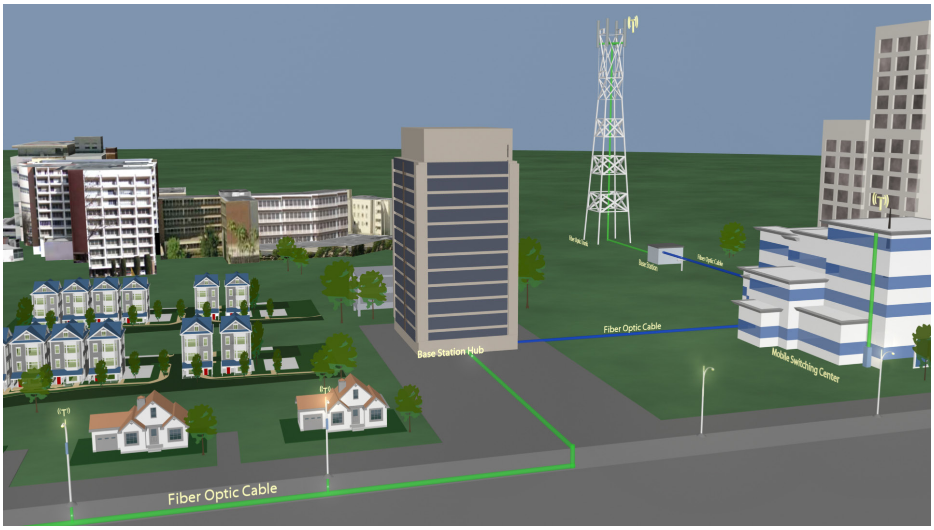
Turn Up and Maintain Cell Towers Quickly, Safely, and Efficiently

With Viavi's Surround the Antenna Solutions

Insatiable data demand, caused by the relentless growth of mobile and Internet of Things (IoT) devices, is driving mobile networks to evolve from a typical macro cell site based coverage topology to a denser capacity-based heterogeneous network. Recent advancements in radio technology (improved power amplifier efficiency, better design and longer MTBF), have enabled service providers to install remote radio units (RRU or RRH) close to the antenna near the top of the tower. This technology improvement has enabled service providers to improve capacity, coverage, and signal integrity, while at the same time reduce electrical, leasing, and cable costs.

Now instead of carrying large bulky coaxial cables for every transceiver path (six or more per operator), service providers can use lighter and significantly fewer fiber and power cables between the RRU at the top of the tower and the baseband unit (BBU). The baseband unit can be located at the base of the tower or remotely at a BBU hotel, allowing for cloud RAN architecture.

The RRU, also called radio equipment (RE), converts the digital baseband signal into the analogue signal and vice versa for transmission/reception over the air. The BBU, also called radio equipment control (REC), performs the processing of the radio protocols, interfaces between the radio network, and the operations and management (O&M) interface.



The fiber link between the BBU and RRU, AKA the "front-haul," carries RF information using either CPRI or OBSAI technology. Basically, RF information from the radio is converted into the digital domain and mapped accordingly so that it can be deciphered at the BBU and vice versa.

Where CPRI/OBSAI technology offers significant advantages, it also creates headaches in the case of fiber-to-the-antenna (FTTA) macro cells, as any RF maintenance or troubleshooting such as interference analysis requires reaching the top of the tower to get access to the RRU. This represents a higher operational expense and security concern.

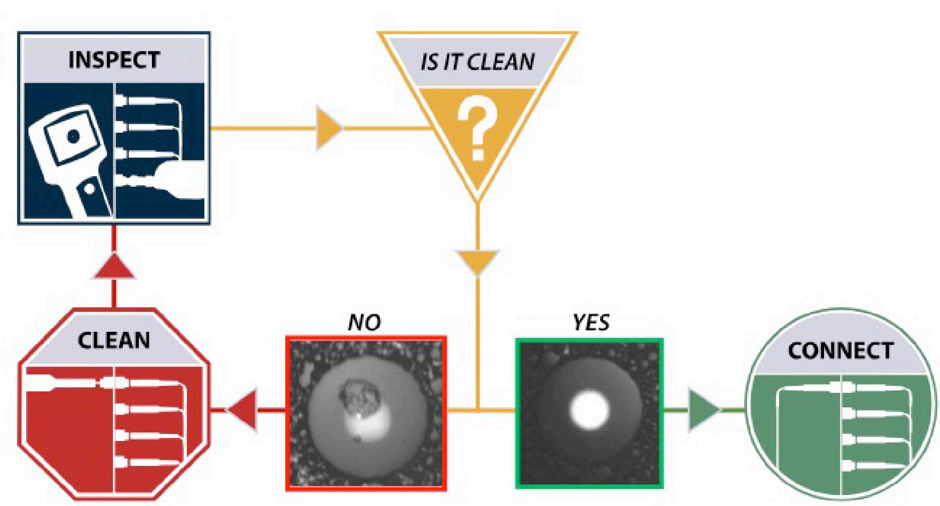
Additionally, cell-site installers now need to perform a wider spectrum of tests so that all cables, connectors, and other active and passive components are properly installed and commissioned. This is done to ensure optimal cell-site performance, thus offering the best possible QoE for mobile subscribers and maximum ROI for the mobile network service provider. Some of the key tests that cell-site technicians may be required to perform before a cell site is accepted can be summarized as follows.

Fiber System Test

Fiber Connector Inspection and Cleaning

Dirty connectors are the number one cause of poor performance in optical networks. Microscopic particles of dirt can create enough signal loss and back reflection, causing significant downtime and network damage. The increasing bandwidth requirements in today's mobile networks leave little room for the errors caused by dirt.

Easily overcome these problems with the right tools and best practices. Using a fiber-inspection microscope to certify connector end-face quality, in accordance with IEC standards or the operator's specification, is the cornerstone of proper fiber deployment. Ensuring fiber connector end-face quality guarantees the link will perform at the highest level possible.



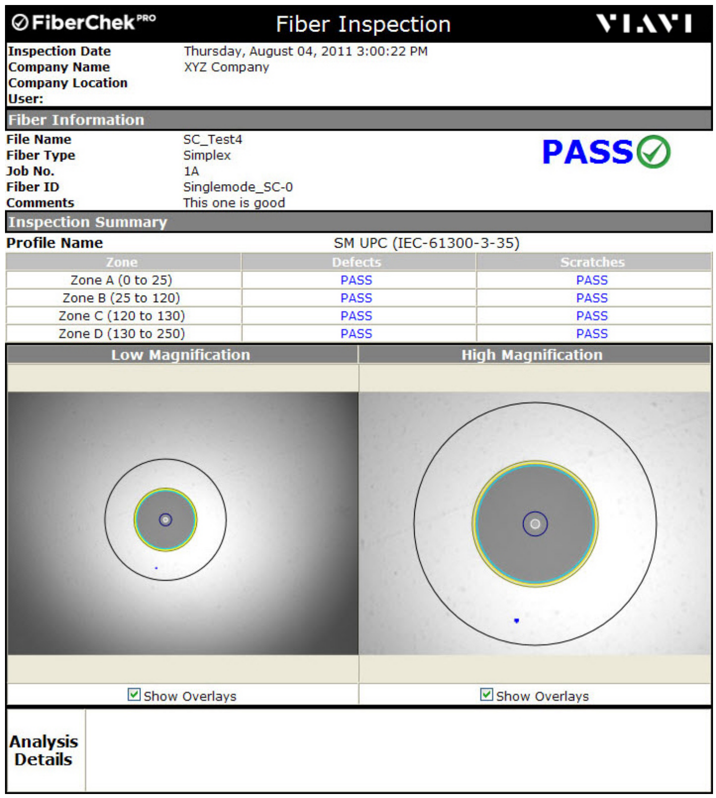
Visual Fault Locator (VFL) Test

One of the most valuable and lowest-cost tools for FTTA is the visual fault locator (VFL). VFL uses brightly visible light to:

1. Check patch cords for microbends, macrobends, breaks, or bad terminations.
2. Verify continuity (determining whether fiber X on this end really matches up with fiber Y on the other end)

Optical Power Test

Certify that fiber cable installation meets system optical budget requirements. A minimum basic Tier 1 test is to perform a link or channel insertion loss measurement using an optical light source (OLS) and optical power meter (OLP or MP) to verify receipt of the correct range of power (not too little, not too much), ensuring that equipment functions at peak performance with maximum optical budget headroom.


FiberChek PRO — Fiber Inspection — VIAVI

Inspection Date	Thursday, August 04, 2011 3:00:22 PM
Company Name	XYZ Company
Company Location	
User:	

Fiber Information

File Name	SC_Test4
Fiber Type	Simplex
Job No.	1A
Fiber ID	Singlemode_SC-0
Comments	This one is good

PASS

Inspection Summary

Profile Name: SM UPC (IEC-61300-3-35)

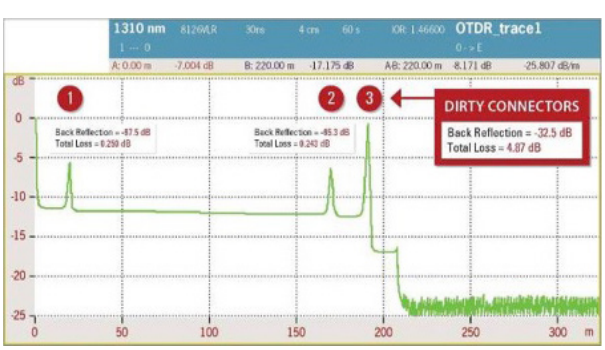
Zone	Defects	Scratches
Zone A (0 to 25)	PASS	PASS
Zone B (25 to 120)	PASS	PASS
Zone C (120 to 130)	PASS	PASS
Zone D (130 to 250)	PASS	PASS

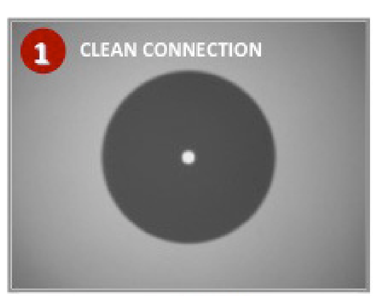
Low Magnification	High Magnification
Show Overlays	Show Overlays

Analysis Details

Optical Time-Domain Reflectometer (OTDR) Test

With installations in elevated locations, it is hard to judge installation quality or any impairment on the cable itself. Tier 2 certification involves OTDRs, which are the only devices that can characterize and measure fiber loss, locate events and impairments, measure the impact (loss) of each, and provide the distance to each one.





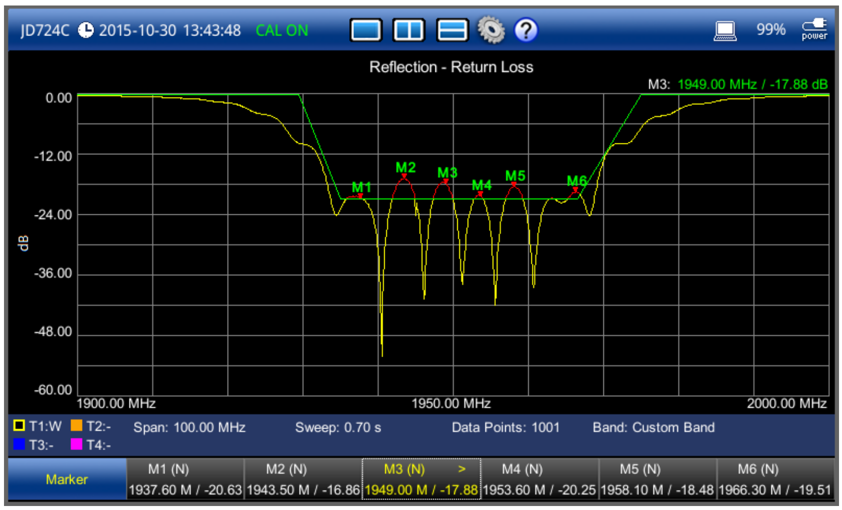
Back Reflection = -67.5 dB
Total Loss = 0.250 dB

Back Reflection = -32.5 dB
Total Loss = 4.87 dB

RF Cable and Antenna System Test

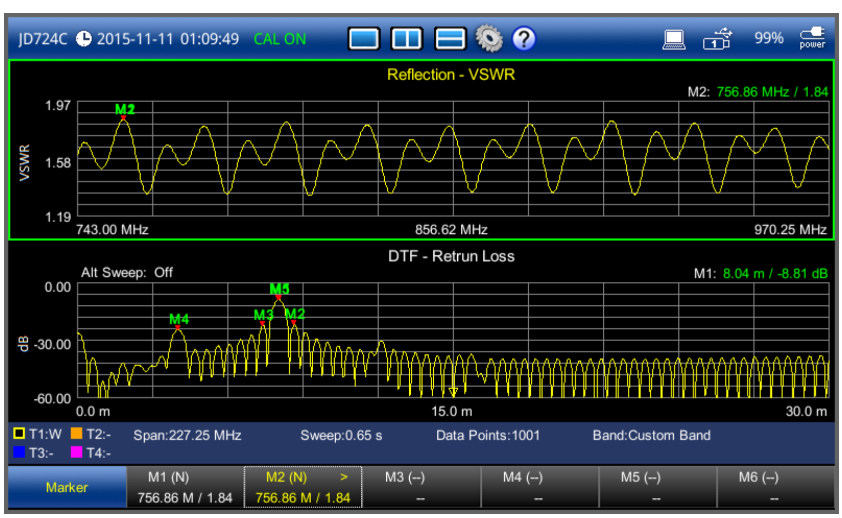
Return Loss

Return loss is the loss of power in the signal returned/reflected by a discontinuity in a transmission line. This discontinuity can be a mismatch with the terminating load or with a device inserted in the line, and is a measure of how well devices or lines are matched. If the impedance match is good, all the energy will be transmitted through and nothing should be reflected.



VSWR

Just like return loss, the VSWR test also indicates how well the cable and antenna system is matched. VSWR stands for Voltage Standing Wave Ratio, and is also referred to as Standing Wave Ratio (SWR) and is a measure of how efficiently RF power is transmitted from the power source, through the transmission line, and into the load.

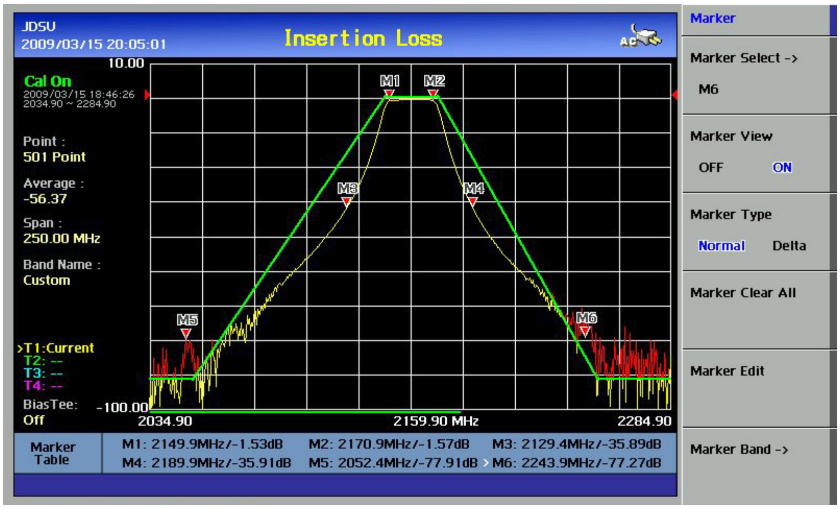


Distance to Fault (DTF)

DTF measurements, typically expressed in units of reflection coefficient, return loss, or VSWR as a function of distance, are used to find common faults in cable and antenna systems. It measures the distance-to-fault along the various system components of the transmission line in order to determine the location(s) of excessive reflections measured. Basically, a built-in source sends signals through the antenna and cable system and looks for reflection back to pin point the fault location caused by poor connections, damaged cables, or faulty antennas.

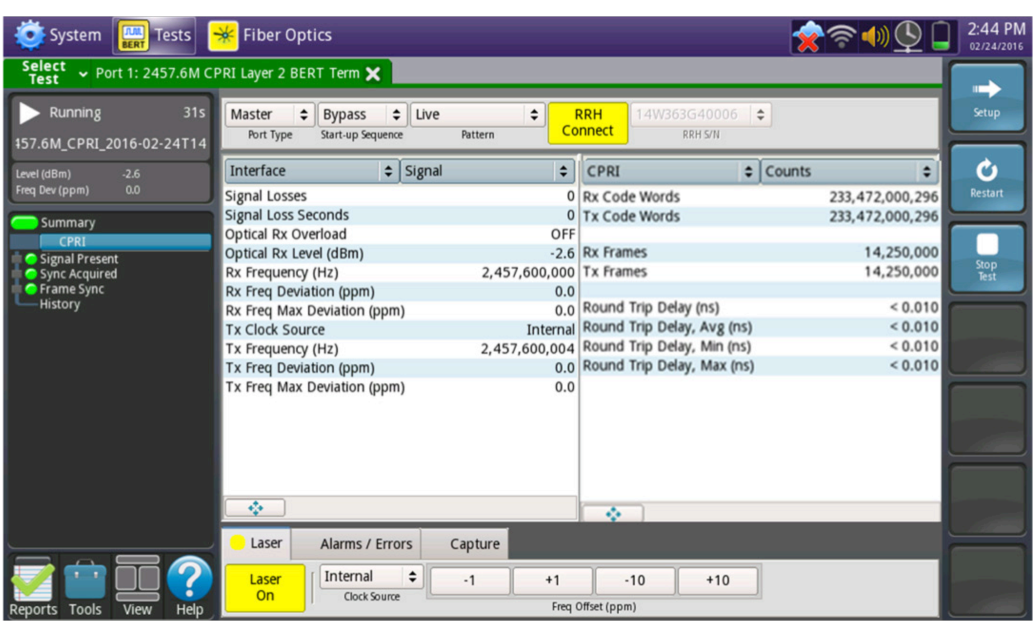
Insertion Loss or Gain Test

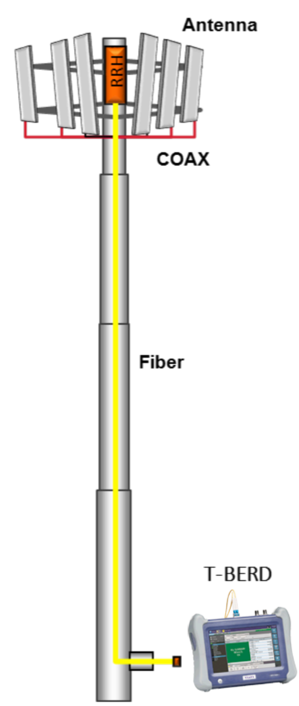
Insertion loss is the loss of signal power resulting from the insertion of a device in a transmission line and is usually expressed in decibels (dB).



CPRI (Fronthaul) Installation Test

CPRI protocol enables the RRH and BBU to interact with each other over distances of several miles. When installing RRHs on towers and rooftops, it is extremely important to test the RRH links before connecting them to the BBU for service activation. Incorrect small form-factor pluggable (SFPs) and misconfiguration/faulty RRHs will disrupt the service, and necessitate the costly return of tower crews and delay the service introduction. The CPRI test checks the power level and signal frequency, initiates a CPRI connection with the RRH, verifies frame synchronization, and measures the roundtrip delay to the RRH. All of these tests can be done from a single location without the need to dispatch a person to the remote site and perform a loopback at the RRH.

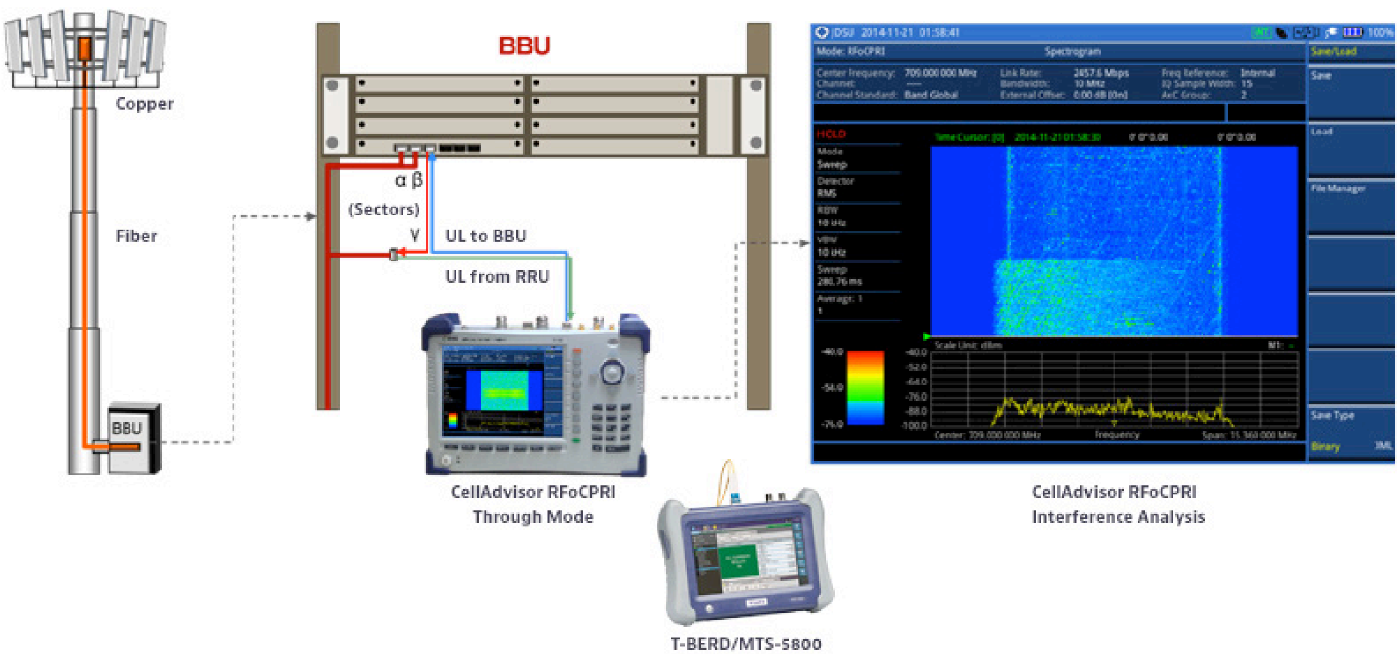




RFoCPRI Troubleshooting or Maintenance Test

Passive Intermodulation (PIM) and interference continue to represent major sources of problems in the field. Testing RFoCPRI allows users to verify PIM and interference from any location that provides access to a CPRI test port. Viavi's CellAdvisor Base Station Analyzer and/or T-BERD/MTS-5800 can be placed in monitor mode between the RRH and BBU, and perform spectral analysis on antenna carrier channels (AxC) embedded in the CPRI signals between the RRH and BBU. The spectral analysis identifies PIM issues and interferers that can be caused by coaxial connections between the RRH and antennas or by external sources. RFoCPRI testing has significant benefits, including:

- Eliminates cell tower climbs and improves safety
- Minimizes the number of test instruments needed
- Significantly reduces maintenance time and operational expenses



Backhaul Testing

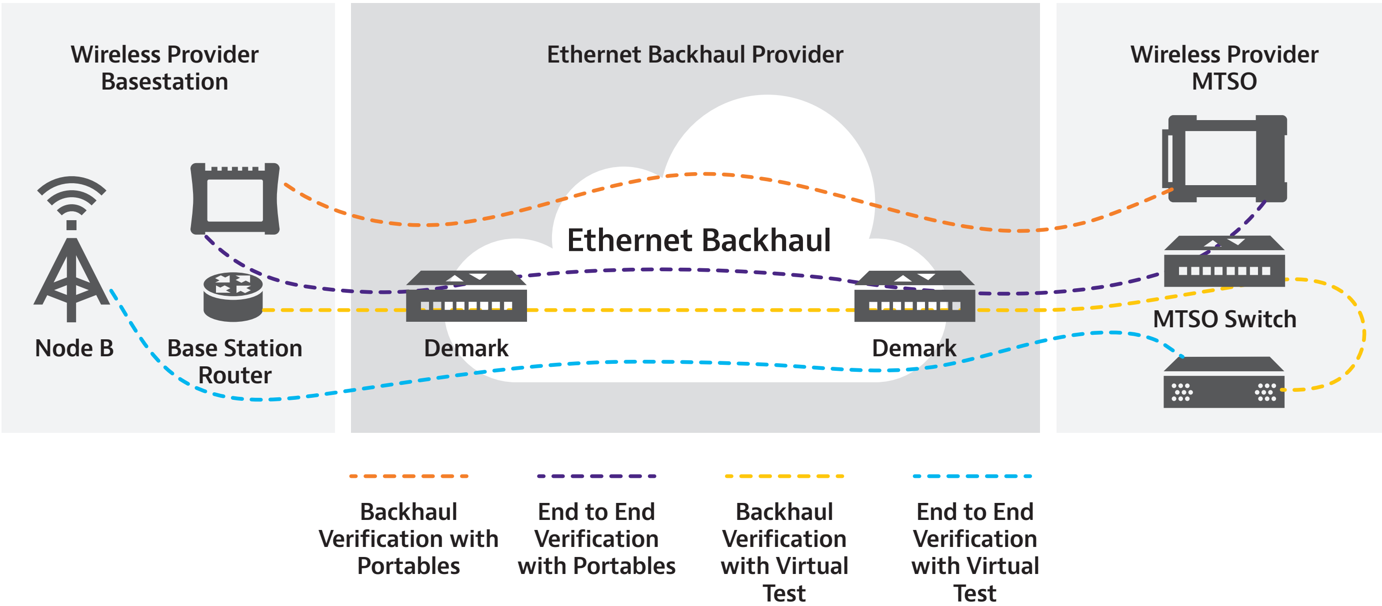
We described "front-haul" as the fiber link between the BBU and RRU. "Backhaul" then, is the link between the BBU and the mobile switching center in the core of the network. That backhaul link, which is usually Ethernet, is used to transmit and receive user voice and data traffic as well as control-plane information to coordinate with other cells in the area. Some of the same types of tests must be performed on the backhaul, including the cleanliness of the fiber connectors (fiber microscope), and the integrity of the underlying fiber back into the network (OTDR). Then the transmission performance of that link must be tested to ensure a robust connection to the mobile switching center. The key tests include:

RFC 2544 or Y.1564

These tests validate end-to-end configuration at either the Ethernet or IP level (depending on the backhaul network specifics) to ensure that key performance objectives such as Committed Information Rate (CIR) , Committed Burst Size (CBS), latency, packet jitter, and frame loss are met. Techs can select either RFC 2544 or Y.1564 to test a single service or select Y.1564 to test multiple classes of service.

RFC 6349 TrueSpeed™

An RFC 6349 test checks end-to-end throughput using TCP traffic to ensure that the network provides the expected throughput without causing retransmissions that place additional strain on the limited wireless spectrum and cause poor end-user qQoE.



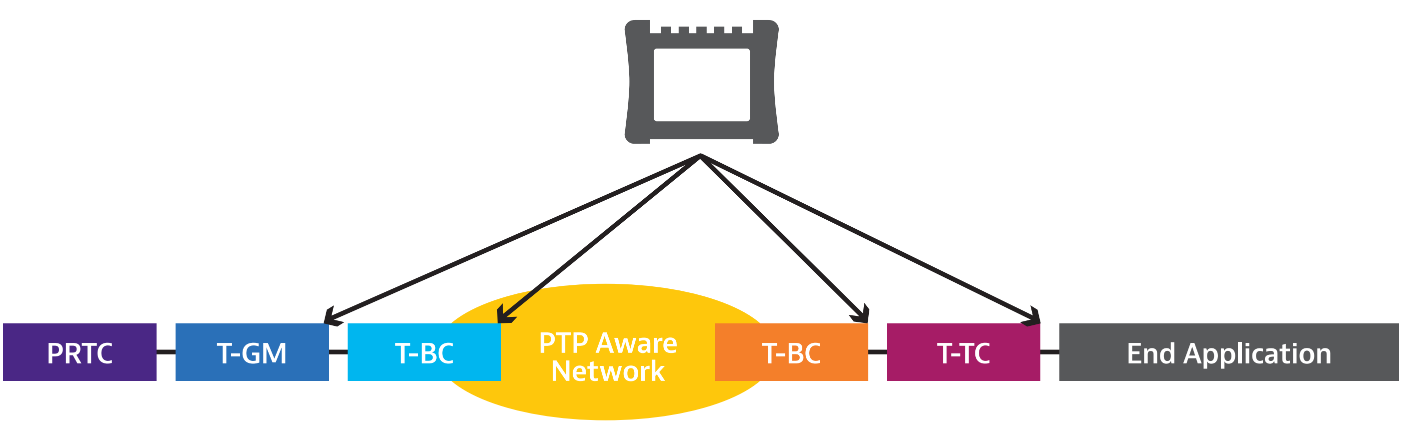
Lastly, the BBU gets its timing reference from the synthesized timing interface, which could be one of several signals such as 1 PPS, E1, T1, 2 MHz, or 10 MHz. The accuracy and stability of this timing reference directly determines the accuracy of the frequency transmitted on the air interface. Poor frequency synchronization of theair interface can lead to interference with neighboring cells, and lead to dropped calls and poor data throughput. The key tests to perform are:

1. Time offset and wander measurements on 1 PPS signals
2. Wander measurements on E1, T1, 2 MHz, 10 MHz signals

Synchronization Test

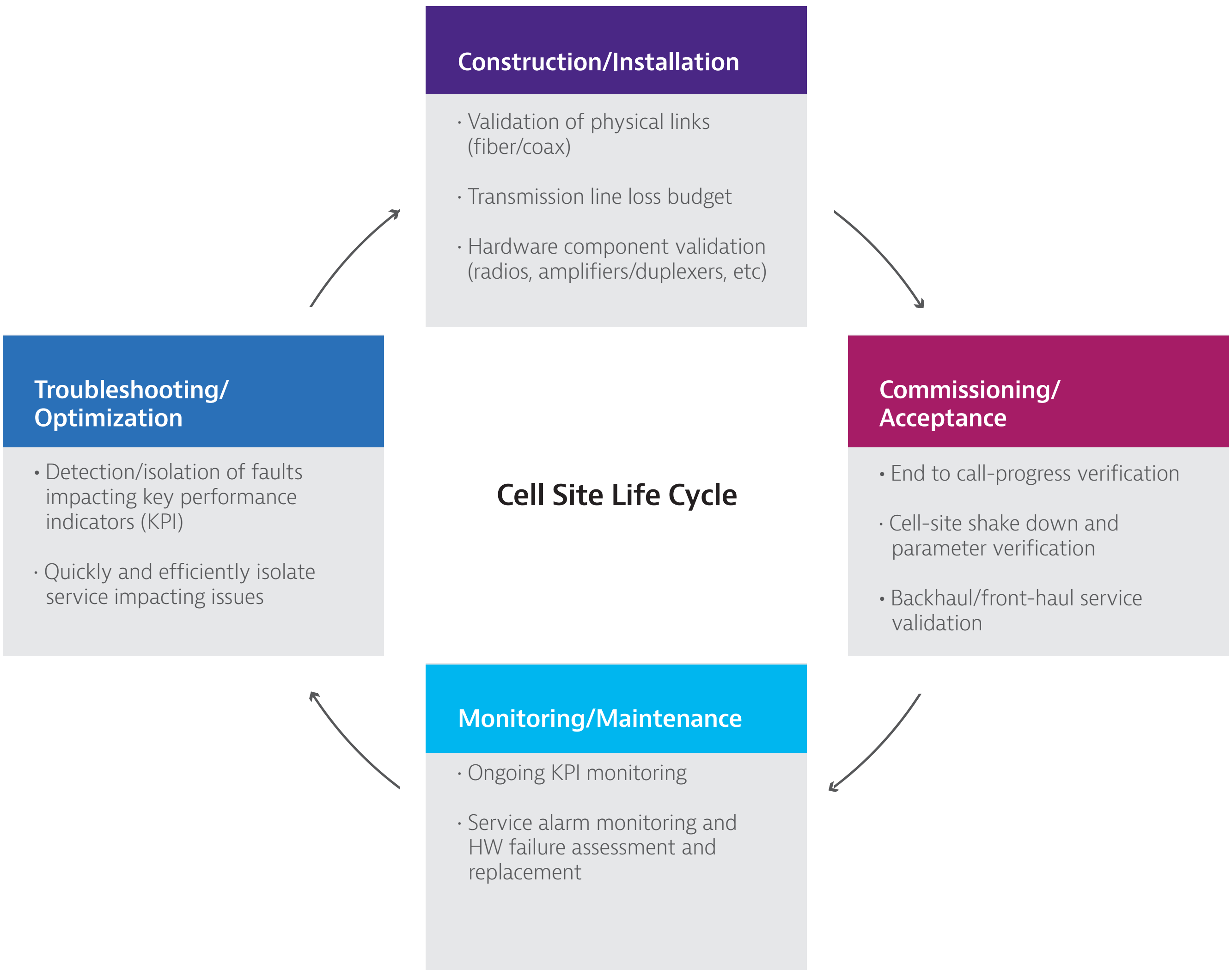
Operation of mobile networks requires proper delivery of frequency and time/phase synchronization to the cell site. GPS and packet-based synchronization technologies such as PTP/IEEE 1588v2 and Synchronous Ethernet represent the synchronization delivery mechanisms. Incorrect synchronization delivery leads to severe operations issues, including interference and call-handover problems.

New methodologies provide simple synchronization tests on the same instruments used for backhaul and fronthaul test. GPS test applications verify the correct position of antennas by checking the number of visible satellites and respective signal strengths. PTP/IEEE 1588v2 test ensures reliable connection of cell sites to Grandmasters and qualifies the backhaul network for proper delivery of synchronization by checking delay, delay variation, time error, wander and frequency offset of PTP, Synchronous Ethernet and 1pps/10MHz/BITS/SETS clock signals.



Viavi’s Comprehensive Cell-Site Test Solutions

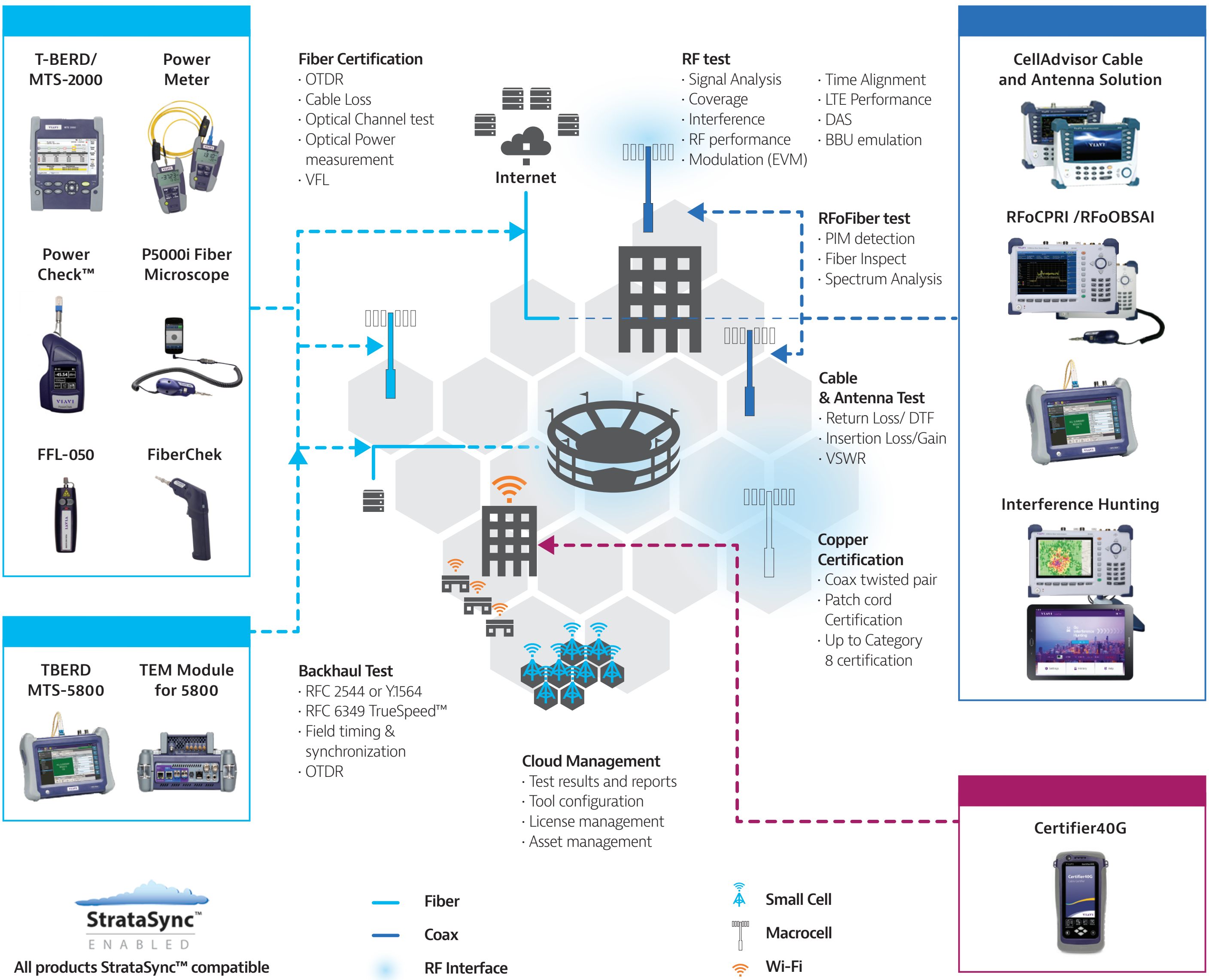
Viavi has been working closely with mobile service providers to create comprehensive test solutions for installing and maintaining Heterogenous Networks (HetNets).



Our solutions cover every aspect of HetNet deployment and maintenance, from fiber installation to RF optimization, and everything in between.

Viavi's Surround the Antenna Solution

Viavi's comprehensive Surround the Antenna solutions are designed to streamline workflows and simplify operations with centralized inventory and test equipment management, and consistent presentation of results. Capitalize on market demand and manage operational costs with Viavi tools that help you turn up towers quickly, safely, and efficiently.



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