White Paper
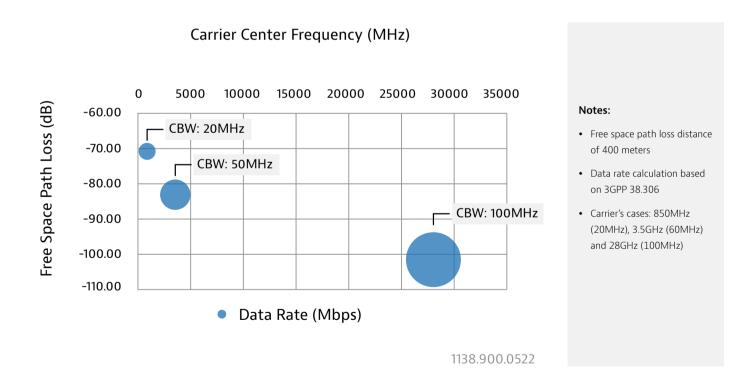
5G in Mid-Band – RAN Validation

OneAdvisor 800 Wireless

5G is being delivered in multiple formats and frequency bands to increase user experience into different areas, coverage, and capacity, for example 5G implementation in low-bands (e.g. < 1 GHz) provides great coverage but spectrum is fragmented with channels typically 5, 10, 15 or 20 MHz wide, limiting capacity; and 5G in high-bands (e.g. >24GHz) provides great capacity with channels 100MHz wide or greater, however coverage is limited due to high propagation and penetration loss. Therefore, 5G in mid-bands (e.g. 1 to 7 GHz) creates a significant opportunity to deliver high capacity with adequate coverage.

Carrier Center Frequency (MHz)

CBW: 20MHz

CBW: 50MHz

CBW: 100MHz

Free Space Path Loss (dB)

Data Rate (Mbps)

Notes:

- Free space path loss distance of 400 meters
- Data rate calculation based on 3GPP 38.306
- Carrier's cases: 850MHz (20MHz), 3.5GHz (60MHz) and 28GHz (100MHz)

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5G Coverage and Capacity

The standards have defined different 5G mid-bands for cellular services, capable of supporting carriers with transmission bandwidth higher than 20MHz, including the following:

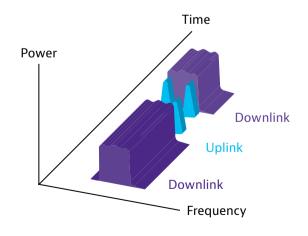| NR Operating Band	Uplink (UL) Band [MHz]	Downlink (DL) Band [MHz]	Duplex Mode
n1	1920 to 1980	2110 to 2170	FDD
n2	1850 to 1910	1950 to 1910	FDD
n7	2500 to 2570	2620 to 2690	FDD
n25	1850 to 1915	1930 to 1995	FDD
n38	2570 to 2620	2570 to 2620	TDD
n39	1880 to 1920	1880 to 1920	TDD
n40	2300 to 2400	2300 to 2400	TDD
n41	2496 to 2690	2496 to 2690	TDD
n46[1]	5150 to 5925	5150 to 5925	TDD
n48	3550 to 3700	3550 to 3700	TDD
n50	1432 to 1517	1432 to 1517	TDD
n65	1920 to 2010	2110 to 2200	FDD
n66	1710 to 1780	2110 to 2200	FDD
n74	1427 to 1470	1475 to 1518	FDD
n77	3300 to 4200	3300 to 4200	TDD
n78	3300 to 3800	3300 to 3800	TDD
n79	4400 to 5000	4400 to 5000	TDD
n96[1]	5925 to 7150	5925 to 7150	TDD

Notes:

1. This band is restricted to operation with shared spectrum channel access

Special interest has been made on newly allocated spectrum, which is not fragmented, offering continuous frequency for high bandwidth delivery, those bands are:

• Band n48 also referred as Citizens Broadband Radio Services (CBRS)

• Band n77, including C-Band allocating 3.7 to 3.98 GHz

The common characteristic of these bands n48 and n77 is that its duplex transmission mode is time division duplex or TDD, where radios (downlink) and mobiles (uplink) are transmitting on the same center frequency but at different timeslots.

The different timeslots are defined by the frame configuration, which is applied throughout the radio access network to avoid inter-cell interference.

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TDD Duplex Communication Mode

The radio access network (RAN) should be properly validated to avoid multiple site revisits, network impairments, and negative user experience. RAN validation covers the following key aspects of the radio access life cycle:

- RAN Deployment, includes effective methodologies to properly install and integrate radios, minimizing site revisits and network impairments.

- RAN Operation, covers two main aspects of efficient radio communication, first, maximizing throughput of both segments, air interface and transport: and second, eliminating any RF interference.

The VIAVI OneAdvisor 800 has been perfectly designed to verify and troubleshoot radio access networks for proper deployment and effective operation.

VIAVI OneAdvisor 800
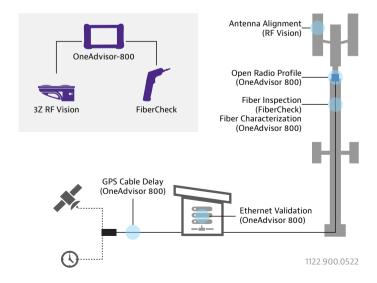All-in-One Solution for RAN Validation

RAN Deployment

Radio deployments are done in two main phases:

- Radio installation, performing the site construction, mounting radios, routing fiber cables, and setting power infrastructure.

- Radio integration, configuring radios, establishing connectivity to the network, enabling transmission over-the-air, and performing call tests.
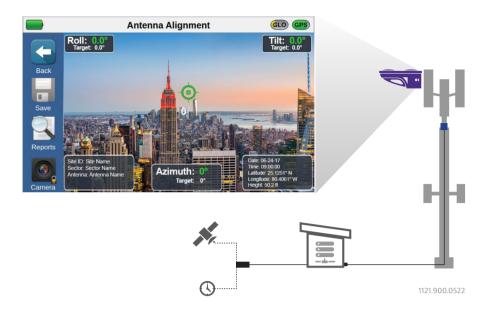
Radio Installation

There are different radio types related to different capacity demand, including small cells, micro cells, and macro cells; and application including indoor and outdoor, covering manufacturing, distributed antenna systems (DAS) and enterprises such as Private 5G.

The common installation aspects for 5G mid-band radios of any type and application are:

Radio Installation

Antenna Alignment (RF Vision)
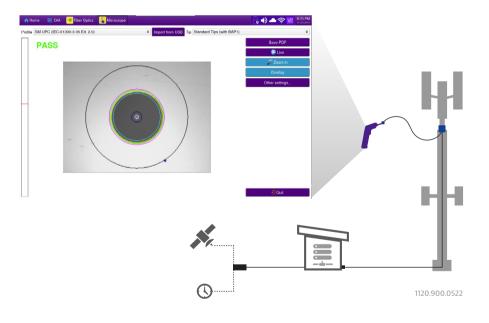

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Key Benefits

Easy and accurate antenna alignment of 5G and microwave antennas per RF design specifications with line-of-sight survey, dual-frequency GNSS technology, and secure report generation.

Ensure radio coverage according to network planning:

- Match antenna alignment with RF design
- Maximize voice quality and data traffic
- Improve data user throughput and KPIs
- Reduce OPEX, and churn
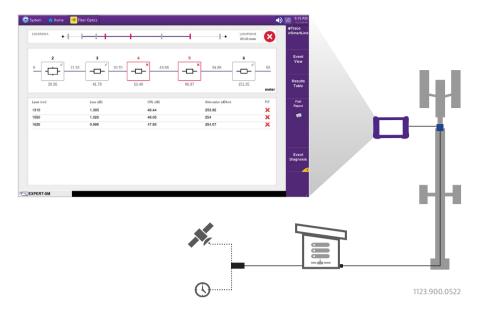
Fiber Inspection (FiberCheck)

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Key Benefits

Fiber inspection with built-in image viewing, auto-focus, pass/fail analysis against standard fiber connector endface quality and storing/recalling results.

Avoid connectivity impairments, and signal degradation due to low optical power at the radio:

- Minimize power loss on connectors, ensure optical power budget is available for growth, fiber extensions, or maintenance.
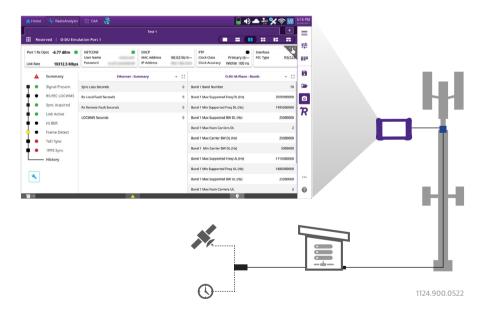
Fiber Characterization (OneAdvisor 800 and OTDR)

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Key Benefits

OneAdvisor with OTDR provides full fiber characterization and location for any in-line elements of a fiber link.

Assess continuity and power loss across the optical link:

- Certify low power loss in the optical link.
- Verify continuity and identify location and contributors of elements exhibiting excessive power loss.

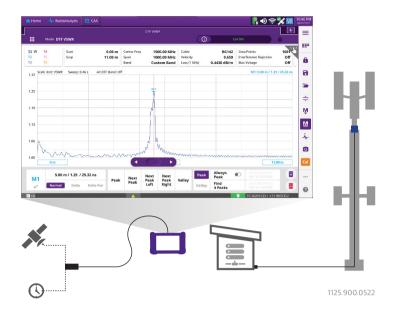# Open Radio Profile (OneAdvisor 800):

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Key Benefits

Open radio unit (O-RU) profile verification with OneAdvisor with O-DU Emulation.

Eliminate site revisits and radio's Non-Trouble-Founds verifying the radio's profile:

- Verify proper optical power levels are received by the radio.
- Validate compatibility of SFP installed in the radio.
- Ensure proper radio type, model, and software is installed.
- Verify proper time and synchronization is set on the radio
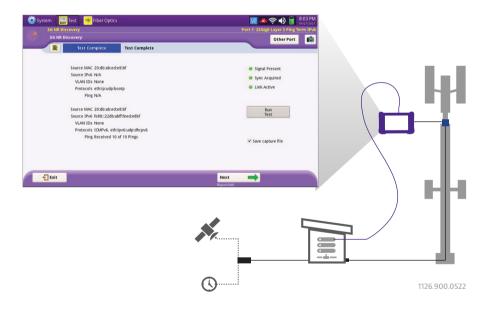
Radio's Time Delay Setting (OneAdvisor 800)

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Key Benefits

Cell site synchronization and timing setting (GPS cable delay).

Cell Site GPS Cable Delay.

- Verify proper conductivity of GPS cable
- Obtain cell site GPS cable delay to set as a time offset in the radio configuration.

Radio Ethernet (OneAdvisor 800)
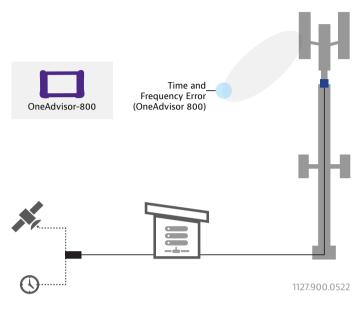

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Key Benefits

5G network discovery validating ethernet connectivity.

Verify Radio's Ethernet Connectivity.

- Verify radio's connectivity to the network.
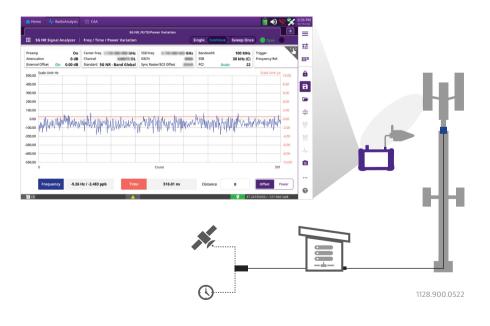- Validate Ethernet link address and signal response

Radio Integration

Radio integration consists of radio configuration, backhaul connectivity and RF transmission. In the case of TDD radios the frame configuration (Downlink and Uplink timeslots) should be the same, and proper synchronization and timing should be applied to avoid inter-cell interference that causes commercial service degradation such as call drops and retransmission.

Radio Installation

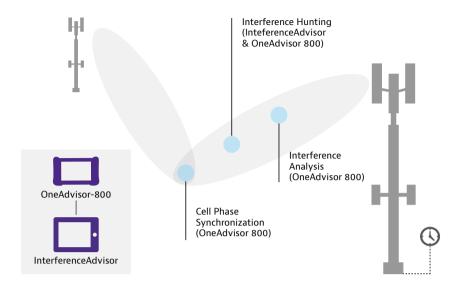## Radio Sync and Timing (OneAdvisor 800):

Key Benefits

5G Signal Analysis verifying the stability and variation of the radio's synchronization and timing.
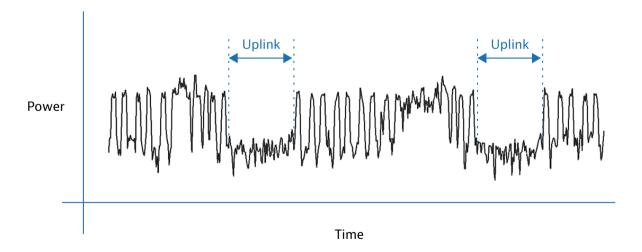
5G Frequency and Time Variation.

- Certify radio's 3GPP conformance of time (1.5µs) and frequency (0.05ppm) stability against primary reference source (GPS).

- Avoid inter-cell interference and network impairments due to excessive timing or synchronization offset
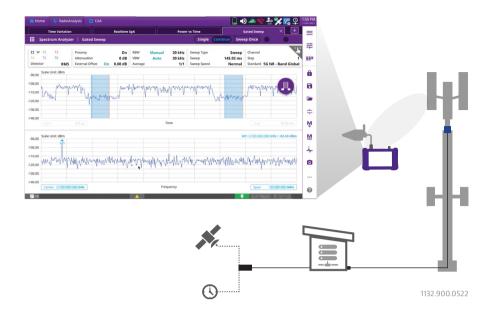
RAN Operation

Radio Maintenance

The most common factor that negatively affects mobile services is RF interference, most importantly affecting mobile's transmission or uplink. In the case of 5G-TDD, mobiles and radios are transmitting in the same frequency, but in different timeslots, therefore interference analysis needs to be done on the uplink timeslots triggering or gating spectrum measurements.

TDD Uplink Timeslots

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5G-TDD Interference Analysis

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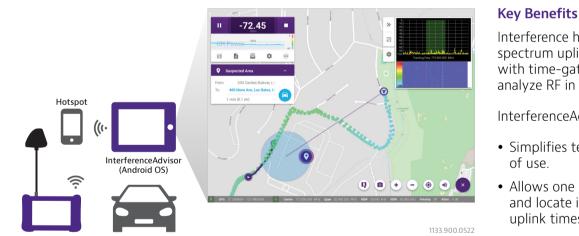
Key Benefits

5G-TDD interference analysis is done with time-gated spectrum to analyze RF in uplink timeslots.

Dual-Gated Sweep Analysis.

- Identifies the presence of interference in uplink timeslots.
- Increases the probability of intercept with dual-gated time windows for interference analysis.
- Characterizes the interference profile to be set for the interference hunting process with InterferenceAdvisor™.

5G-TDD Interference Hunting

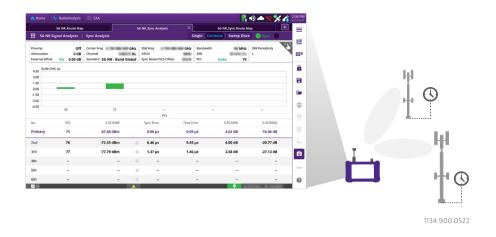1133.900.0522

Key Benefits

Interference hunting of time-gated spectrum uplink analysis is done with time-gated spectrum to analyze RF in uplink timeslots.

InterferenceAdvisor™ for 5G-TDD.

- Simplifies test setup for ease of use.
- Allows one RF engineer to identify and locate interference in 5G-TDD uplink timeslots.
- Automatically generates a heat-map of the interference power level during a drive test.
- Gives optional navigation instructions to the detected location of interference.

5G-TDD Cell-Phase Synchronization

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Key Benefits

Ensure proper synchronization and timing is transmitted over the radio access network to avoid inter-cell interference.

Cell Phase Synchronization Verification.

- Certifies proper synchronization between cell sites (< 3μs).
- Avoids inter-cell interference (downlink overlaps with uplink of adjacent cell site).
- Automatically displays PASS / FAIL indicators.
- Easily identifies the cell site (PCI) out of synchronization.

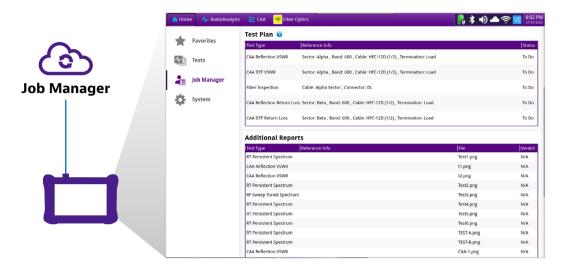# Test Process Automation with Job Manager and StrataSync

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

- In accordance with mobile operator's test criteria.
- Coverage of all radio types (LTE and 5G) and topologies (Macro-cell, Small-cell, C-RAN, and/or DAS).
- Test results are automatically uploaded into StrataSync cloud with simple PASS/FAIL indicators.

Job Manager

VIAVI Job Manager automates test processes, offers mobile network operations and cell site construction teams a self-guided test solution, and improves 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.
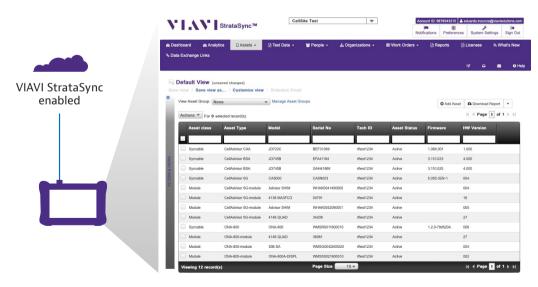
Job Manager

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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.

VIAVI StrataSync enabled

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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

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StrataSync – Asset Management

References

1. GSMA Estimating the mid-band spectrum needs in the 2025–2030 time frame, July-2021
2. 3GPP TS 38.104 V17.3.0 Base Station (BS) radio transmission and reception
3. 3GPP TS 38.306 V16.7.0 User Equipment (UE) radio access capabilities
4. VIAVI Brochure – OneAdvisor 800 Wireless; All-in-One Cell-site Installation and Maintenance Test Solution

VIAVI Solutions

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