Research on Distributed Work in the Context of 5G Analysis of Distributed Base Station BBU Deployment Strategy

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Abstract. How an optical cable network architecture integrates with the wireless access network will directly affect whether it can smoothly transition to carrying 5G services. In this context, the centralized deployment of distributed base-band units (BBUs) can effectively reduce the reliance on server rooms and supporting resources, facilitate centralized maintenance and capacity expansion, and improve the utilization rate of BBUs. This paper will analyze the deployment mode of distributed base station BBUs, and propose deployment strategies and recommendations for different deployment scenarios.

Keywords: Distributed Base Station · 5G Network · BBU Deployment

1 Introduction

A number of cities around the world are currently experimenting with 5G base stations. In the current society, the research on 5G wireless network has never stopped. However, the 5G network requires a large number of antennas, and the energy consumption of the base station is also increasing. Moreover, due to the fast transmission frequency of the 5G wireless network, the coverage range of the base stations is limited to a certain extent, which will also lead to a great increase in the number of wireless base stations [1]. Therefore, the base station must be well planned. According to the current network situation in China, the planning of 5G wireless network can be carried out from the two aspects of "distributed base station" and "base-band unit (BBU) resource pool", so as to better promote the 5G network.

In comparison with 4G networks, 5G networks offer higher performance in terms of access capacity and data transmission [2]. However, 5G base stations must be built at a higher density than 4G [3]. Presently, there is a gap between the basic resources of fiber optic cable networks and the construction demand for 5G networks [4], which means the fiber optic cable networks should be significantly upgraded and integrated to meet the construction requirements.

How an optical cable network architecture merges with a wireless access network will directly affect whether it can smoothly transition to carry 5G services. With the large-scale construction of 5G remote station, the centralized deployment of BBU can

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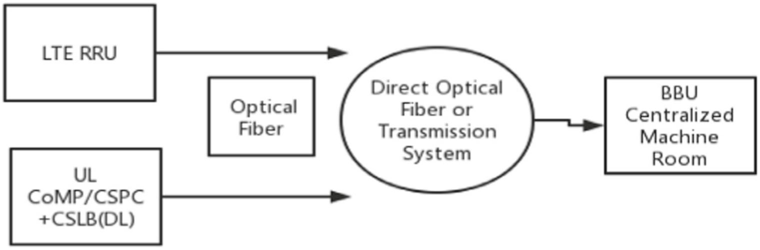

Fig. 1. BBU Network Architecture

effectively reduce the dependence on the machine room and supporting resources, facilitate centralized maintenance and capacity expansion, and improve the utilization rate of BBU. However, it requires a large number of end converged cores, which is bound to consume a large number of existing transmission resources and cause a great impact on the optical cable network [5]. By analyzing the wireless access network and an optical cable network architecture, the best integration mode of the two is explored, which has practical guiding significance for building a high-quality and reliable optical cable network with smooth evolution ability and good cost-effectiveness.

It is anticipated that distributed base stations will overtake centralized base stations as the dominant form of mobile network infrastructure [6]. The networking mode of BBU + RRU (remote radio unit) has the characteristics of fast, economical and high resource utilization rate compared with the macro base station. At present, it has been widely used in mobile network construction. The 5G network is based on the BBU centralized deployment of distributed BBU + RRU equipment [7]. By adjusting the deployment architecture of the radio base station, a certain number of BBU baseband resources are installed in the same physical machine room, as shown in Fig. 1. There is only RRU at the remote site. After the BBU is centrally deployed, the overall architecture of the original wireless network remains unchanged. The BBU and the RRU are connected in a star like manner through the optical cable network to improve the utilization rate of the BBU.

This paper will examine the deployment strategy of distributed base station BBUs in a 5G communication scenario, as well as the centralized BBU placement network model. These recommendations will provide practical guidance for building a high-quality, reliable and cost-effective optical cable network.

2 Comparison of BBU Centralized Deployment and Traditional Construction Model

2.1 Investment Costs

Let's use the assumed data for analysis, and compare the BBU concentration of 6 base stations with that of 2 base stations under 1 BBU. Assume that the server room rent is USD 2,000/month and the RRU rent is USD 500/month for ten years.

According to the traditional model, if six new server rooms and related equipment are built, 0.75 km of new fiber optic cable per station is required along with six new towers, the total cost will be $2,658 million. Putting three BBUs centrally, erecting six towers, and laying 0.75 km of new fiber optic cable per RRU site will cost $1.046 million. Compared to traditional station construction methods, centralized BBU construction can reduce the construction cost of server rooms, transmission rooms, and server rooms by about 60%.

2.2 Construction Period

With the improvement of people's awareness of green environmental protection, more and more attention is paid to wireless electromagnetic radiation. It is more and more difficult to obtain station site resources. Even if many properties are successfully selected, they cannot be built because of the opposition of surrounding residents. During the construction of the station, especially the outdoor supporting projects, it is easy to be obstructed by the owner and affect the construction period. A central deployment of BBU can reduce the selection of a site and the construction time for the equipment room [8], thereby reducing construction time by approximately 30% compared with the traditional way of constructing stations.

2.3 Access Mode of BBU Centralized Deployment

Considering the investment costs associated with BBU centralized deployment, fiber cores, pipes and other resources, there is flexibility to choose white light direct drive, color light direct drive, etc.

3 Analysis of Distributed Base Station BBU Deployment Strategy

Based on the centralized deployment of BBUs, a network evolution can use the baseband pool sharing method to achieve dynamic sharing of baseband capacity, dynamic allocation and scheduling of baseband resources, and even in areas where "call migration" occurs. Besides achieving efficient deployment and reducing BBU construction, it also enables centralized operation and maintenance control and saves energy [9]. By leveraging centralized baseband processing and collaborative radio technologies, multi-standard operational support may be more flexible and provides greater bandwidth and load balancing. Multi-cell collaboration technology can be used for the next evolution of the common baseband BBU-RRU network since it can help transform interference into useful signals by collaborating with multiple adjacent cells, improving channel quality, enhancing average cell throughput, and enhancing edge user throughput.

Furthermore, centralized BBU deployment has several advantages in terms of post-maintenance. In its first phase, it can improve the utilization rate of BBU equipment, reduce the number of BBU configurations, and reduce construction costs such as wireless network investments and infrastructure fees [10]. Secondly, the centralized BBU use wireless base station rooms for sites, so that it can take full advantage of the optical cable, power supply, air conditioning and other supporting resources, and improve the utilization rate of the room and equipment. A third advantage of BBU is that it is installed in a convenient location, which allows for better performance of construction and maintenance. Four, the BBU and RRU are configured as a star network with a simple network structure and centralized and unified optical path scheduling. In this strategy, there are fewer requirements for ring networking and optical cable ringing between BBU and RRU.

However, such a strategy has great challenges in terms of fiber optic network. The deployment of the BBU more centrally will prevent the transmission equipment at the RRU site from convergent multiple RRU services and transmitting them simultaneously, which will result in a greater utilization of the fiber resources, of which the deployment more centrally will lead to more utilization of the fiber cores. Moreover, trunk and distribution lines require a large amount of pipeline resources, resulting in an increase in investment. If wavelength division equipment is deployed, the cost of single station access will be high. Due to the large number of fiber optic cable projects, as well as supporting pipeline construction, the overall progress of the project will slow down, and the construction period is difficult to predict.

In terms of machine room, the site selection condition of BBU's central machine room is strict. If the effort is directed at the convergence room, a new GPS antenna is needed by the side convergence room [11]. This will increase construction difficulties. Further, it is necessary to modify the power supply and reduce the original load in some of the rooms, but this construction is risky and difficult.

4 Network Models for BBU Placement

The proposed model is based on a service aggregation area/integrated access area as the measurement unit. According to related references [12] [13], it is estimated that the average coverage area of the micro-grid division is 24 km2 per service aggregation area, 6 km2 per integrated access area, and 1 km2 per micro-grid. A macro base station is placed at 500 m intervals in dense urban areas, and a micro base station is placed at a distance of 700 m in general urban areas. BBUs can thus be classified into the following models based on the level of concentration from high to low [14].

Model 1: Highly concentrated BBU pool, where BBUs are concentrated at the aggregation node level. The BBU is centralized in the aggregation room, with 3 RRUs per base station occupying 6 cores (dual-fiber, dual-transmission mode) or 3 cores (single-fiber, dual-transmission mode). Wiring cable and fiber optic cable are essentially chained together, and the end access length of each site is approximately 0.5 km. Backbone convergence rooms require approximately 1 km of wiring length per site, while the average length of backbone fiber optic cables is approximately 1.5 km. An ordinary convergence room occupies approximately 1.5 km of wiring length per site.

Model 2: Medium-concentration BBU pool, where BBUs are placed at the wiring cable level. The BBU is mainly concentrated in the base station and a fiber optic communication link is built between the base station and the backbone fiber optic interchange. BBU and RRU pulling points are connected by a fiber optic cable to the backbone fiber optical interchange box, 3 RRUs per base station occupy 6 cores (double fiber, double transmission) or 3 cores fiber optic cable (single fiber, double transmission). A fiber optic cable terminates at each end of the wire, and the length of each end access cable is approximately 0.5 km. The backbone convergence room mode requires approximately 1 km of wiring length per site, and does not require a fiber optic cable core for connectivity.

Model 3: Low-concentration BBU pool, BBU concentrated in the micro-grid. Base stations have three RRUs that occupy six fiber cores (dual-fiber, dual-transmission mode) or three fiber cores (single-fiber, dual-transmission mode), and the wiring cable and the end cable are chained together, with the end access length of each station being about 0.5 km.

5 Conclusion

Decentralized deployment of BBUs uses the least fiber optic cable resources and provides the highest level of security, whereas centralized deployment is the trend for the future. It is possible to reduce the cost of wireless equipment and transmission equipment by selecting the appropriate BBU concentration and BBU location and constructing converged fiber optic cables. Using an infrastructure network model to determine the optimal design for the construction of fiber optic networks, this paper examines the relationship between different BBU concentrations and locations and the construction cost of fiber optic networks.

With small business volumes, BBU pools with high concentrations are recommended, because coverage areas of broadband rings are small, and the density of equipment rooms in the town is low, which eases pressure on backbone fiber cores and saves funds to support base stations. Due to the high cost and substantial resource requirements of the optical cable direct drive access method, optical pickup direct drive is ideally suited for convergence.

Medium-concentration BBU pools are suitable for scenarios where there are only a small number of centrally deployed server rooms in the coverage area, usually in the main urban areas or towns with more intensive services. Because the BBUs are concentrated within the better-maintained base stations, the fiber optic cable occupies fewer resources than the model and only the wiring resources. BBUs and RRUs are connected by a relatively short distance and security risks are relatively small.

The low-concentration BBU pools are suitable for dense service areas in urban and main city areas with limited fiber core resources. This deployment method consumes the least fiber resources and is the safest.

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