Research on O-RAN Core Network Architecture

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I. Purpose

With the advancement of technology, the emergence of applications such as big data, artificial intelligence, and Internet-of-Things (IoT) has led to significant growth in wireless communication technology. The development and characteristics of 5G have propelled network architectures towards openness and greatly reduced deployment costs. Telecom giants in countries like the United States, Japan, and Europe have already adopted O-RAN (Open Radio Access Network) technology. In Taiwan, the Ministry of Economic Affairs has also collaborated with multiple companies to create the "First 5G Open Architecture Network Experimental Platform" to seize the international market.

The network architecture of O-RAN (as shown in Figure 1) involves the disaggregation of traditional 4G RAN (Radio Access Network) functions, thereby increasing the flexibility and agility of network deployment. Additionally, O-RAN utilizes open-source systems, including the use of white-box devices, which significantly reduces the cost of network infrastructure deployment. Therefore, O-RAN is considered the most feasible solution for the next generation of RAN. The O-RAN Alliance has already conducted concept verification to demonstrate the functionality of network equipment based on O-RAN and the interoperability among multiple vendors. They have also emphasized the importance of developing a commercially viable O-RAN ecosystem.

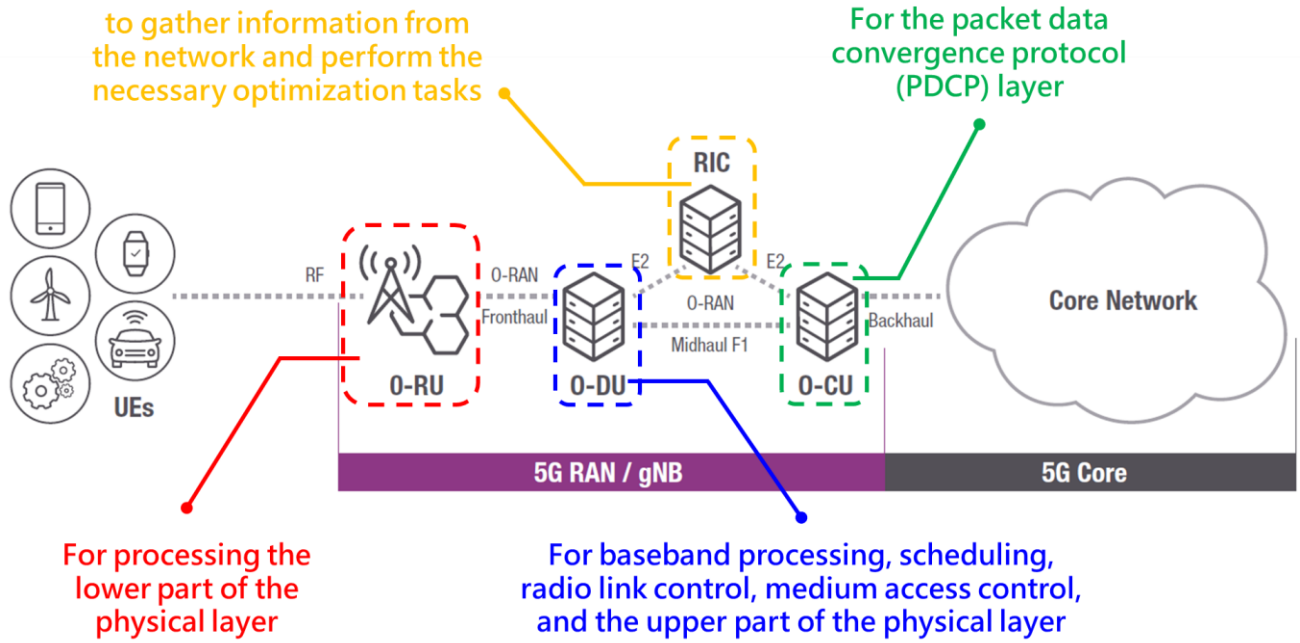

Figure 1 The network architecture of O-RAN

Reference: Keysight_The essential guide for understanding O-RAN

Due to its low cost and rapid deployment capabilities as a white-box solution, O-RAN is an attractive option for various applications. It offers high controllability and integrates easily with Mobile

Edge Computing (MEC) technologies. Additionally, Taiwanese communication equipment vendors have developed O-RAN devices, making them a potential solution for the power industry. Taiwan Power Company (Taipower) could consider establishing an O-RAN network infrastructure. If security concerns are considered, Taipower can build and develop wireless technologies based on the 3GPP standard, optimizing them according to the requirements of the smart grid. In summary, this project aims to study the architecture of the O-RAN core network and assess the feasibility of implementing this technology in Taipower's smart grid.

II. Research Results

This study aims to procure a set of Open RAN wireless communication network equipment to deploy a Stand-Alone (SA) architecture. In comparison to the Non-Standalone (NSA) architecture, the SA architecture does not require the use of LTE (i.e., 4G) base stations and the Evolved Packet Core (EPC) of the 4G core network. Instead, it only requires 5G base stations and the 5G Core network. The diagrams illustrating the NSA and SA network architectures can be found in Figure 2. The project has obtained the necessary permits for setting up the experimental network and radio stations. The allocated radio frequency for the obtained radio stations is 4.8-4.9 GHz, a dedicated frequency band assigned by the government to various enterprises. In the future, an application can be made to the Ministry of Digital Development to repurpose the experimental network for obtaining a dedicated network license.

Based on actual measurements, in a single User Equipment (UE) scenario with a DL/UL ratio of 8:2 (8 for downlink and 2 for uplink), the system demonstrates a downlink throughput of approximately 800 Mbps and an uplink throughput of approximately 200 Mbps. Considering the current speed test results and the characteristics of mobile networks, this system can be applied in small-scale power fields, such as collecting information from power devices within a specific power field and transmitting it back to a control center or other applications. Additionally, if there is a need for rapid deployment of wireless networks in the short term, the fast deployment feature of O-RAN equipment can serve as a preliminary evaluation of field performance.

Currently, the experimental network of this O-RAN system is limited to the designated area for radio wave transmission and is not connected to public telecommunications networks. This is done to ensure the independence and closed nature of the dedicated mobile broadband telecommunications network, in compliance with telecommunications regulations. Considering cybersecurity concerns, the system is not yet connected to any internal network.

In the future, this O-RAN system can be further enhanced by integrating it with Mobile Edge Computing (MEC). MEC enables data processing and analysis to be performed closer to the data source, allowing computation, storage, and network resources to be moved as close to the users or endpoints as possible. This helps alleviate bandwidth constraints and reduces data errors and transmission delays. Moreover, MEC allows data to be kept at the local edge, which, when combined with Taipower Company's self-built dedicated frequency and network, can enhance data security and increase control over the telecommunications network. This ensures that the communication requirements of power applications are met while maintaining high data security.

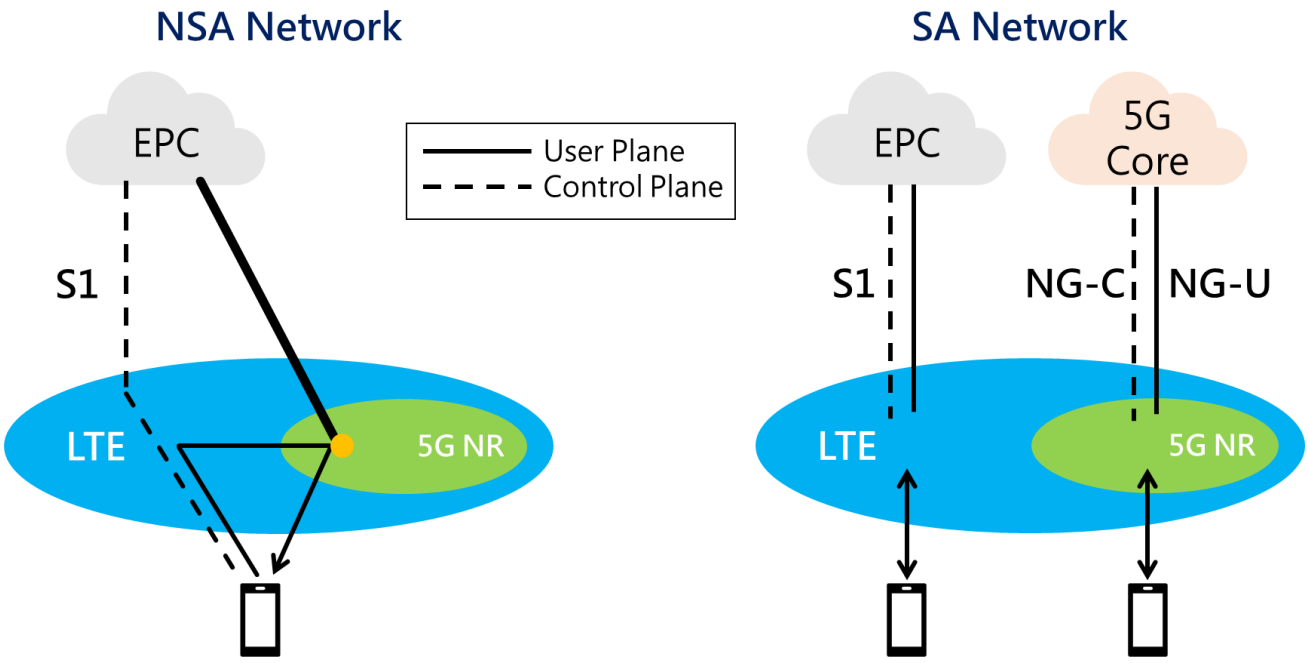

Figure 2 NSA Network vs. SA Network

Reference: This project