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Future of 5G Wireless System

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ABSTRACT
Globally, the commercialization of 5G networks is rapidly increasing. It is considered essential for long-term industrial development in globally relevant economies and will impact numerous industries. To improve consumer experiences and bring about the digital industrial revolution, 5G communications are crucial. Furthermore, 5G requires even more fusion of DOICT and other technologies. According to a white paper, research on the 5G-to account for architecture evolution and function enhancement, advanced follow-up evolution is required. The white paper investigates the network evolution architecture of 5G-Advanced and 5G-LTE networks. Uses artificial intelligence, convergence, and enablement as three aspects to explore the technical development trajectory of 5G-Advanced. Artificial intelligence refers to network AI that can improve a network's intelligent operation and maintenance. This covers the full application of artificial intelligence, digital twins, recognition systems, and intention networks. 5G, industry network convergence, home network convergence, and space-air-ground network convergence are all examples of convergence. integrated development Enabling makes it possible to develop deterministic and interactive 5G communication capabilities, which are crucial for supporting the industry's digital transformation. Enabling In addition, current technologies such as network slicing and placement are improved to better suit this goal.
Keywords — Software Defined Network, Cloud Computing, Network Technology Evolution.

I. INTRODUCTION

Wireless networks and mobile communication have undergone significant advancements in the past decade. The increase in resource demand, and the growth of 3G and 4G wireless networks, particularly for multimedia data with strict quality of service (QoS) standards, has propelled the development of 3G and 4G wireless networks. However, technological advancements alone cannot guarantee satisfactory service levels. Thus, the development of 5G networks, which go beyond 4G, has become Many difficulties that must be addressed, including the need for larger data rates and capacities, reduced pricing, lower end-to-end latency, and improved inter-device communication. Analyzing future or next-generation information system networks is highly challenging, and this article provides a thorough analysis of the state of the art by surveying supporting technologies for networking and next-generation mobile systems. The end-to-end evolution of the 5G Advanced network relies on the evolution of the core network, which serves as the hub of the network industry and engine for future business growth. The core network is interconnected with various services and applications, while a range of conventional terminals and access networks connect the complete network topology to the core network. Promoting the development Based on genuine business needs, 5G core network technology and architecture would assist operators in increasing their return on investment and assisting business users in efficiently utilizing 5G networks for their digital transformation (Letaief, et al., 2019).
The current 4G LTE technology will be replaced by a new standard known as 5G, which is the fifth generation of wireless technology. This new standard is expected to enable a wide range of new applications and services by providing faster bandwidth, lower latency, and higher dependability. The 5G system is built on an innovative architecture that utilizes software-defined networking, cloud computing, and state-of-the-art antenna technologies (You, et al., 2021).

II. SPECIFICATIONS OF 5G TECHNOLOGY

According to (Khan, et al., 2020), the primary characteristics of 5G technology include:
High Speeds: According to predictions, 5G technology would provide data speeds of up to 10 Gbps, which is almost 100 times faster than 4G LTE.
Low Latency: 5G technology will have a latency of less than one millisecond, enabling it to enable applications that call for real-time interactions, like remote surgery and autonomous vehicles.
Increased Capacity: 5G technology is anticipated to provide a higher network capacity, allowing for the simultaneous connection of more devices.
Better Coverage: 5G technology is anticipated to provide better coverage, even in locations where it is presently challenging to receive a strong signal.
Energy Efficient: 5G technology is anticipated to use less energy than 4G LTE, extending the life of device batteries.

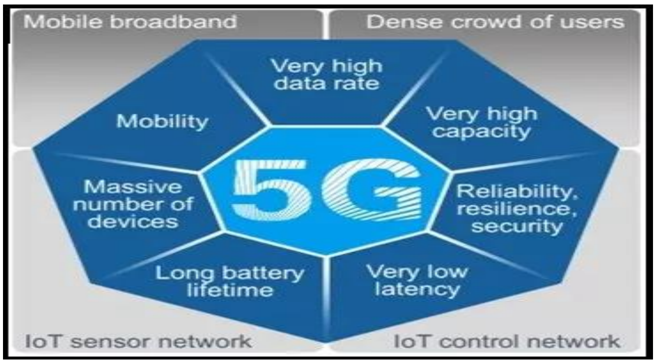

Fig. 1 5g Wireless System

III. SOFTWARE-DEFINED NETWORKING (SDN) FOR 5G

A. SDN AND NFV

SDN (Software-Defined Networking)

Software-defined networking (SDN) has been introduced and explained in numerous ways for data networks and the next-generation internet.The most thorough and widely accepted definition is provided by the Open Networking Foundation (ONF), a non-profit organization dedicated to the standardization, development,and commercialization of SDN (Xiao, et al., 2017).

The qualities of SDN, as defined by the Open Networking Foundation, include the direct programmability of network services and applications, dynamic and manageable architecture, flexibility, and affordability. This is achieved through the separation of network control from the underlying data plane, direct control plane programming via an open interface, and the use of a network controller to define the operation of the infrastructure. SDN is a good choice for managing high-bandwidth, dynamic networks because it allows for changes to be made at the software level without requiring hardware changes. This is more appealing than traditional hardware-based network architectures for reconfiguring and rerouting complex networks in real time. SDN also ensures QoS at every level of user requirement, making it an attractive architecture for large networks (Jangir, et al., 2020).

New applications and services are made available through networking designs that are different from traditional hardware-based ones.

NETWORK FUNCTION VIRTUALIZATION (NFV)

An important aspect of SDN is Network Functions Virtualization (NFV). While SDN and NFV are complementary, they are not completely dependent on each other. Network functions can be virtualized and utilized without SDN, and vice versa. NFV can effectively isolate network functions and implement them in software, which can be centralized at remote network servers or in the cloud using an open interface like OpenFlow, separating these functions, including routing decisions, from underlying hardware components like routers and switches. This can provide a highly flexible network design for quick reconfiguration. Compared to conventional hardware-based network architectures, this approach enables new applications and services and guarantees QoS at any level (). Therefore, from the perspective of reconfiguring and managing complex networks in real-time, it is a desirable architecture. SDN and NFV have complementary properties, making SDNs more advantageous than traditional hardware-based networks. The main benefits include lower costs, reduced power consumption due to equipment consolidation, shorter processing times thanks to a shorter network operator innovation cycle, centralized network provisioning resulting from the separation of the data plane from the network control plane, higher functionality, lower hardware costs, cloud abstraction, guaranteed content delivery, physical rather than virtual networking management, and others. Figure 1 compares the advantages of

SDN with those of conventional hardware-based networks (Singh, et al., 2020).

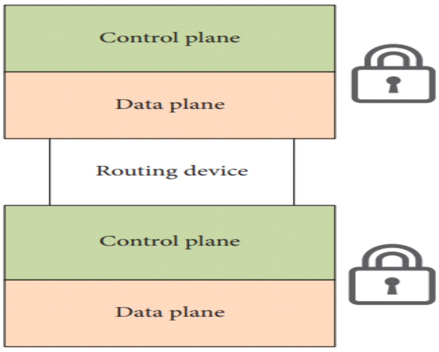

Fig. 2 Traditional Hardware Between Network

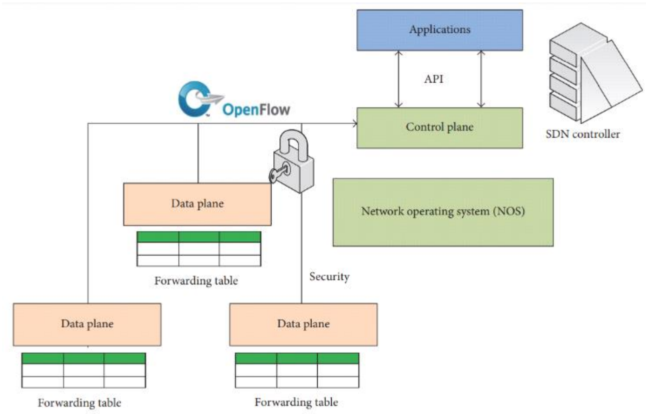

Fig. 3 Software-Defined Network

IV. NETWORK TECHNOLOGY EVOLUTION

The 5G-Advanced evolution is a comprehensive fusion of data technology, industrial field network technology, and ICT technology. The telecom cloud infrastructure is often used after the full adoption of 4G, and IT technology is fully integrated into the communication network. NFV, containers, SDN, and API-based system capability exposure have all been commercially validated in the actual telecom cloud landing process (Ahammadi, et al., 2022). However, the network edge differs significantly from the centralized deployment of cloud computing in terms of its business model, deployment model, operation and maintenance model, resource availability, and resource efficiency. The Linux Foundation has proposed the construction of an edge-native application form by merging various edge capabilities, and this approach must be balanced with the cloud-native characteristics for 5G-Advanced to proceed towards cloud-network integration using the same network architecture. 5G-Advanced also requires leveraging network convergence capabilities further by incorporating various NSA generations and models. SA refers to social automation and is related to the integration of a person's social, familial, and professional networks. The 5G-Advanced core network is being prepared for a fully converged network design that includes land, sea, air, and space, due to the development of satellite communications. The increasing demand for ICT technologies for operational and manufacturing needs will result in the inclusion of OT, which will provide mobile networks with additional genetic components. For example, the Industrial Internet has more stringent network quality standards than the traditional consumer Internet, and the network must be able to provide high bandwidth and low latency for machine vision-based quality inspection scenarios. The network needs to support deterministic transmission, guarantee connection quantity and bandwidth, and offer an intelligent production line for flexible manufacturing, as well as accurate network positioning and data-gathering services. As a result, wireless access networks must perform as well in real-time as wired access networks in terms of dependability, availability, determinism, and reliability while considering the rollout of 5G (Rawat, et al., 2021).

Full DOICT integration will help facilitate network adjustments and capacity expansions, leading to overall digital development and integration of OT and CT. 5G-advanced networks will be an important infrastructure component in integrating people, machines, materials, procedures, and the environment for industrial design, R&D, production, and management. The digital shift of industries is driven by extensive interconnection, including services, and will be accelerated by data technologies. A strong foundation of connectivity, digital extraction, data modelling, analysis, and judgment will serve as the cornerstone of the digital economy. Big data, artificial intelligence, and other technologies can create data models based on intricate business processes and algorithms, allowing for more precise digital extraction, accurate analyses, and evaluations using digital twin technologies, and optimizing digital impact in all spheres of society (Rawat, et al., 2023).

V. CLOUD COMPUTING

A. *Cloud Computing for 5G Network*

Some of the key advantages of 5G include high speed, low latency, and a large capacity to support a wide range of real-time multimedia applications. 5G is being developed as a smart wireless network architecture for multidimensional massive data processing that utilizes new models such as SDN or NFV. Network virtualization is a novel concept that can present significant challenges, but it offers next-generation networking by utilizing IP networks, the Internet, and wireless technology. Service-oriented architecture (SOA) will be a critical component of network-as-a-service (NaaS), which is enabled by the convergence of networking with cloud computing. Network virtualization design with SOA is gaining attention from both academic and business communities. However, there are still issues with QoS and QoE user requirements. Cloud computing is a crucial technology for the future as it can reduce costs for both service providers and users by efficiently distributing resources. Cloud computing has become a primary reference design for 5G networks due to its high data throughput, high mobility, and centralized administration services, and can be used even if the consumer's systems are not directly installed. The corporate and academic communities have taken a greater interest in cloud computing as the number of mobile devices increases with technological innovation and the expanding popularity of mobile services (Gour, et al., 2022).

B. *Challenging Issues and Future Directions In 5G*

The paradigm of computing is evolving, and cloud computing has emerged as a new networking technology with the concept of resource distribution and sharing. It offers universal on-demand access, centralized control, great flexibility, and cost efficiency. This has garnered significant interest from academics and organizations, and it has had a huge impact on the ICT community by advancing architecture. Applications and services supporting cloud computing architecture are becoming increasingly important, and future networking will benefit from this architecture. Cloud computing has an advantage over traditional network and service architecture in terms of resource management because of its distributed, dynamic, and diversified resources. However, the old network architecture is limited in terms of mobility functions and cannot keep up with new characteristics, especially the static QoS index approach, due to the development of semiconductor and human on-demand technology (). Due to its higher capacity and improved accessibility, 5G is expected to provide on-demand mobile applications and services. The development of other technologies, such as social networks, wearable technology, the Internet of Things, and cloud computing, will also contribute to the growth of 5G. Traditional network applications will shift towards a more human-centric focus, and a flexible QoS model can be established using resource descriptions. To implement QoS in 5G, series, parallel, and hybrid techniques can be used. The cloud computing service architecture can be divided into three categories: SaaS, IaaS, and PaaS. Figure 6 shows the tier-based architecture of cloud computing services. Examples of SaaS include Google Apps, Salesforce, and Microsoft Office 365, while IaaS applications include Amazon Cloud Formation, Google Compute Engine and Rack Space Cloud (You, et al., 2021).

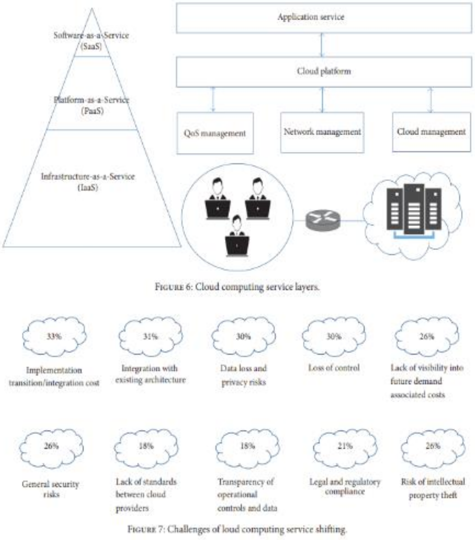

Fig. 5 Future direction in 5G

VI. CONCLUSION

Next-generation wireless networks and mobile systems are expected to provide high-speed access that is not constrained by time or location. The NGN must handle large data flows, real-time data handling, and centralized views of the entire network with minimum delay, more security, fewer data losses, and lower error rates. This necessitates the incorporation of new technology or methodologies. Network architecture, service frameworks, and topologies will be critical for satisfying the future networking infrastructure requirements of the 5G network. Extensive IoT connectivity, virtual experiences and media, and real-time communication will be required for the 5G infrastructure. The future of the network will be determined by the integration of emerging technologies such as cloud computing, SDN, NFV, and E2E networking design. SDN-NFV integration would provide dynamic data control, centralized network provisioning, and the flexibility to respond swiftly to new services and innovations.

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