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APPLICATION SPECIFIC 5G RAN SPLIT OPTIONS IN A SINGLE RADIO UNIT

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ABSTRACT

Various technical specifications, such as Third Generation Partnership Project (3GPP) and Open Radio Access Network (O-RAN) specifications, define various functional splits that can be utilized for a Fifth Generation RAN (5G-RAN). For example, Split option 2 and Split option 7.2 are the typical implementations, and Split option 6 (Physical layer/femto application platform interface (PHY/FAPI)) is likely to be prevalent soon. Split option 7.2 is fronthaul heavy and involves strict latency budgets. For example, Split option 7.2 needs roughly four times the bandwidth of Split option 2/6 for the same amount of user plane throughput. Presented herein is a system in which a RAN Radio Unit (RU) can be operated simultaneously in two connectivity split options in order to cater to different use-cases simultaneously.

DETAILED DESCRIPTION

3GPP/ORAN specifications define various functional splits for a RAN, including Split option 2, Split option 7.2, and Split option 6, which have different tradeoffs and system requirements. For example, Split option 7.2 is fronthaul heavy and involves tight latency budgets such that Split option 7.2 needs roughly four times (4x) the bandwidth of Split option 2/6 for the same amount of user plane throughput. Although option 7.2 is best suited for use cases requiring high reliability and spectral reuse, Split option 2/6 can cater to throughput demanding use cases by easing load and latency requirements on the fronthaul network.

Consider an example of a factory floor involving use cases that typically cover both mission-critical connectivity and large file firmware download. Economically, it is often not feasible to deploy two separate Radio Units (RUs) supporting different split options to cater to different use cases in the same physical location. Further, real estate and co cabling can drive up the cost and increase deployment complexity.

Thus, it would be advantageous if an RU could support two connectivity options/functions simultaneously. This would avoid the need for another physical unit and its associated expenses. If additional compute resources were available in an RU for Layer 2 (L2) and/or upper Layer 1 (L1) functions, it would be feasible to support both Split option 7.2 and Split option 2 or 6 on the same RU. With this motivation in mind, this proposal provides a system in which an RU can be operated simultaneously in two connectivity options catering to different use-cases simultaneously. In various implementations, an Operations, Administration and Maintenance (OAM) system or the like can be utilized to configure an RU to operate in different split options or modes simultaneously.

Figure 1, below, illustrates an example 5G-RAN architecture in which a 5G RU can be configured to support two connectivity options.

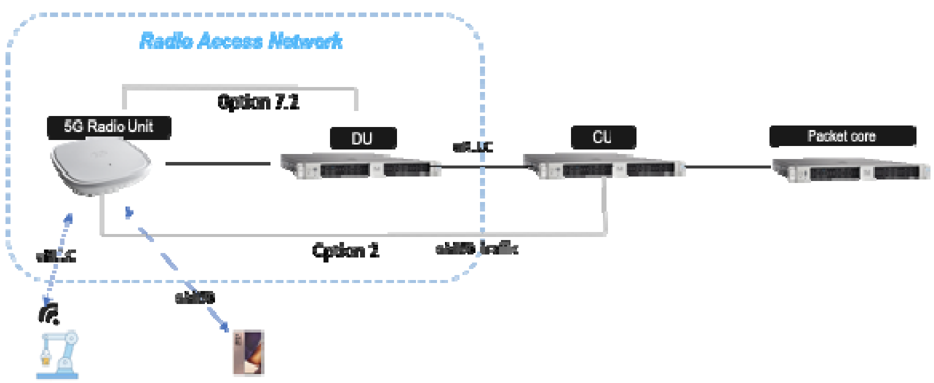

Figure 1: 5G-RAN Architecture Involving a 5G RU Supporting Two Connectivity Options

The dual connectivity option architecture, as illustrated in Figure 1, may provide considerable advantages over current deployments. For example, an RU with 4X4 capability can be configured into two 2X2 carriers. Each carrier can be configured to use different split options as follows.

1. A first carrier configured with RAN Split option 7.2 can:
    - Utilize a shared carrier for better spectral efficiency and zero mobility detriments;
    - Anchor Ultra-Reliable and Low-Latency Communication (URLLC) users/bearers;

- Facilitate control plane communications as a primary carrier for enhanced Mobile Broadband (eMBB) users; and
- Utilize shared, locally licensed, and/or licensed spectrum, which is more reliable but scarce.

2. A second carrier configured with RAN Split option 2 may:
   - Provide a segmented spectrum with a reuse factor;
   - Anchor eMBB users/bearers;
   - Facilitate user plane traffic for eMBB users as a secondary carrier;
   - Utilize 6 Gigahertz (GHz) / New Radio unlicensed (NR-U) and/or millimeter wave (mmWave) spectrum.

As illustrated in the architecture of Figure 1, both carriers will have a common Central or Centralized Unit (CU) at which the bearer split could take place. During operation, a user equipment (UE) can connect to Split 7.2 and Split 2 carriers in this architecture to exploit the benefits of redundant radio paths to improve connection reliability and can utilize different paths for different service needs (Split 7.2 versus Split 2). In some instances, network slices can also be supported with this architecture in which each carrier can be dedicated to a specific slice.

Figure 2, below, illustrates example details that may be associated with an RU dual split mode stack.

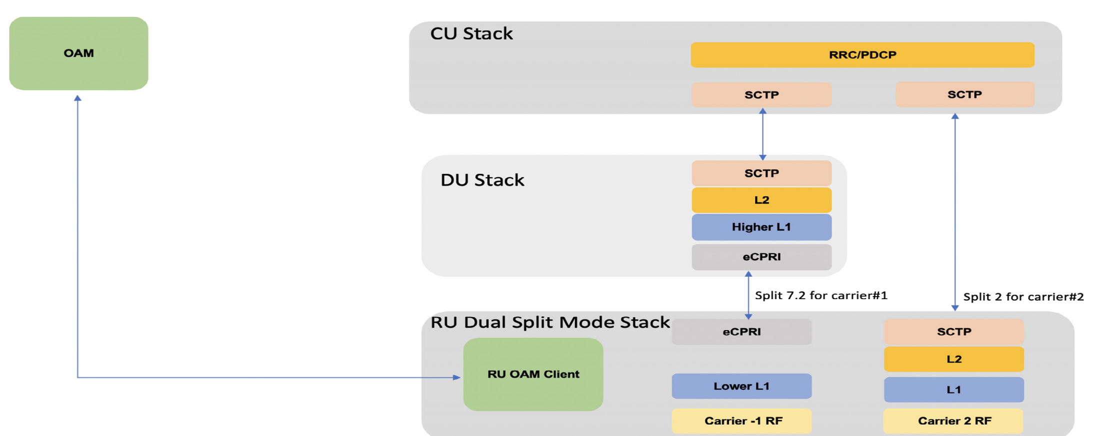

Figure 2: RU Dual Split Mode Stack

As illustrated in Figure 2, lower L1 functionality for the RU can be used for the primary carrier with Split option 7.2 and communications with a Distributed Unit (DU) can be provided over an enhanced Common Public Radio Interface (eCPRI) fronthaul connection. Full L1 functionality can be integrated with local L2 code for the RU for implementing the secondary carrier for Split 2 operations. In some instances, providing dual connectivity of a single UE across split options can help in overcoming scenarios involving DU failures.

In summary, a system is provided herein in which a single RU can be configured to operate in two different O-RAN Split options simultaneously (e.g., Split option 7.2 and Split option 2). The RU can provide dual stack operations for a primary and a secondary carrier simultaneously. In one instance, control and user plane traffic for URLLC users and control plane traffic for eMBB users can be anchored on Split option 7.2 and user plane traffic for eMBB users can be anchored on Split option 2. In one instances, assisted mode functionality can be utilized for NR-U operations in which the control channel can be provided via (locally) licensed spectrum via the 7.2 split, whereas the data channel can be provided on NR-U spectrum in order to exploit high channel bandwidth without being limited by 7.2 split fronthaul complexity. Similar functionality can be provided via mmWave spectrum. In some instances, a dual mode RU may support mapping network slices to a particular O-RAN Split option.