Cloud Native Architecture Of Network Quality Characteristic Analysis System In Wired and Wireless Convergence Network

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***Abstract*—Recently, according as most services have recently transitioned to supporting mobile service and existing services have been made it easier to access, there have been researches about using effectively wireless resources and increasing service processing speed. And research about network analysis technology becomes as a key area to configure and place complex and flexible network elements efficiently, and to include dynamically allocating and deallocating network resources to support quality of service for each service with service awareness.**

In this paper, in order to measure the performance data and quality data of each segment of the network in a wired and wireless convergence network, we describe architecture of the analysis system that manage divided into multiple segment according to characteristics and zone, and that integrate and analyze network various network quality characteristics, and that provides function to analyze network performance data using AI and function to optimize network resource management using the analysis results.

Keywords—cloud native network data analysis system; scalable architecture, integrated analysis about various network quality characteristics

I. INTRODUCTION

As most services have recently transitioned to supporting mobile service and existing services have been made it easier to access, there have been researches about using effectively wireless resources and increasing service processing speed. In addition, as AI (Artificial intelligence)-based services have developed rapidly and are applied to all vertical costumer and domains, as shown in Fig. 1, the static and hierarchical network structure is becoming complex and flexible to support AI-based services.

Research on network quality analysis technology has been reconsidered again to perform efficient network resource management, such as allocating and deallocating network resources according to network conditions, as part of effectively using expensive mobile network resources and efficiently managing network resources in a complex and flexible manner. emerging as an important field. In particular, network analysis technology in 5G has become increasingly important as a technique for relocating and dynamically configuring core network functions. [1]

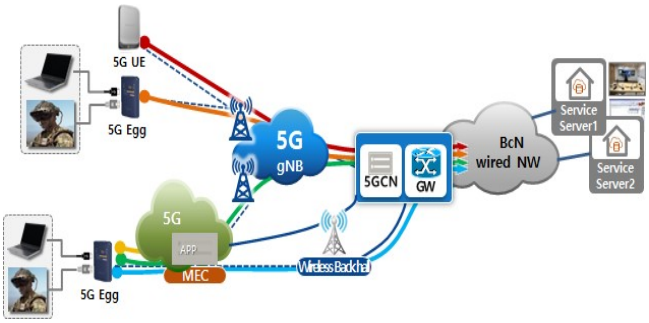

Fig. 1. Example of complex network node deployment

In this paper, we introduce the architecture of the network analysis system to efficiently use network resources and guarantee the quality of various services by collecting and analyzing network performance information suitable for network characteristics in wired and wireless convergence network with high complexity.

II. RELATED WORK

A. Traditional Traffic Analysis technology

Techniques for monitoring, measuring, and analyzing network quality have been researched for a long time since the spread of the Internet. For traditional wired network performance management, a method of analyzing performance indicators by passively/actively collecting and measuring quality data of end-to-end or quality data of point-to-point transmission of a specific segment. And key performance indicators of traditional wired network analysis technology were such as network traffic throughputs, packet loss, delay, and jitter. Based on these measurement indicators, the network planer and network operator managed network resources by

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traffic load balancing or network planning functions were performed.

B. 3GPP

The quality characteristics of wireless networks are very different from wired networks. The quality characteristics of wireless networks can be defined by analyzing the signal strength, noise level, frequency, bandwidth, and the location of wireless devices. [6]

With the introduction of 5G network configuration technologies such as MEC and Private5G, large-scale data analysis technologies are required. Through data analysis of 5G network, various analyses such as mobility analysis, machine-to-machine communication, geographic location tracking, and service usage by time can be performed, and network resources (5G core network functions, mobile base stations, etc.) can be deployed or functions such as automatic allocation and recovery of wireless resources according to network status and traffic load balancing (control route) can be performed. In other words, data analytics can be seen as a powerful tool for enabling the transformation of envisioned challenging 5G features into a reality.

Performance indicators suitable for characteristics of wireless networks are defined in standards for each generation (ex: 4G LTE, 5G), and Accessibility, Integrity, Utilization, Mobility, Retainability, and Maintainability are the key performance indicator of 5G in 3GPP [2].

In contrast to wired networks, there is a difference in the minimum peak rate requirements for uplink and downlink in 5G. The minimum requirements are 10 Gbps for uplink and 20 Gbps for downlink. [4] Because 5G supports a variety of service types, each service type requires different performance metrics. For example, the eMBB (enhanced mobile broadband) service requires high bandwidth and low latency to process large amounts of media data, so performance indicators such as bandwidth and latency are important. On the other hand, URLLC (ultra-reliable and low-latency communications) [3] service requires high reliability and low latency, so performance indicators such as reliability and latency are important. Therefore, it is necessary to apply different performance indicators according to each service type, and to design and optimize the network to meet them. [5]

C. Trend of Traffic Analysis technology

On the other hand, network analysis technology is applied to edge computing, which can reduce network traffic and support low-latency services for massive data processing such as IoT or real-time data. and measures network status to reduce network traffic while performing its functions. In addition, it provides security functions such as anomaly detection and malware detection based on AI, supports service continuity by predicting network situations, and enables specific network management that is aware of both the network and the service through cloud-native-based analysis of large-scale data. Through such technology, efficient network operation and stable service provision become possible.

III. CLOUD NATIVE ARCHITECTURE

Collecting and analyzing quality data with different characteristics, such as those related works mentioned above, requires different approaches depending on the wired or wireless connection and the type of service.

Recently, as service access is often done wirelessly while the servers that provide the service may be on a wired network, the complexity of supporting the service has increased. In such an environment, managing network quality has become more complex, requiring the identification and elimination of factors that cause a decrease in service quality. Research on network quality management has become more complicated as it covers various service/network fields and operating methods such as virtualization, edge computing, and even artificial intelligence technologies, and the techniques for effective network resource management have developed dramatically. However, there is still insufficient research on analyzing network quality characteristics comprehensively, taking into account the differences in quality indicators between wireless and wired networks.

This paper describes the architecture of a quality analysis system that measures the quality of each segment of a wired and wireless hybrid network by dividing it into multiple segments and integrating different network quality characteristics. The integrated information is then analyzed using AI, and the analysis results are utilized to optimize performance.

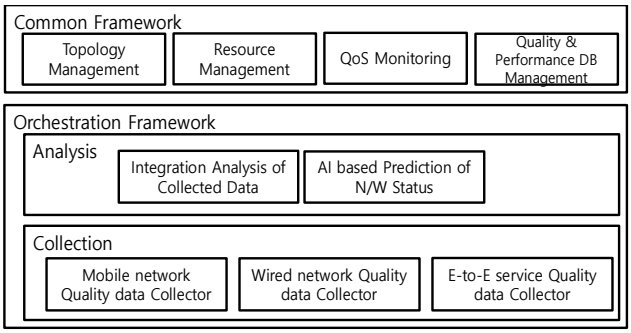

Fig. 2. Architecture Of Network Quality Characteristic Analysis System

As shown in Fig. 2, this structure is largely divided into Common Framework and Orchestration Framework, and Orchestration Framework is further divided into Analysis and Collection functions.

The multi-segment integrated network collection and analysis modules are orchestrated for scalability, making it easy to support functions such as various performance information collection methods, dynamic wireless measurement data volume addition and subtraction, and big data analysis.

A. Common Framework

- The Topology Management function is crucial for identifying the path of service delivery and measuring performance segment by segment and end-to-end.
- The Resource Management function is used to determine the capacity of wired and wireless network resources, and is essential for optimization and QoS management.
- The Quality & Performance DB Management function manages performance databases and is capable of orchestration.

B. Collection module in Orchestration Framework

The methods and performance indicators for collecting wired/wireless network and end-to-end performance data are different, so the functions are divided into the following, and all information collected in this module is managed in the Quality & Performance DB Management function. It is also orchestrated for the expansion of the subject of collection.

- Mobile network Quality data Collector collects wireless characteristic performance indicators such as Accessibility, Integrity, Utilization, Mobility, and Retainability. Collect delay, jitter, loss, throughput, etc. The three functions included in the collection module are increased or decreased according to network complexity to support the performance management function.
- Wired network quality data collector function collects data measured in a specific segment of the wired network and manages the measurement information by matching with network topology information.
- The E-to-E service Quality Data Collector function measures performance information between service providers and end users according to service characteristics and provides information used when comprehensively analyzing wired/wireless performance information.

C. *Analysis module in Orchestration Framework*

- Integration Analysis of Collected Data The integrated analysis function, which analyzes performance by integrating performance data for each segments and different quality characteristics collected from the collection module, maps the network topology and collected data and replaces the quality according to the wired / wireless characteristic performance index with the overall performance data. Analyze. In addition, it checks the status and performance information of network components (routers, etc.) from the results of integrated analysis of network component performance information and performance indicators for each segments, identifies network quality deterioration points, and generates integrated wire/wireless performance analysis information. The wired/wireless performance integrated analysis information generated in this way is managed by the characteristic data DB manager.
- The AI-based network condition prediction function predicts the network condition by analyzing the data collected by all functions. For example, it can perform a function of predicting and coping with future performance by learning data usage increase patterns or data flow patterns according to specific services using reinforcement learning techniques. In addition, this function evaluates the performance of the network in each category based on the integrated analyzed quality data, detects and specifies the performance deterioration segments through segments performance information and access point performance information, and loads to optimize the segments or the entire segments. Reconstructed information is derived by performing information reconstruction (performance optimization) by balancing and rebalancing. At this time, the reconstructed information (optimization information) may include information according to network characteristics such as network slice configuration and scale-in/out. The two functions included in the analysis module are increased or decreased according to network integration calculation and the size of the collected data to support the performance management function.

IV. CONCLUSION

The paper describes the definition of performance metrics for network characteristics in each wireless and wired segment and explains the functional structure for collecting data based on network characteristics to integrate and analyze performance quality data for each segment with different quality variations due to performance indicators. Additionally, it explains the functional structure for optimizing the network by performing network prediction functions, such as allocating/deallocating network resources and traffic load balancing based on traffic patterns analysis of wireless and wired traffic data. Furthermore, each function is orchestrated to support expanding data collection targets and applying various analysis patterns.

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