White Paper

Open Fronthaul Test Applications with T-BERD/MTS-5800

Open Radio Access Network (O-RAN) is being adopted by operators and equipment manufacturers worldwide to reduce infrastructure deployment cost and lower the barrier to entry for new product innovation. As a leader in 5G test and measurement, VIAVI Solutions has developed a comprehensive test suite with modules for lab validation, field deployment and service assurance. This paper provides an overview of Open Fronthaul test applications supported by the VIAVI Solutions T-BERD®/MTS-5800 product line.

Challenges of testing Open Fronthaul

In O-RAN, Open Fronthaul is defined as the link between the O-DU and O-RU. It facilitates the use of standardized multi-vendor interfaces which paves the path to successful interoperability between O-DU and O-RU. The transport protocol of Open Fronthaul is also known as eCPRI. This packet-based transport technology significantly reduces the fronthaul bandwidth compared to the simple, but bandwidth intensive, CPRI interface used in 4G/LTE networks. eCPRI, however, presents some new challenges associated with packet-based technologies including packet loss or packet delay variation. Furthermore, eCPRI is not a synchronous technology and relies on synchronization technologies such as Precision Time Protocol (PTP) and optionally synchronous Ethernet (SyncE).

Successful interoperability of O-DU and O-RU can be achieved only if the underlying transport and synchronization networks meet their performance requirements. Transport errors will break the exchange of O-RAN protocol. An M-Plane session may not be established, or Control and User Plane packets may arrive late or be partially missing at an O-RU. Synchronization is another important aspect of O-RAN protocol exchange. Proper synchronization of the O-RU enables it to lock and transmit respective waveforms over the air while meeting Time Alignment Error (TAE) limits set by 3GPP standards.

Following are four use cases for verification and troubleshooting of the Open Fronthaul interface. The first use case verifies the health of the Open Fronthaul interface between an O-DU and an O-RU. The second and third use case involve the use of Fronthaul Transport Nodes (FTN) between the O-DU and O-RU, and verification methods for the successful operation of the transport and synchronization networks across these FTN nodes. The last use case delivers a methodology for troubleshooting the Open Fronthaul interface.

Use Case 1: Transport and Synchronization Verification of the Open Fronthaul

The field-tested VIAVI T-BERD/MTS-5800 solution can be used to validate the health of the Open Fronthaul in the lab and in the field giving visibility into the protocol messages between the O-DU and O-RU. The verification is done by conducting optical power, frequency offset, packet loss, bandwidth utilization and PTP/SyncE message counts.

Transport Health Verification

- Power Level
- Frequency Offset
- Packet Count
- Bandwidth Utilization

Synchronization Verification

- PTP Connection
- Message Count

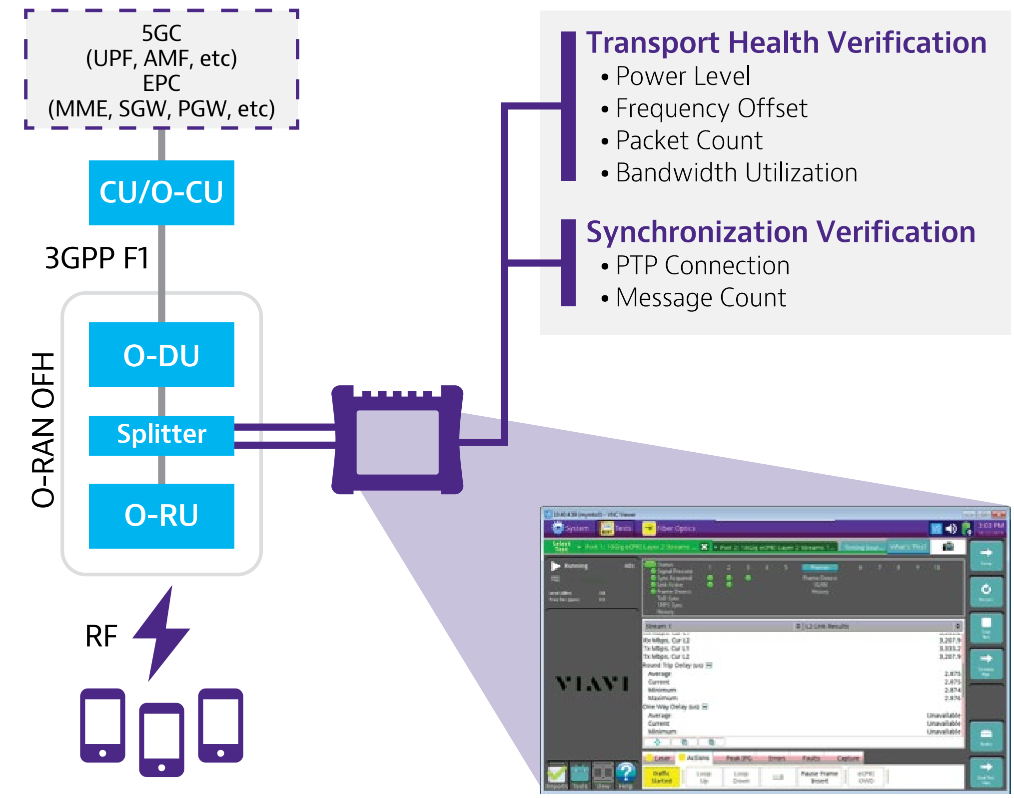

Figure 1. Fronthaul Analyzer – Transport and Synchronization Network Test

Use Case 2: Verification of Open Fronthaul Transport Network

Fronthaul transport nodes (FTN) aggregate and transport traffic between CPRI/eCPRI-based RRH/O-RU and BBU/O-DU. While they simplify the fronthaul topology, they can introduce transport and synchronization issues. Validating FTN-based networks is essential to minimizing any issues caused by excessive packet loss, delays, jitter and poor QoS. In a multivendor O-DU/O-RU deployment, these issues can create more complexity in the validation, verification and troubleshooting of the Open Fronthaul, and other O-RAN components. Verifying FTN readiness for O-RAN is necessary for a smooth O-RAN deployment.

The VIAVI T-BERD/MTS-5800-100G performs eCPRI tests including throughput, , delay, and packet jitter. Engineers can configure eCPRI message types according to eCPRI specification, measure bandwidth for each message type, and measure packet delay with sub 5ns accuracy as shown in Figure 2. By performing FTN tests, engineers can validate the transport requirements of the Open Fronthaul transport network across FTNs against network specifications.

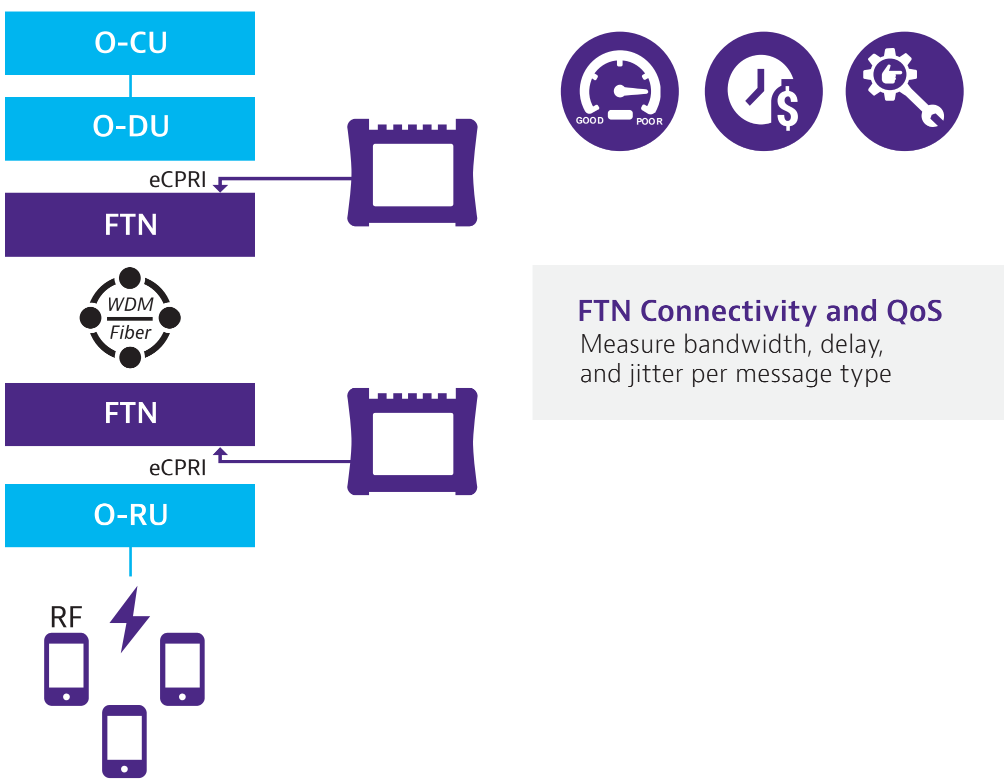

Figure 2. Fronthaul Analyzer –FTN Transport Test

Use Case 3: Verification of Open Fronthaul Synchronization Networks

Open Fronthaul networks can be synchronized in several modes as depicted in Figure 3 and as described in the O-RAN WG4 CUS specification. Where LLS-C1 through LLS-C3 modes rely on PTP/SyncE for O-RU synchronization, LLS-C4 works based on a local GNSS-based timing source at the O-RU. In LLS-C1 mode, the O-RU obtains its source from the O-DU, whereas LLS-C2 and LLS-C3 deploy one or several fronthaul transport nodes between the O-DU and O-RU. In LLS-C2, the Telecom Grandmaster (T-GM) resides in the O-DU or connected to the O-DU that performs an Interworking Function/T-BC function. In LLS-C3, the T-GM and T-BC functions are assigned to the fronthaul network, and both O-DU and O-RU play the role of a telecom time slave clock (T-TSC).

The PTP networks can support an ITU-T G.8275.1 (Full Timing Support) profile, or ITU-T G.8275.2 (Partial/Assisted Partial Timing Support) profile. The former profile is expected to be the main one to be deployed in future fronthaul networks. It is characterized by one or several Telecom Boundary Clock (T-BC) functions resident in the fronthaul transport nodes. They ensure the proper function and performance of the synchronization plane in line with network limits provided in standards such as ITU-T G.8271.1. Timing error constitutes one of the most important parameters for the proper operation of the radio network.

The T-BERD/MTS-5800 delivers the complete set of testing parameters, thresholds/masks and profiles for verification of synchronization standards. The measurements can be performed at the output of any T-BC as provided in the example of LLS-C3 mode in Figure 3. The measurements can also be conducted at any available 1PPS output interface.

Performing accurate synchronization measurements requires a highly stable and accurate reference source. T-BERD/MTS-5800 can be equipped with a Timing Expansion Module (TEM) that includes a GNSS receiver and a Rubidium clock.

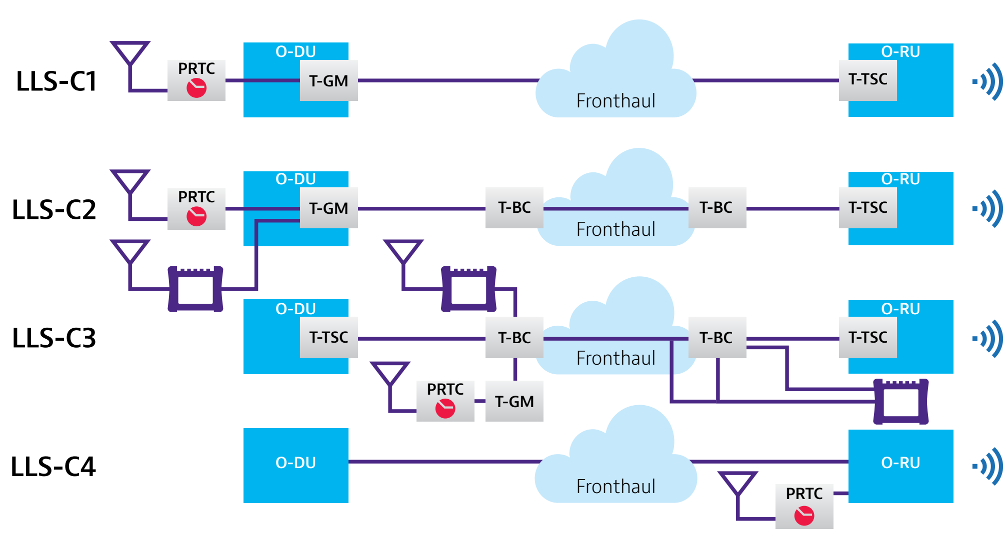

Figure 3. O-RAN WG4 S-Plane Topologies

Use Case 4: Control/User Plane Connectivity and Packet Capture

eCPRI based O-RAN technology relies on transmission of Real Time Control Plane (CP) and User Plane (UP) packets between the O-DU and the O-RU. In an O-RAN environment with O-DU and O-RU from potentially different vendors, any anomalies in transmission of Control and User Plane packets can lead to problems in O-RU or O-DU. T-BERD/MTS-5800 not only can check the health of the Open Fronthaul, but it also can filter Open Fronthaul Real Time Control Plane and User Plane packets and capture those packets to validate if the packet transmission is compliant with the Open Fronthaul specification. Operators can view the captured and filtered packets in Wireshark expediting the analysis and allowing faster troubleshooting and a successful on-time network launch.

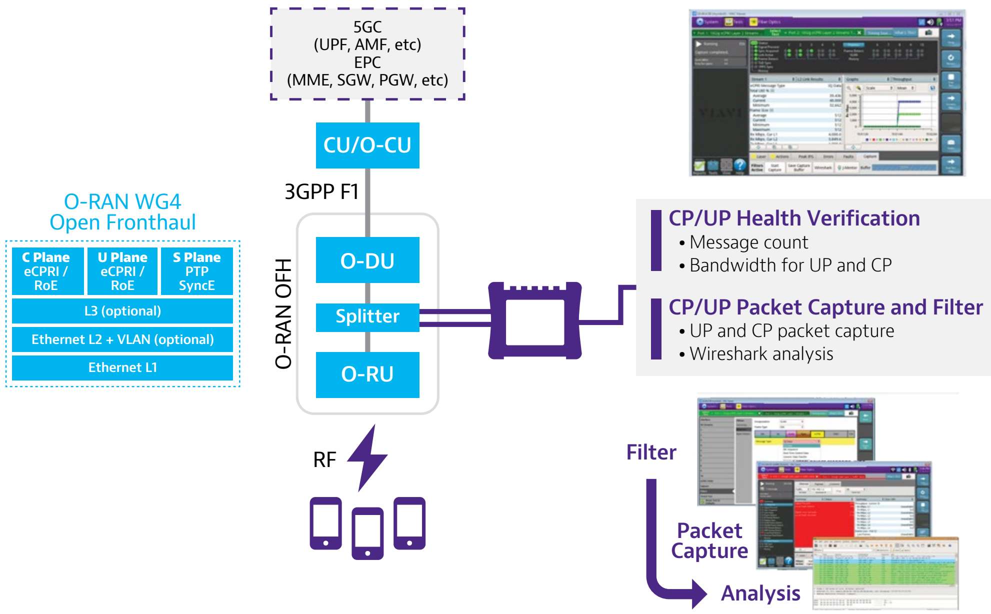

Figure 4. CP/UP Analysis using a T-BERD/MTS-5800

Summary

The VIAVI Solutions T-BERD/MTS-5800 is essential for testing and troubleshooting Open Fronthaul transport and synchronization networks. It allows simple verification of the health of the network with optical power level, frequency offset, packet loss, jitter and synchronization message counts. Further, it characterizes the performance of Open Fronthaul across Fronthaul Transport Nodes by performing bandwidth utilization, delay, jitter and time error measurements. Finally, its packet filtering and capturing/decoding enables efficient troubleshooting of Open Fronthaul transport problems by capturing eCPRI packets for analysis with Wireshark.

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