An Integrated Monitoring System for 5G Crosshaul Network

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***Abstract-* This research provides a method for integrated centralized monitoring under the 5G Crosshaul architecture. Our method establishes a process to provide integrated monitoring technology and intelligent obstacle location for end-to-end circuits across multiple domains. The monitor page shows the operating status of the 5G Crosshaul service composed of Multi-Technology, which are a base station, Mobile Fronthaul (MFH), Mobile Backhaul (MBH) and core network. The process proposed by this method includes the following technologies, encapsulating and formalizing cross-domain services and service analysis mechanisms. For the service, it integrates the service status and abnormal events of network equipment and circuits through regularized data to integrate data from different domains. The service-impacted level based on the importance of resources and provide a reference to the basis of the handling of obstacles. In addition, provide a notification mechanism to proactively notify relevant personnel, and show root cause analysis result. Through the above methods, providing Root cause of obstacles and abnormal impact range of services, reduce the time for removing obstacles and improve service quality.**

Keywords—Crosshaul Network, Composite Digital Services

I. INTRODUCTION

The fifth generation mobile communication (5G) technology is an extension of 4G. The three major features are Enhanced Mobile Broadband (eMBB), Ultra reliable Low latency Communications (URLLC), and Massive Machine Type Communications (mMTC)[1]. To support these service requirements, telecom operators must build more equipment and optimize circuit transmission performance. 5G is more complicated in structure than the 3G and 4G, and can be roughly divided into Mobile Fronthaul (MFH) and Mobile Backhaul(MBH) [2], and covering the mobile core network [3]. Common planning frameworks on the MFH architecture include DRAN (distributed radio access network) and CRAN (cloud radio access network)[4][5] and MBH is managed through Software-Defined Networking (SDN) technology [6] [7]. Each of these different domains has different network management mechanisms, which results in the failure of effective connection between services and network resources. When obstacles occur, multiple parties are involved, it is not easy to detect, and it consumes manpower, which affects service quality and customer experience.

This research provides an integrated centralized monitoring method. For reference, TM forum proposes the concepts of Digital Services Reference Architecture (DSRA) architecture [8] and Sample Management Interface (SMI) [9]. Package services include service status, service exception events, etc., to improve the integration and reuse of services and solve the issue of cross-domain service integration. Through this mechanism, the centralized service monitoring and obstacle locating mechanism can be achieved to help maintenance personnel reduce the time for troubleshooting and improve service quality.

II. METHODOLOGY

A. Encapsulating and formalizing cross-domain services

The goal of this system is to establish a cross-domain service integration monitoring, as shown in Fig. 1, to collect the network management information of each domain. This study is based on DSRA, through digital service organization, each service encapsulates the service health status (Normal, Critical, Major, Minor, Suppress) and events that lead to service anomalies, providing front-end users with an interface to understand the current status and the causes of status anomalies. Service status judges and event generation are determined through their own internal indicators, such as through the setting of event thresholds, and no indicators are provided when packaging services, in order to reduce operational settings and the content of simplistic data exchange.

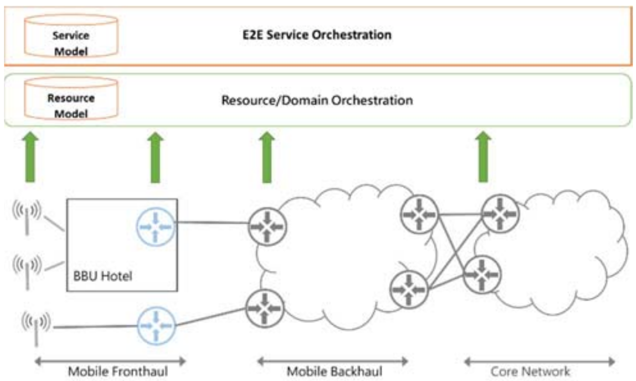

Fig. 1. Crosshaul Network

The composite service assembly analyzes the health status of the composite service by setting the Service Policy and setting, the influence weight of each sub-service, as shown in Fig. 2.

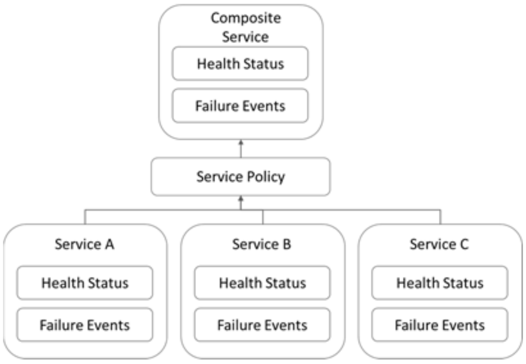

Fig. 2. Composite service architecture

To exchange data object formats, we use JSON as the standard for exchanging data, and the exchange interface is implemented as a Restful interface. After a unified exchange standard and interface, it reduces the labor and time required for the data interface.

We disassemble the Crosshaul Network service, which consists of three sub-services MFH , MBH , and mobile core network, as shown in Fig. 3.

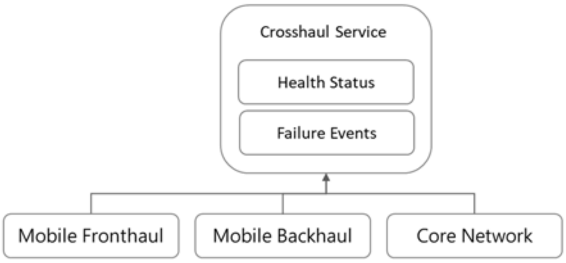

Fig. 3. Crosshaul Network Service

•Mobile Fronthaul

Including base station, Coarse wavelength division multiplexing, RRU (Remote Radio Unit), BBU (Baseband Unit), Access Router and other equipment and transmission service status. In this study, an ID serving a circuit dedicated line connected from a base station is packaged, including power failure and signal loss of each device. The performance data includes information such as optical power, latency, temperature, Background Block Error Ratio (BBE), Errored Second (ES), Severely Errored Second (SES), and Unavailable Seconds (UAS). MFH's current common planning architectures include DRAN and CRAN. Under the framework of this research, through regularized packets, all can be achieved.

•Mobile Backhaul

This architecture introduces Layer 3 Virtual Private Network, L3VPN-based, and takes the virtual circuit number as the basis for encapsulation, including the virtual circuit's traffic, number of packets, and the status of the routing device in the middle of the series to encapsulate. In addition, it also makes judgments on Precision Time Protocol (PTP) services to ensure the quality of data services. It retrieves clock source values, active and standby status switching, and Synchronous Ethernet status monitoring through the Simple Network Management Protocol (SNMP).

•Core Network

According to the service area package, including the registration failure rate, Centralized User Database (CUDB): a database that stores user data. If an alarm occurs, it will affect the user's inability to complete the registration process, Evolved Packet Gateway (EPG): session management and packet transmission.

B. Service Policy

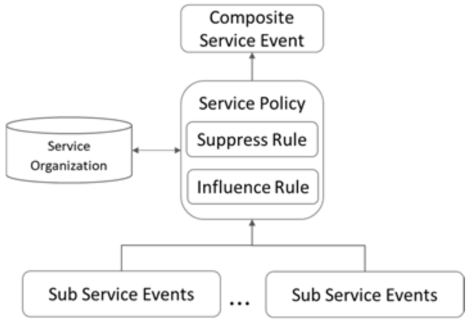

Fig. 4. Service Policy

To define cross-service data aggregation, the Service Policy we defined includes service impact modules and alarm suppression modules. The service impact module is configured to compare whether the service has a backup mechanism. If a single circuit is abnormal, it will not affect the operation of the overall network service. At this time, the alarm level of the composite service will be adjusted to Minor. Through cross-segment analysis, it is also possible to analyze the service interruption of multiple base stations with similar latitude and longitude caused by abnormal access to the core network to locate the obstacle. The alarm suppression module provides the status as under construction and maintenance, and provides maintenance personnel settings to avoid the alarm misleading other maintenance personnel.

III. IMPLEMENTATION

According to the research method in the previous chapter, we established an integrated monitoring system, as shown in Fig. 5. The Inventory Data Adapter to access all configuration data, including network infrastructure, transmission equipment and base station. According to the configuration data, establish a Network Management Systems (NMS) Data Adapter to collect the operating status of all equipment and circuits.

From the perspective of users, we collect the operating status of services from Quality of Service (QoS) to ensure that all services can meet various quality indicators. Collect information to conduct cross-domain analysis through the Multi-domain Event Management module, and display the analysis results in the integrated monitoring system function module. In addition, through the alarm module, the results will be sent by SMS and e-mail to inform the relevant personnel. The monitoring system function module mainly has four functions.

The Authentication Authorization module determines the range that the user can monitor. The Dashboard displays the service status, the event panel displays abnormal events, and the End to End Analysis displays obstacle location analysis.

The alarm suppression module sets the circuit suppression state.

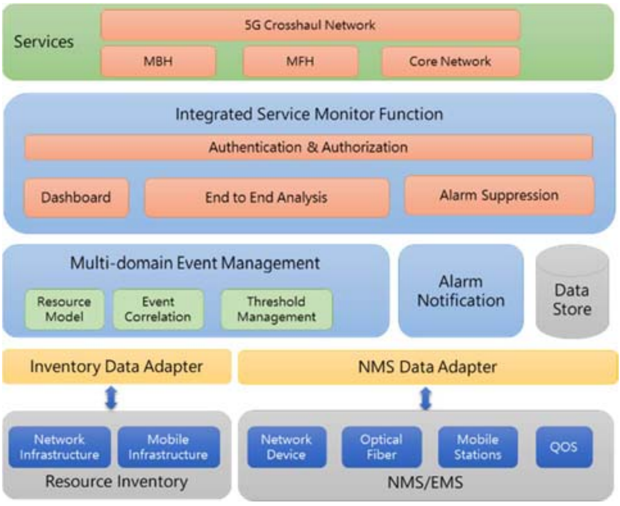

Fig. 5. System Architecture Dashboard displays

The dashboard displays the service on a single page, and the first layer classified by geographical area to facilitate regional maintenance. According to the statistics, the DRAN service, CRAN service, access network service. As shown in Fig. 6, the green light indicates normal service, the yellow light indicates major, the red light indicates critical, and the gray light indicates no service.

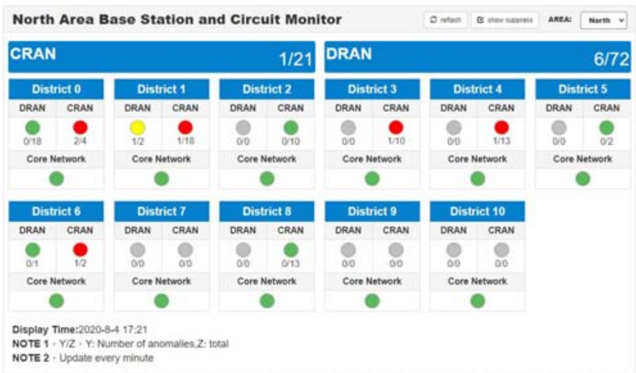

Fig. 6. Dashboard

The End to End Analysis list is shown in Fig.7, which lists the status of the base station, transmission equipment, MFH network, and core network access points based on the MFH dedicated line number. The service can be accurately located through the page Abnormal location. The alarm suppression module can also be used on this page to enable maintenance personnel to intuitively fill in alarm events and related instructions, such as construction and maintenance in the past two days.

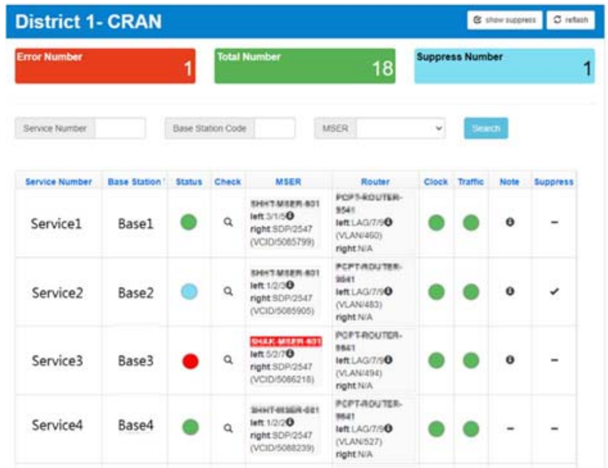

Fig. 7. CRAN End to End Analysis List

IV. CONCLUSION

Under the 5G network architecture, through cross-domain analysis, we integrate MFH, MBH, and core networks to accurately locate the root cause of obstacles, save communication time between different maintenance teams. Effectively shorten the time from more than 2 hours to less than 10 minutes.

This architecture can also be applied to the 4G architecture or various 5G deployment methods through the concept of service management and assembly. It is formalized on the Dashboard to provide maintenance personnel to quickly grasp the current network status. In the future, information such as the estimation of the number of service bases at each base station can be used in the future to further estimate the number of service impacts. If it is caused by the abnormal of the equipment by the partner manufacturer, it can be helpful in the analysis of service loss.

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