in the process of exploring network intelligence to support operators' monetization. This needs the whole industry to collective to push forward and solve. Such tasks include:

- Enhance device and network collaboration to improve service experience: Promote intelligent collaboration between networks and terminals. For example, improve 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, for example, network selection, application/service data transmission time and path selection, and energy saving.

- Build a global unified experience evaluation system and have a unified measurement standard for experience: First step is to establish a globally experience evaluation system. For example, establish a global service experience indicator (KQI and MOS) evaluation system to work with ITU, 3GPP, ETSI, and GSMA standard or alliances organization to quantitatively measure service experience. Next step is to build a deterministic experience assurance network solution to support sell service experience as traffic volume.
- Continue to explore new scenarios and business opportunities for network intelligence: Continue to incubate and explore new network intelligence monetization scenarios. For example, open network intelligence as a service with Open APIs for monetization. For example, combine network intelligence with network slicing to offer experience monetization of segmented services.



Glossary

Term	Description
2G	2nd Generation (of Mobile Technology)
3CC	3 Component Carrier (CA)
3G	3rd Generation (of Mobile Technology)
3GPP	Third Generation Partnership Project
4G	4th Generation (of Mobile Technology)
5G	5th Generation (of Mobile Technology)
6G	6th Generation (of Mobile Technology)
5GC	5G Core (Network)
AF	Application Function
AI	Artificial Intelligence
AIS	Advanced Info Service (Thai Operator)
AMF	Access & Mobility Management Function (part of 5GC)
AnLF	Analytics Logical Function
API	Application Programming Interface
APP	Application
ARPU	Average Revenue Per User
B2B	Business to Business
B5G	Beyond 5G
BOSS	Business & Operations Support Systems
BSS	Business Support Systems
CA	Carrier Aggregation
CAGR	Compound Annual Growth Rate
CMCC	China Mobile Communications Corporation

Term	Description
CNNIC	China Internet Network Information Centre
DCCF	Data Collection Coordination Function
DL	Downlink
DN	Data Network
DOU	Average handset data traffic per month (MB/user/month)
E2E	End-to-End
eMBB	Enhanced Mobile Broadband
eNodeB	Evolved Node B (4G RAN)
ETSI	European Telecoms Standards Institute
FWA	Fixed Wireless Access
Gbps	Giga bits per second
GB	Giga Bytes
GBR	Guaranteed Bit Rate
GLOMO	GLOBAL MOBILE
GMV	Gross Merchandise Volume
GSA	Global (mobile) Suppliers Association
GSMA	GSM Association
GSMAi	GSMA Intelligence
GSM	Global System for Mobile (Communication)
HD	High Density
IEEE	Institute of Electrical and Electronic Engineers
IoT	Internet of Things
IPC	Intelligent Packet Core
IPE	Intelligent Personalized Experience

Term	Description
ITU-T	International Telecommunications Union (Telecommunications)
KQI	Key Quality Indicator
KT	Korea Telecom
LMF	Location Management Function (part of 5GC)
MB	Megabytes
Mbps	Mega bits per second
ML	Machine Learning
mm	Millemetre
ms	Milleseconds
MOS	Mean Opinion Score
MOU	Minutes Of Usage
ms	milleseconds
MTLF	Model Training Logical Function
NE	Network Element
NEF	Network Exposure Function (part of 5GC)
NI	Network Identifier
NITZ	Network Broadcast
NSA	Non-Standalone
NWDAF	Network Data Analytics Function
OND	Operator Name Display
OTT	Over The Top
PCF	Policy Control Function (part of 5GC)
PFD	Packet Flow Descriptor
POC	Proof of Concept

Term	Description
PRB	Physical Resource Block
PUBG	Player Unknown's Battle Grounds (a video game)
QoD	Quality on Demand
QoE	Quality of Experience
QoS	Quality of Service
RAN	Radio Access Network
RIC	RAN Intelligent Controller
SA	Standalone
SIM	Subscriber Identity Module
SLA	Service Level Agreement
SMS	Short Messaging Service
SMSF	SMS Function (5GC)
TSG	Terminal Steering Group (a GSMA WG)
ToB	To Business
UAE	United Arab Emirates
UAV	Unmanned Aerial Vehicle
UE	User Equipment
UN	United Nations
UPF	User Plane Function (part of 5GC)
US	United States
USD	US Dollars
USA	United States of America
V2X	Vehicle-to-everything
VIP	Very Important Person

Term	Description
VVIP	Very VIP
VVIP	Very VVIP
VR	Virtual Reality
WG	Working Group
WTP	Willingness To Pay
ZB	Zettabyte (2 raised to the 70th power)

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GSMA Head Office

1 Angel Lane
London
EC4R 3AB
UK

Email: info@gsma.com

