VIAVI Solutions

Application Note

Open RAN Radio Verification

VIAVI OneAdvisor 800

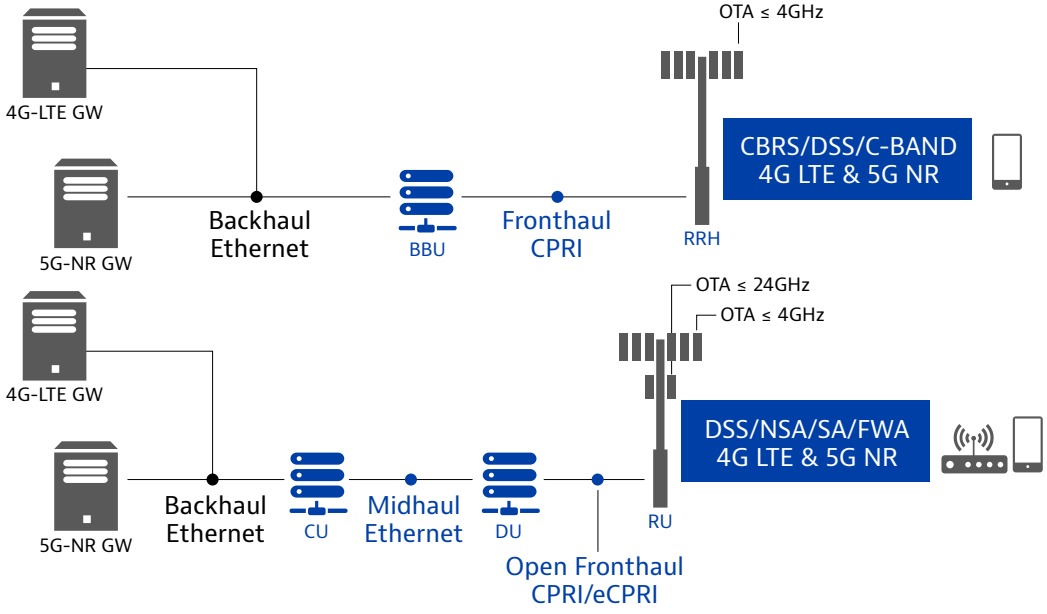
The VIAVI OneAdvisor 800 is the ideal portable test solution to verify and troubleshoot open RAN radios for effective network deployment. It eliminates cell site revisits during network integration, improves network availability, and reduces installation costs.

Open RAN Overview

Open RAN sets out to deliver well-defined specifications to the industry with the goal of enabling open RAN based programmable networks consisting of fully disaggregated modular open RAN network functions. These networks are designed to be multi-vendor and interoperable over open interfaces, running on cloud-based virtual systems. open RAN allows operators to design and deploy mixed-vendor networks and network slices which is key to delivering mixed use cases via the same infrastructure.

Open Fronthaul

Open RAN open fronthaul is an evolution of conventional RAN fronthaul topologies where centralized base-band units controlled remote radio units via a common public radio interface (CPRI); however, the need for a higher bandwidth capacity and interoperability requires a new open fronthaul with different interface splits, open network elements, and protocol planes.



RAN and open RAN Network Topologies

Traditional fronthaul architectures were based on CPRI, where radio elements were designed to receive control signals from the base band unit (BBU) as well as communication of user signals such as downlink and uplink from/to the BBU, respectively. The main function was performing digital/analog conversion and analog signal management for carrier assignment, amplification and filtering.

The introduction of 5G applications, e.g., ultra-reliable low latency, massive machine type communication and enhanced mobile broadband, brings new set of requirements for radio elements and new considerations for the fronthaul functional split. These include:

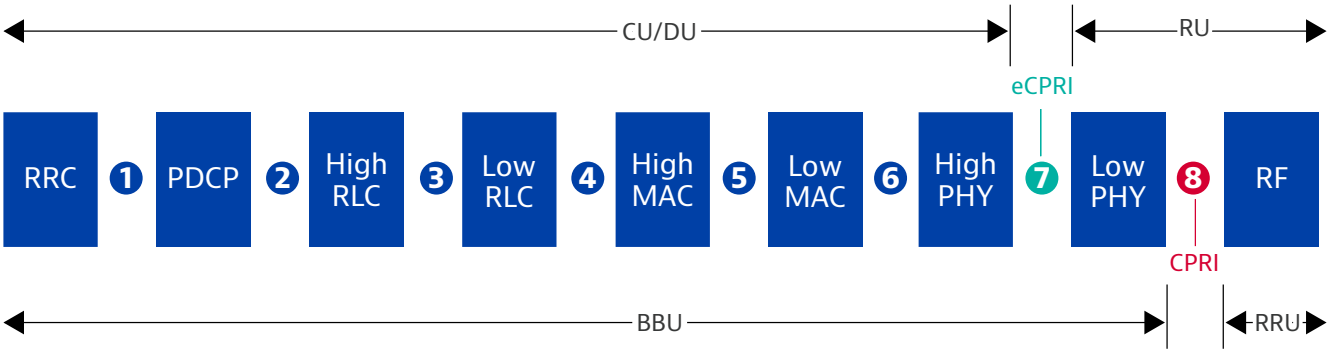
a. Increase bandwidth capacity to support a higher number of antennas and wider channels

b. Increase supported distance between radio elements and base band units

c. Reduce delay, timing and jitter for low latency applications

d. Keep radio elements as simple as possible, reducing cost, size, weight and power consumption

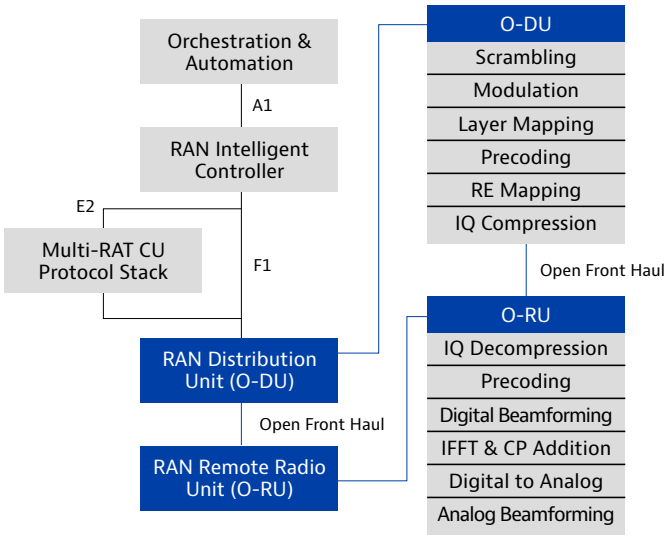
The above considerations, in addition to having an open interface for interoperability, derived the definition of fronthaul lower layer split (option 7).



Fronthaul Lower Layer Split

Open RAN open fronthaul architecture defines the O-DU and O-RU elements as follows:

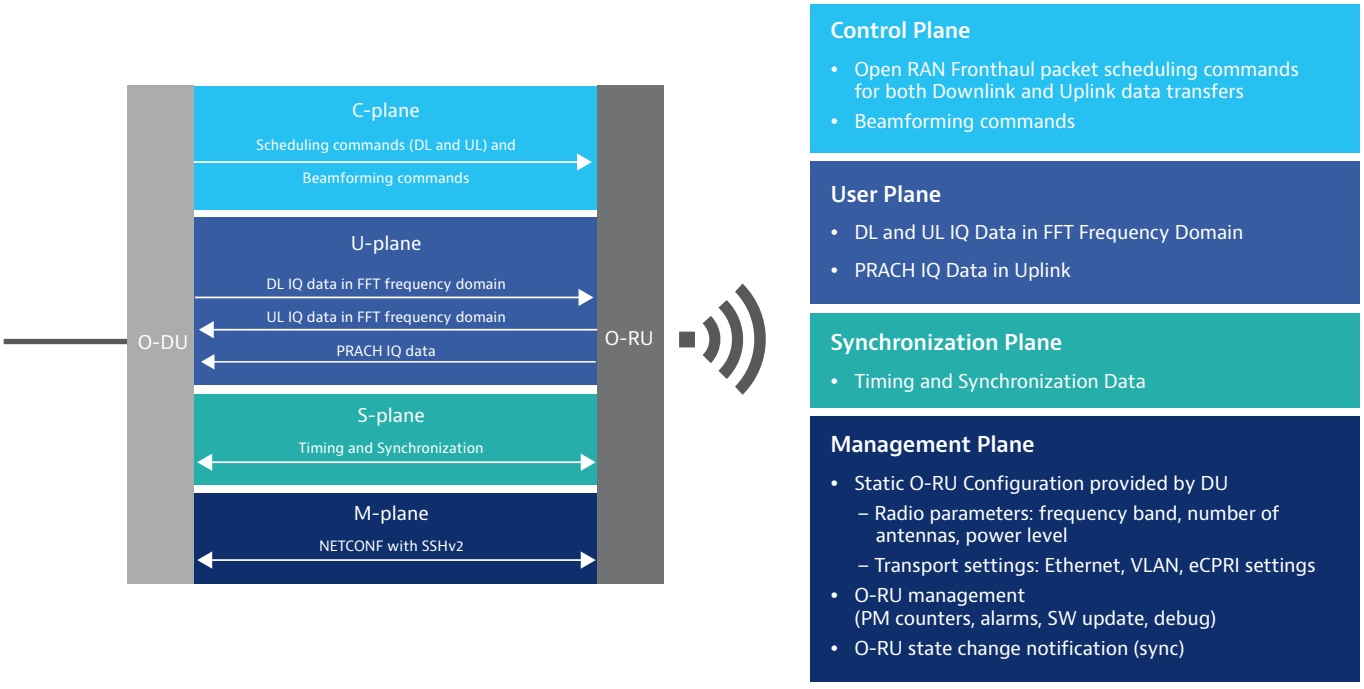
- Open RAN Distirbution Unit (O-DU) is a logical node hosting RLC/MAC/High-PHY layers based on a lower layer functional split
- Open RAN Radio Unit (O-RU) is a logical node hosting Low-PHY layer and RF processing based on a lower layer functional split



Open RAN Fronthaul Functional Split

The Open Fronthaul includes the Control User Synchronization (CUS) plane and the Management (M) plane over Low Layer Split interfaces. open RAN defines these interface planes as follows:

- Control Plane: refers to real-time control between O-DU and O-RU, not including the IQ sample data (part of the User Plane).
- Management Plane: refers to non-real-time management operations between the O-DU and the O-RU.
- Synchronization Plane: refers to traffic between the O-RU or O-DU to a synchronization controller which is generally an IEEE-1588 Grand Master.
- User Plane: refers to IQ sample data transferred between O-DU and O-RU.



Open Fronthaul Functional Description

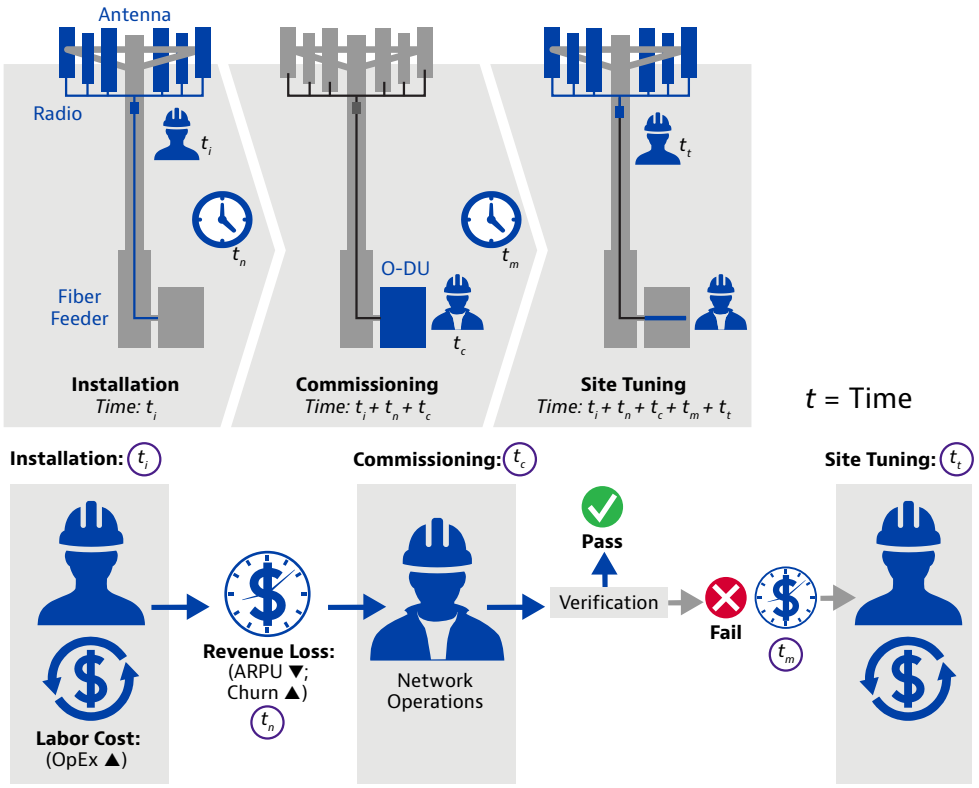
Service providers are deploying 5G networks as an evolution of LTE networks, as a shared infrastructure (dynamic spectrum sharing), or as a new technology taking full advantage of the benefits that 5G technology brings. It is essential to execute its deployment effectively and efficiently by testing all components to minimize site revisits, avoid deployment delays, reduce intermittent service availability or even reduce no-trouble-found (NTF) on components.

Open RAN Radio Verification

Radio deployments are conducted in a well-defined process, generally including the following three phases:

1. Cell site installation: covering cell-site construction, fiber and power cable rollout and connectivity as well as mounting the radios and antennas for each sector.
2. Cell site commissioning: configuring the network elements such as BBU or CU, and its interface with the radios, turning up service, and conducting a service verification.
3. Cell site tuning: tuning antennas if needed and resolving any installation issues.

A major challenge for mobile service providers is the overall time that this installation process takes, and the requirement to realize revenue quickly, remain competitive and minimize customer churn.



Cell Site Deployment Process

With the OneAdvisor 800 with O-DU Emulation, cell site technicians follow a streamlined process for open RAN radio verification.

1. Turn on the radio unit to ensure it works properly
2. Validate that the the SFP is tuned to/operating at the correct rate
3. Confirm there are no issues with the fiber.

As a result, providers:

- Avoid returning to the site for troubleshooting and rework
- Improve time to market
- Reduce costs

Total installation time depends on a number of factors:

- Installation time (t_i) varies from weeks to months based on permissions, construction, and complexity of the cell-site
- Time between installation and commissioning (t_n) averages 15 to 30 days: installers and network commissioning have different schedules and priorities
- Commissioning time (t_c) requires a few days to a week based on backhaul performance and potential troubleshooting issues
- Time between commissioning and site tuning (t_m) averages 15 to 30 days.
- Site tuning (t_t) varies from a few days to weeks based on repairs and availability of replacement parts

The total installation time (T) adds up to several months: $T = t_i + t_n + t_c + t_m + t_t$. This extended time can drastically affect mobile operators financially. They cannot provide or charge for services and they risk churning existing customers to other mobile service operators.

Cell-Site Deployment Process	Days	Revenue Loss	Churn Cost	Labor	Opportunity Cost
t_i: Time of installation	7	$11,667	$233		$11,900
t_n: Time for commissioning	7	$11,667	$233		$11,900
t_c: Time of commissioning	30	$50,000	$1,000		$51,000
t_m: Time for tower crew	30	$50,000	$1,000		$51,000
t_t: Time of repair and tuning	1	$1,667	$3		$1,700
Tower Crew Re-Visit	1			$3,000	$3,000
Total Time and Cost	**76**	**$125,000**	**$2,500**	**$3,000**	**$130,500**

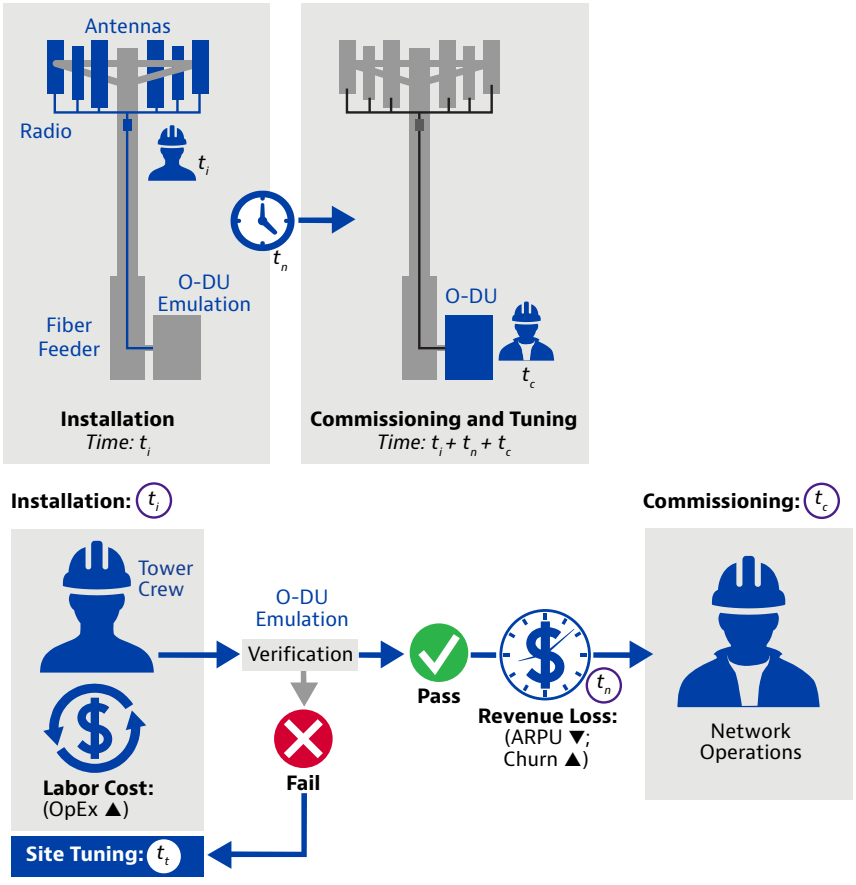
Table 1. Cell Site Deployment Cost Scenario

The considerations for the above model are:

- Revenue loss = daily ARPU x subscribers, where the typical monthly ARPU (average revenue per user) is $50.00 or $1.67 per day for 1,000 service subscribers
- Churn cost = revenue x 2% churn rate

OneAdvisor 800 with O-DU Emulation

Site tuning or installation verification is currently done as a third phase of the process, since it requires the O-DU to communicate with the O-RU and perform a functional test. However, this process can be eliminated if the O-DU can be emulated to conduct the O-RU functionality at the installation phase. Effectively turn-up and verification can occur at the time of installation.



Cell Site Deployment with O-DU Emulation

The main benefits that O-DU Emulation brings to service providers are on-time network deployment and cell site installation cost reduction, some key value areas are the following:

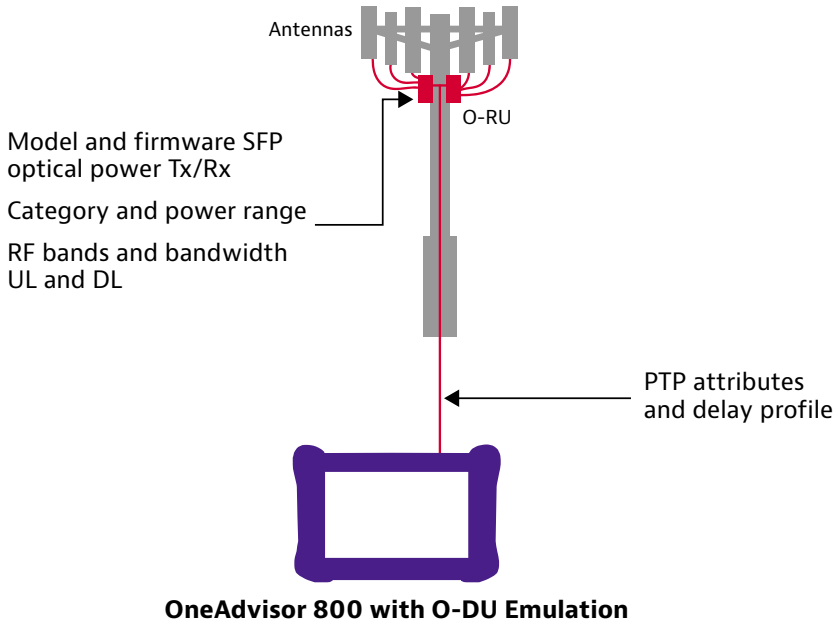
- Reduces cell-site revisits by ensuring proper radios are installed in all sectors
- Ensures service availability, by validating proper synchronization and avoiding inter-cell interference
- Avoids no-trouble-found of components, verifying the proper SFP components and installed in the O-RU
- Minimize service degradation by ensuring proper optical power levels are received by the O-RU

O-DU Emulation was developed and incorporated into the VIAVI OneAdvisor to be the all-in- one test solution for 5G cell site deployments, the main test functions of O-DU Emulation are related to open RAN fronthaul M-Plane.

The cost savings achieved with O-DU Emulation can be significant. Considering the cost scenario in Table 1, O-DU Emulation yields a 31-day reduction in deployment time and opportunity cost savings of $54,000 per cell site.

Cell-Site Deployment Process	**Days**	**Revenue Loss**	**Churn Cost**	**Labor**	**Opportunity Cost**
t_i: Time of installation	7	$11,667	$233		$11,900
t_n: Time for commissioning	0	$0	$0		$0
t_t: Time of repair and tuning	1	$1,667	$33		$1,700
t_c: Time of commissioning	7	$11,667	$233		$11,900
t_m: Time for tower crew	30	$50,000	$1,000		$51,000
Tower Crew Re-Visit	0	$0	$0	$0	$0
Total Time and Cost	**45**	**$75,000**	**$1,500**	**$0**	**$76,500**

Table 2. Cell Site Deployment Cost Scenario with O-DU Emulation



Key Benefits of OneAdvisor 800 with O-DU Emulation

O-DU Emulation was developed and incorporated into the VIAVI OneAdvisor to be the all-in-one test solution for 5G cell site deployments, the main test functions of O-DU Emulation are related to open RAN fronthaul M-Plane.

O-DU Emulation	Test Description
O-RU General Information	Serial Number, SW version, Build code Manufacturer, MAC Address, IP Address, M-Plane Version, CUS–Plane version
O-RU SFP Information	Model, Port, Vendor, Rx Power, Tx Power, Temperature
O-RU M-Plane Capability	Category, Ports, Streams, Max and Min power per PA Antenna
O-RU M-Plane Bands	Band number, UL and DL frequency range, and bandwidth
O-RU M-Plane PTP Profile	Valid count DL and UL, Profile
O-RU M-Plane Delay Profile	UL and DL delay

Table 3. O-DU Emulation Tests

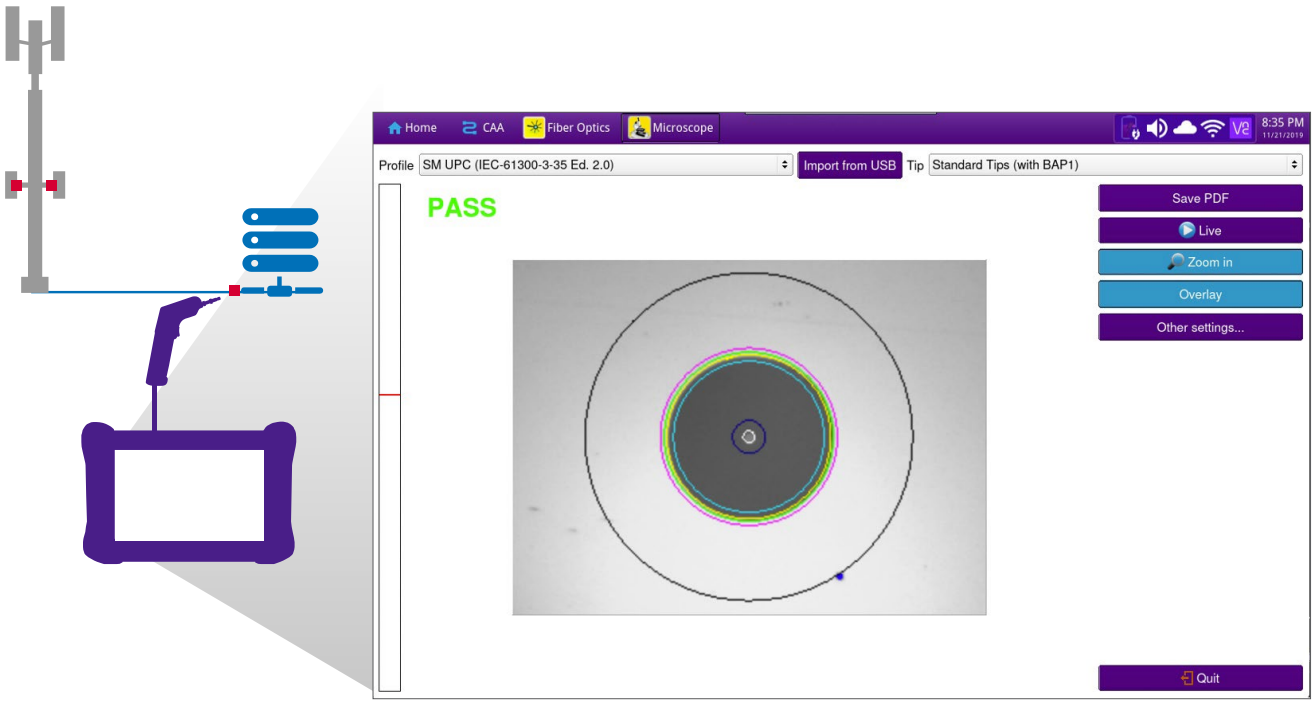
OneAdvisor 800 All-In-One Cell Site Deployment Verification

The xhaul infrastructure of a cellsite is composed of fiber links between its multiple elements, including O-CU, O-DU and O-RU.

Fiber Inspection

The most common cause of signal degradation in an optical transmission system between transmitter, fiber link, and receiver is dirt on fiber connectors which can get contaminated very easily when the connectors are exposed to the environment.

Therefore, the first step in achieving acceptable insertion- and return-loss in a fiber link is to inspect the fiber connector's end-faces with the OneAdvisor 800 equipped with a fiber microscope, P5000i or FiberChek, capable of performing standard-based PASS/FAIL measurements, collecting results, and creating comprehensive close-out reports.

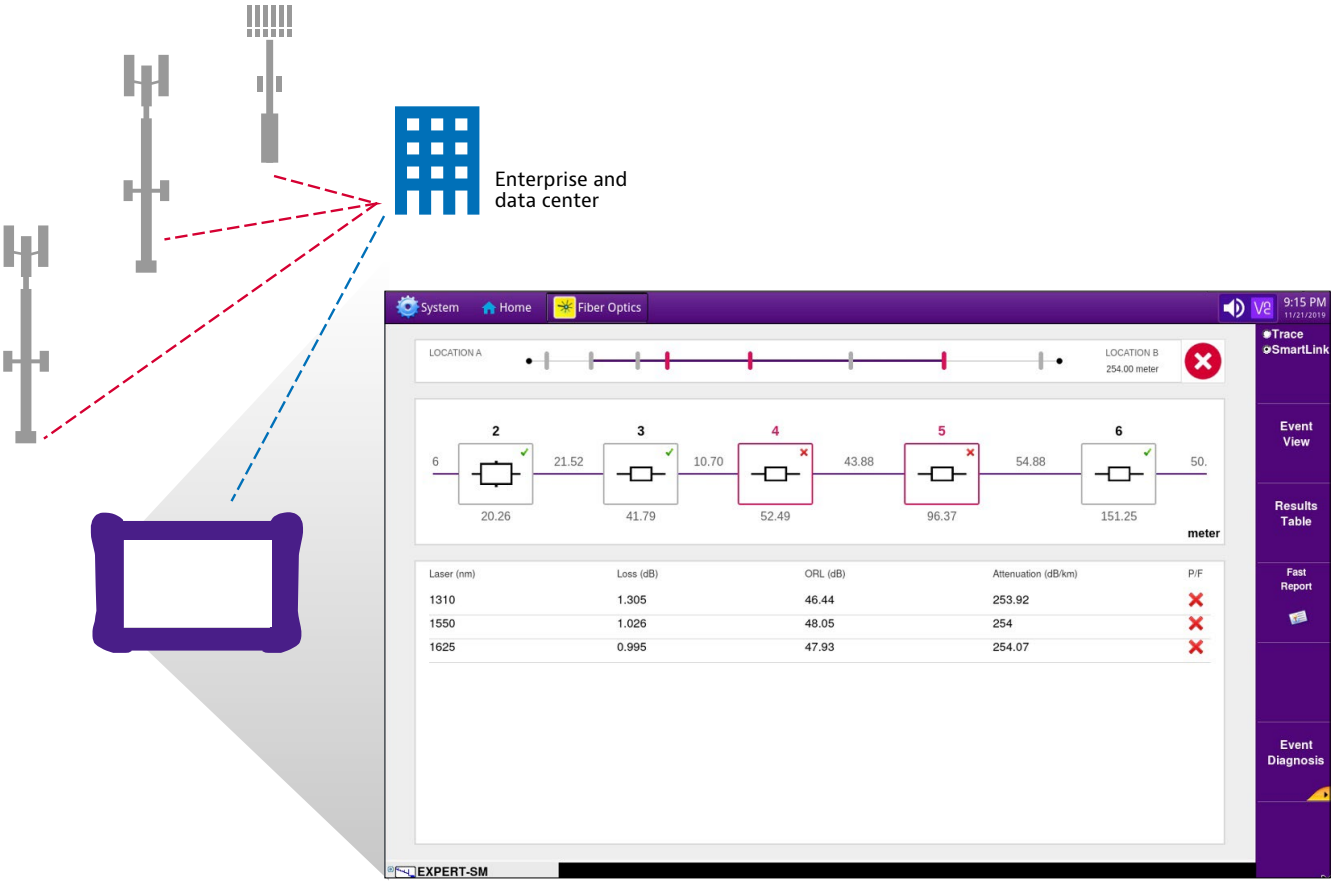


OneAdvisor 800 Fiber Inspection

Fiber Characterization

Fiber is now more prevalent in cell sites of any kind, from small cells and macro cells, to distributed antenna systems (DAS) and centralized radio access network (C-RAN). The most effective method to characterize a fiber link is with an optical time-domain reflectometer (OTDR).

OneAdvisor 800 can be equipped with an OTDR module capable of performing fiber testing for single-mode and/or multi-mode fibers in a simple, fast, and cost-effective manner.



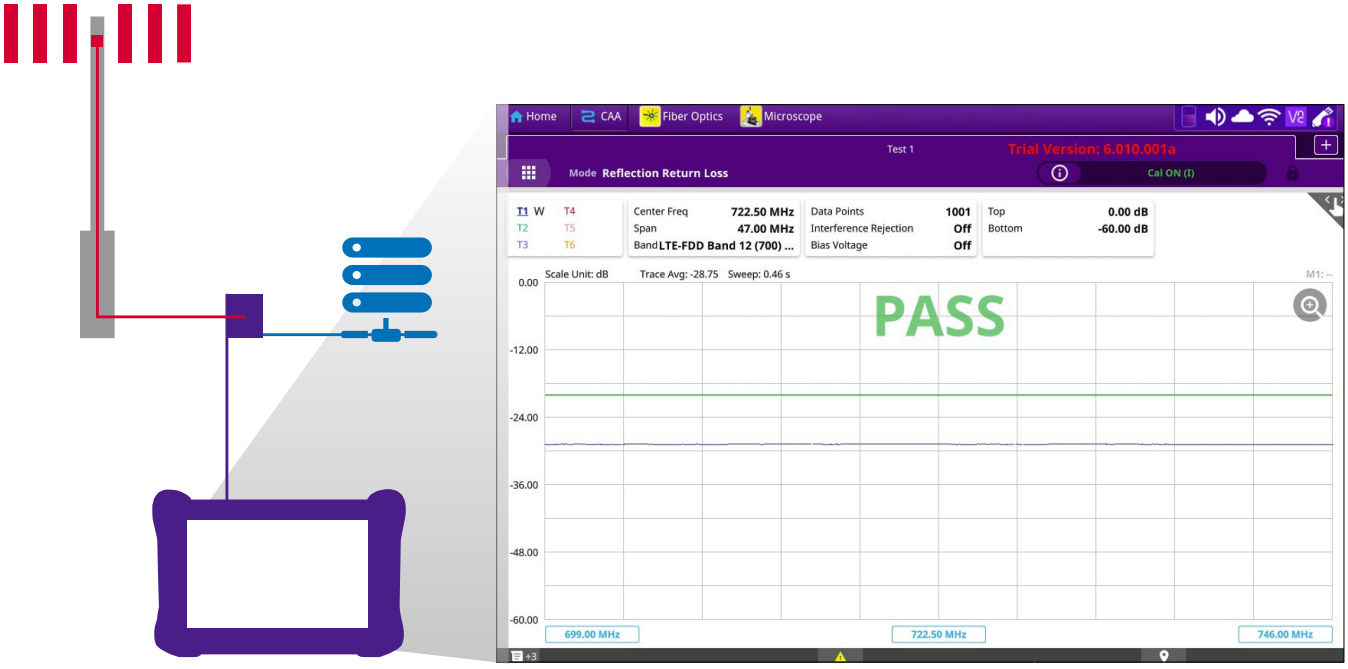
OneAdvisor 800 Fiber Characterization – OTDR

Cable and Antenna Analysis

OneAdvisor 800 can be equipped with a Cable and Antenna Analyzer module allowing cell technicians to verify connectivity between the radio and antennas which are RF devices including cables, jumpers, filters and duplexer, and the antenna. The OneAdvisor 800 can measure:

- Return Loss and VSWR
- Distance to Fault
- Cable Loss

The OneAdvisor 800's user-friendly GUI provides intuitive PASS/FAIL results and instantly identifies problems. It easily enables technicians to determine if the cell site meets the coaxial transmission specifications.

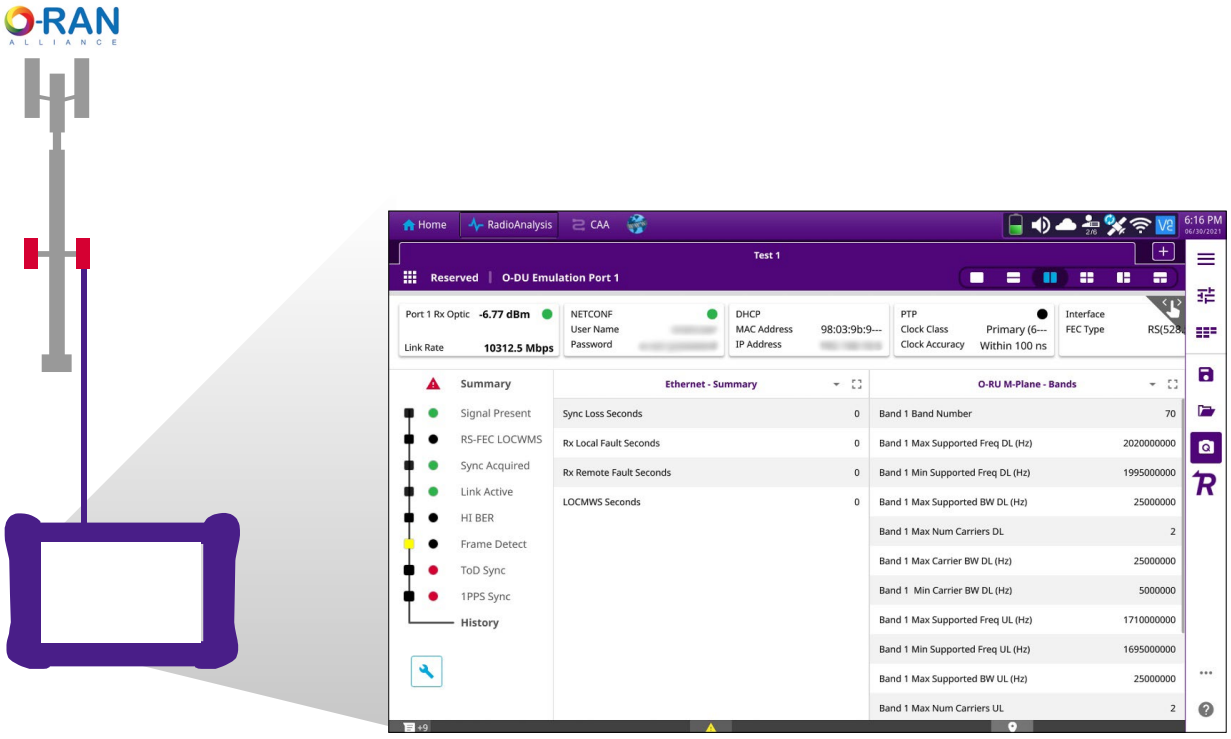


OneAdvisor 800 Coaxial Cable and Antenna Analysis – Return Loss

Open RAN Radio Verification

OneAdvisor 800 with O-DU Emulation allows cell technicians to verify the connectivity and profile of the O-RU including:

- O-RU connectivity: communication, optical power Tx/Rx (SFP)
- O-RU profile: Radio model, serial number, software, MAC and IP Addresses, operating bands
- O-RU Synchronization and Timing: PTP and SyncE verification



OneAdvisor 800 open RAN O-DU Emulation Verification

Test Process Automation with Job Manager and StrataSync

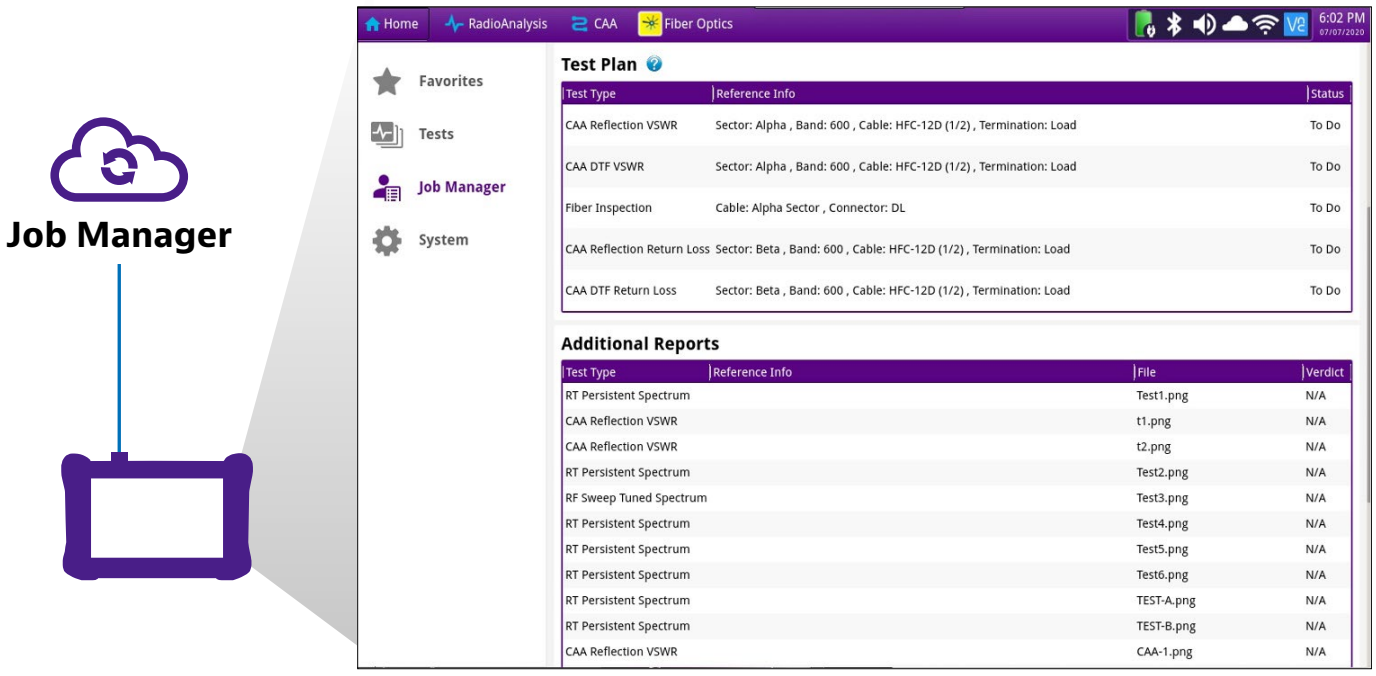
VIAVI Test Process Automation allows cell technicians to perform installation and maintenances tests with confidence:

- In accordance with mobile operator's test criteria
- Covering all radio types (LTE and 5G) and topologies (Macro-cell, Small-cell, C-RAN, and/or DAS)
- Automatically uploading test results to the StrataSync cloud with simple PASS/FAIL indicator

Job Manager

VIAVI Job Manager automates test processes, offering mobile network operations and cell site construction teams a self-guided test solution, improving efficiency in the field for cell-site installation and maintenance.

Job Manager automates the entire process ensuring the proper test sequence is executed according to the mobile operator's requirements. Further, it minimizes configuration time and formats test results into consistent, consolidated reports.

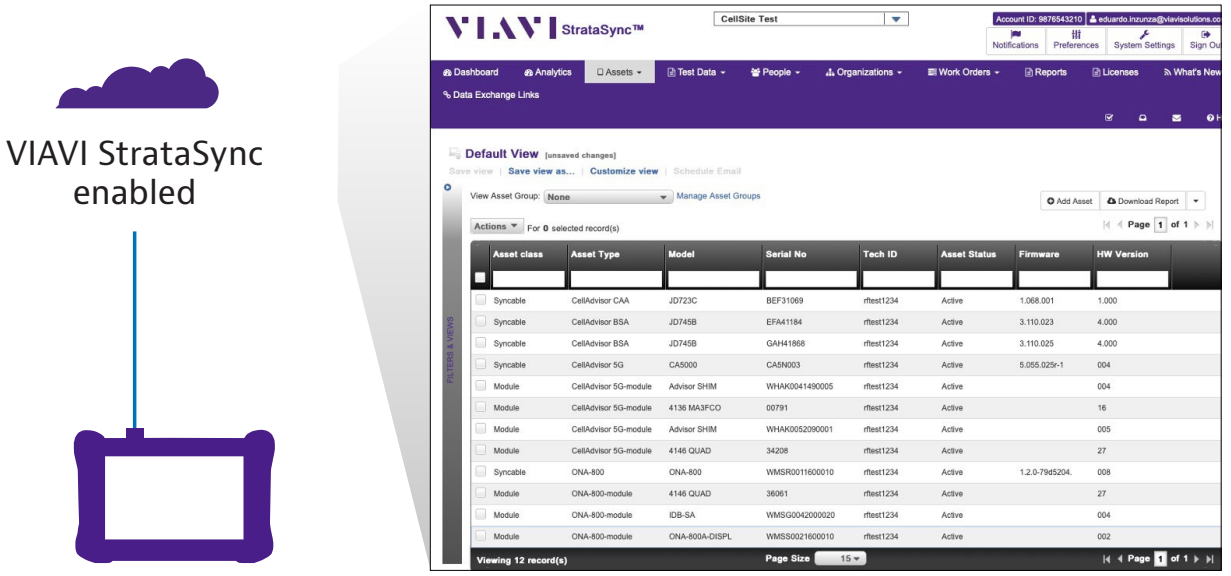


OneAdvisor 800 Job Manager

StrataSync

StrataSync is a cloud-hosted system from VIAVI that provides centralized management of test solutions including test set management, test configurations, data management, and test results.

StrataSync is designed to eliminate email dispatches, manual test procedures, manual report consolidation, test solution availability and test devices that need calibration.



StrataSync – Asset Management

Faster Work Speed

Eliminate wasted time trying to remember which tests to run and how to run them

Greater Consistency

Drive consistent, repeatable results, regardless of technician skill or experience

Lower Training Costs

New technicians get up to speed quickly with easy-to-follow prompts

Peace of Mind

Test results automatically saved to StrataSync cloud

References

[1]. VIAVI Test Suite for open RAN Specifications; white paper

[2]. VIAVI 5G Fronthaul Handbook; Application Note

[3]. Open RAN: Towards and Open and Smart RAN; white paper, October 2018

[4]. Open RAN Minimum Viable Plan and Acceleration towards Commercialization; white paper, 29 June 2021

[5]. Open RAN Fronthaul Working Group; Control, User and Synchronization Plane Specification

[6]. Open RAN Fronthaul Working Group; Management Plane Specifications

VIAVI Solutions

Contact Us **+1 844 GO VIAVI**
(+1 844 468 4284)

To reach the VIAVI office nearest you,
visit viavisolutions.com/contact

oneadvisor-800-oran-an-xpf-nse-ae
30193219 900 1021