VIAVI Solutions

Application Note

Importance of Testing Public-Safety Mobile Networks

Public Safety communication has evolved over the last couple of decades. Significant strides have been made in the public safety community to ensure first responders are provided with the right communication tools to improve their emergency response capabilities.

In 2012, U.S Congress enacted the Middle-Class Tax Relief and Job Recovery Act of 2012 (Spectrum Act) which:

- Directed the Commission to allocate the D-Block (758–763 MHz / 788–793 MHz) to public safety for use in a nationwide broadband network; and
- Formed the First Responder Network Authority (FirstNet) as an independent authority within the U.S. Department of Commerce. FirstNet is charged with responsibilities for deploying and operating the nationwide public safety broadband network and will hold the license for both the existing public safety broadband spectrum (763–769 MHz/793 799 MHz) and the reallocated D Block.
- Allocated up to $7 billion dollars to FirstNet to construct this nationwide public safety broadband network.

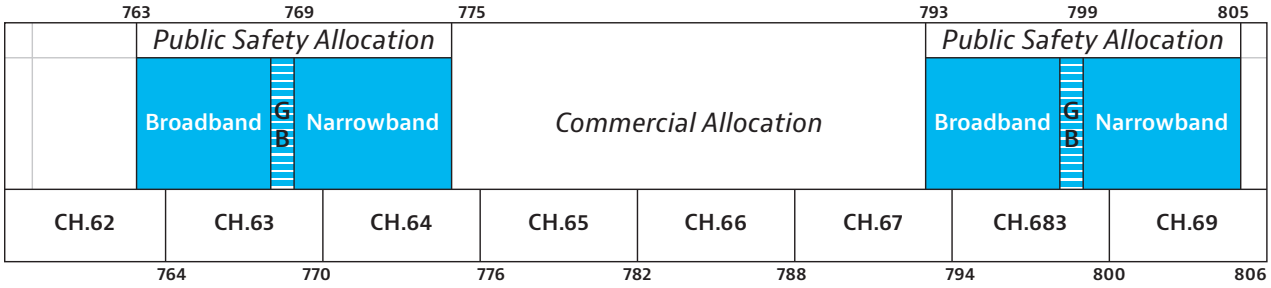
FirstNet Mission

To deploy, operate, maintain, and improve the first high-speed, nationwide wireless broadband network dedicated to public safety. This reliable, highly secure, interoperable, and innovative public safety communications platform will bring 21st century tools to public safety agencies and first responders, allowing them to get more information quickly and helping them to make faster and better decisions.

FirstNet™

The following figure depicts spectrum allocated for public safety in the 700 MHz band after enactment of the Spectrum Act:

700 MHz Band Plan for Public Safety Services



The key fundamentals for the FirstNet program are to deploy a reliable, interoperable and innovative broadband network that equips first responders across the U.S., with tools to help save lives, solve crimes and keep our communities and emergency responders safe. The technology specified for this new network build on band class 14 will be in compliance with the minimal technical requirements of commercial LTE technology.

Today, first responders use land mobile radio (LMR) networks for mission-critical voice communication. LMR networks are designed to meet emergency responders' unique mission-critical requirements and provide guaranteed priority access to responders. FirstNet plans to offer mission-critical voice services over the **nationwide public safety broadband network** NPSBN – along with video and data – when voice over LTE functionalities meet or exceed first responders' mission-critical needs.

But to get to a state where first responders can use the commercial LTE networks for mission-critical voice and guaranteed priority access, networks need to be tested throughout the life cycle, from lab through deployment. Capacity-limiting situations under emergency conditions need to be tested to ensure that during an actual emergency scenario, first responders have priority access and can perform their duties without any delays or network anomalies.

VIAVI works with wireless service providers and operators of wireless networks around the world to help them plan, deploy, maintain and optimize throughout the network life cycle. Testing and assurance during the life cycle significantly reduces Capex and OpEx and improves quality of service. Some of the key areas of testing can be summarized as follows:

1. Test and validation during the planning stage:

Validating networks in the lab environment allows service providers to improve service deployment time, enhance service quality and reduce problem resolution time in the field. Proper planning and design ensures coverage and capacity requirements are met. Hotspots and critical network areas are discovered and remedied, and during network load condition testing resources are prioritized per specific application and user type.

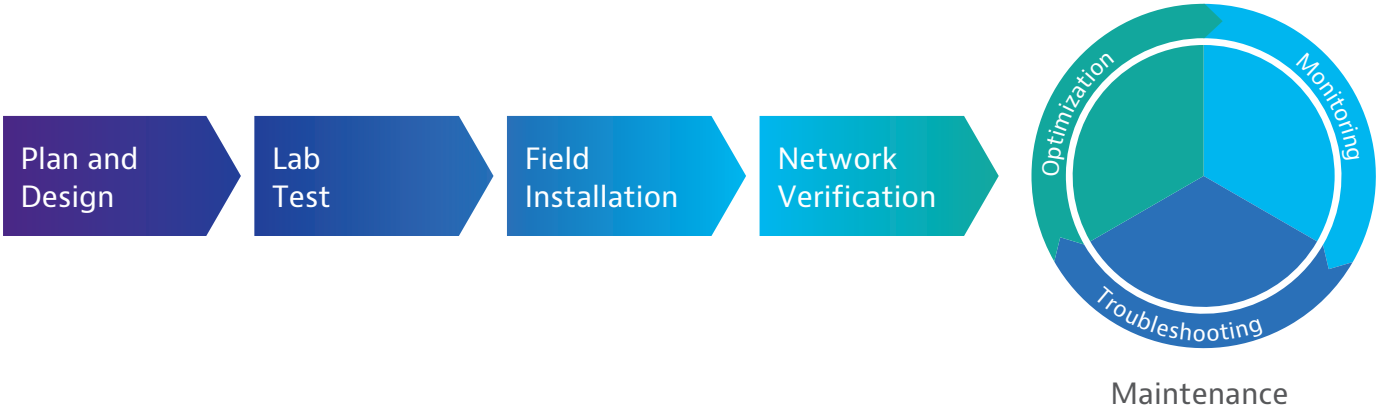


Figure 1: Network Life Cycle

2. Service integration and activation testing:

Deploying a wireless network is a complex process and requires installing and commissioning several network nodes from the core of the network through the backhaul to eNode-Bs. Multiple physical interfaces such as fiber, copper, and RF are used for voice and data exchange. In modern mobile networks, distributed radio access network (RAN) architectures have allowed the deployment of diverse types of cell sites including macro cells, distributed antenna systems (DAS), centralized RAN (C-RAN), and small cells. This has further complicated the deployment process as different cell sites may require different skill sets for validation and service activation. Ensuring that every component and interface of the network is working per design is essential to guarantee the best QoS and maximum return on investment (ROI).

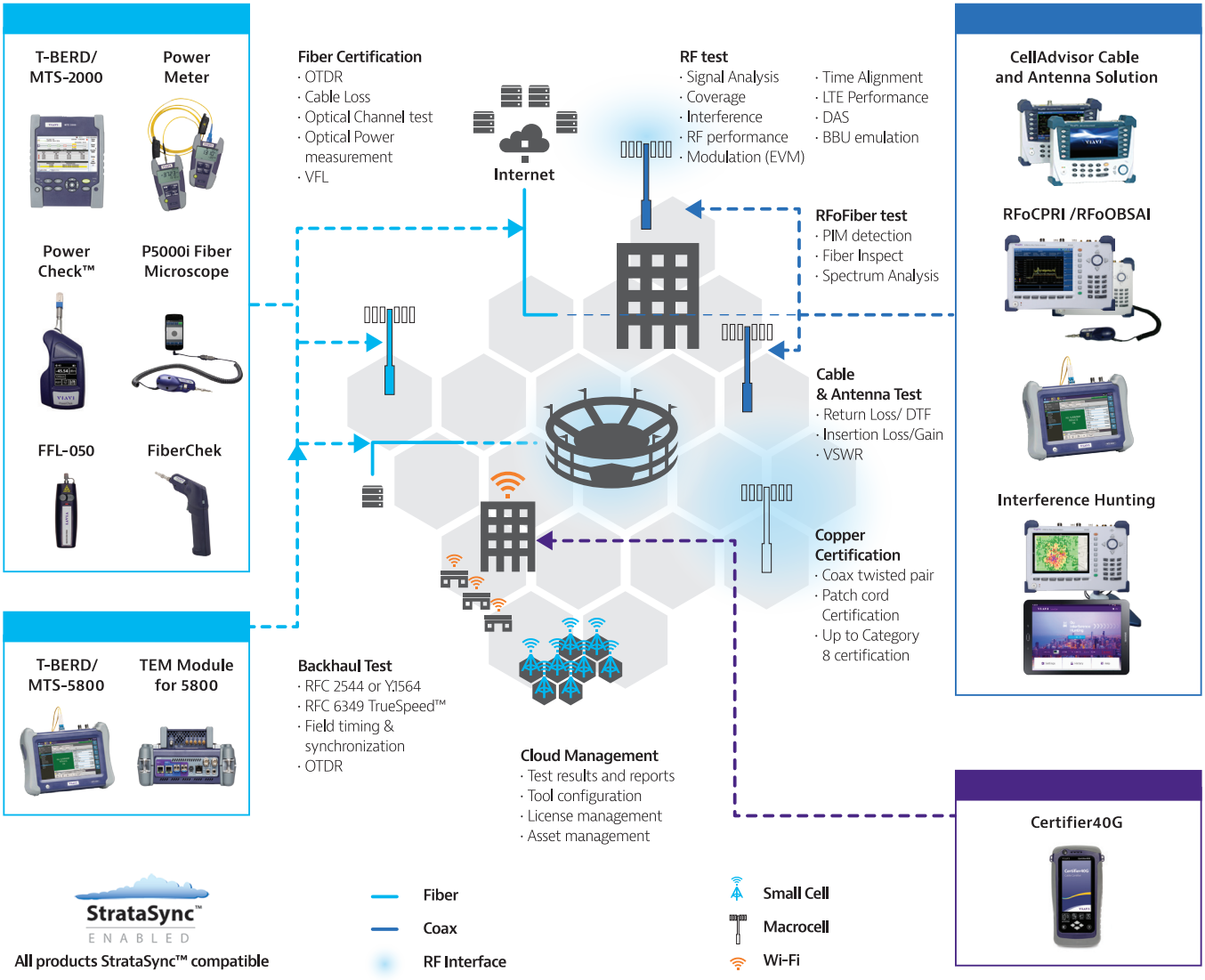


Figure 2: VIAVI Cell-Site Deployment solution

3. Network maintenance:
Network Performance monitoring and assurance allows operators to accelerate the detection and diagnosis of network service outages and degradations in performance. It also helps operators focus on troubleshooting activities which are truly impacting their customers and to meet service level agreements (SLA).

The following reviews some of the key test and assurance solutions and the related applications that can streamline the overall deployment and management of complex mobile networks. Deploying a new network or overlaying a network with new channels offers a different set of challenges compared to just adding capacity or coverage for an existing network, especially when the overlaid network is sharing the same physical resources with different types of users and services.

Planning and Lab Testing:

To make FirstNet economically viable, RF spectrum and network resources must be shared with a network partner who could use excess spectrum capacity for regular users and services. First responder use will be prioritized and other users will be preempted if necessary. In this scenario, proper testing needs to be done to ensure that in an emergency where there is a sudden demand on the network resources, FirstNet users' access to the network and their applications such as voice and data are, in fact, prioritized over regular users and applications. These scenarios need to be properly tested in the lab before the network goes into production to avoid any catastrophic outcomes.

VIAVI's CapacityAdvisor is an industry-proven solution that can help validate mobile networks against emergency situations. CapacityAdvisor offers an ultra-high density solution with realistic UE emulation and traffic generation capability for different type, priority and distribution of UEs. With VIAVI's CapacityAdvisor, service providers can perform advanced load testing and performance validation in the lab environment to emulate real-world scenarios by taking the following steps:

Step1: Setting up the test environment with the number of cells in service, bands in use such as band class 14 for FirstNet, and number of carriers.

Step 2: Defining subscriber groups, such as first responders with the highest access priority, extended primary users, and general public with the normal access priority.

Step 3: Generating different types and thresholds of traffic; example, best-effort Internet, email, VoLTE, emergency VoLTE, video streaming, etc.

Step 4: Simulating a network emergency, creating sudden, high-user demand with commercial and public safety traffic.

Step 5: Evaluating and validating network performance and QoS and configuring overload thresholds to control traffic balance.

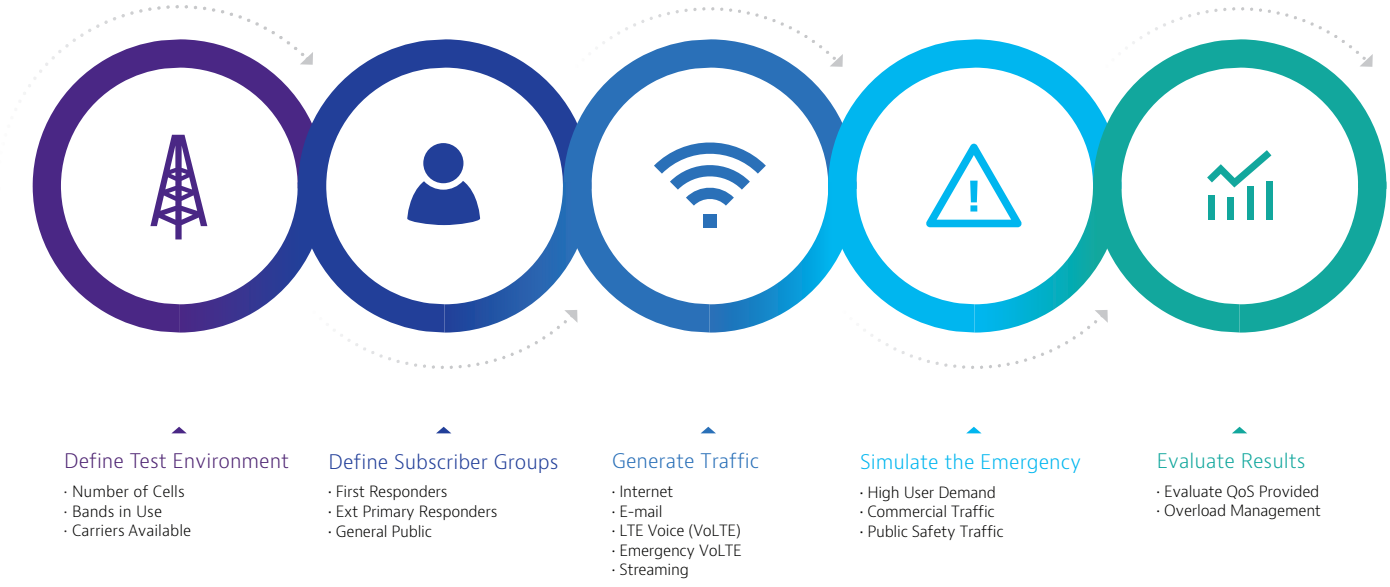


Figure 3: VIAVI CapacityAdvisor Lab Solution

Performing capacity, traffic management and performance test in pre-production lab networks improves service deployment time.

Another key part of network planning is correctly identifying coverage and capacity issues. In a mobile network, over 50% of the data is typically consumed in less than 1% of the network area so having the ability to predict and identify network hotspots can significantly reduce CAPEX. Adding network capacity at the right location can significantly improve ROI and improve QoS.

VIAVI's Location Intelligence solution captures all events, all calls, all locations, all the time and provides a clear network map of location where service is inadequate. Using this information, RF planners can accurately drive solutions to overcome network service gaps.

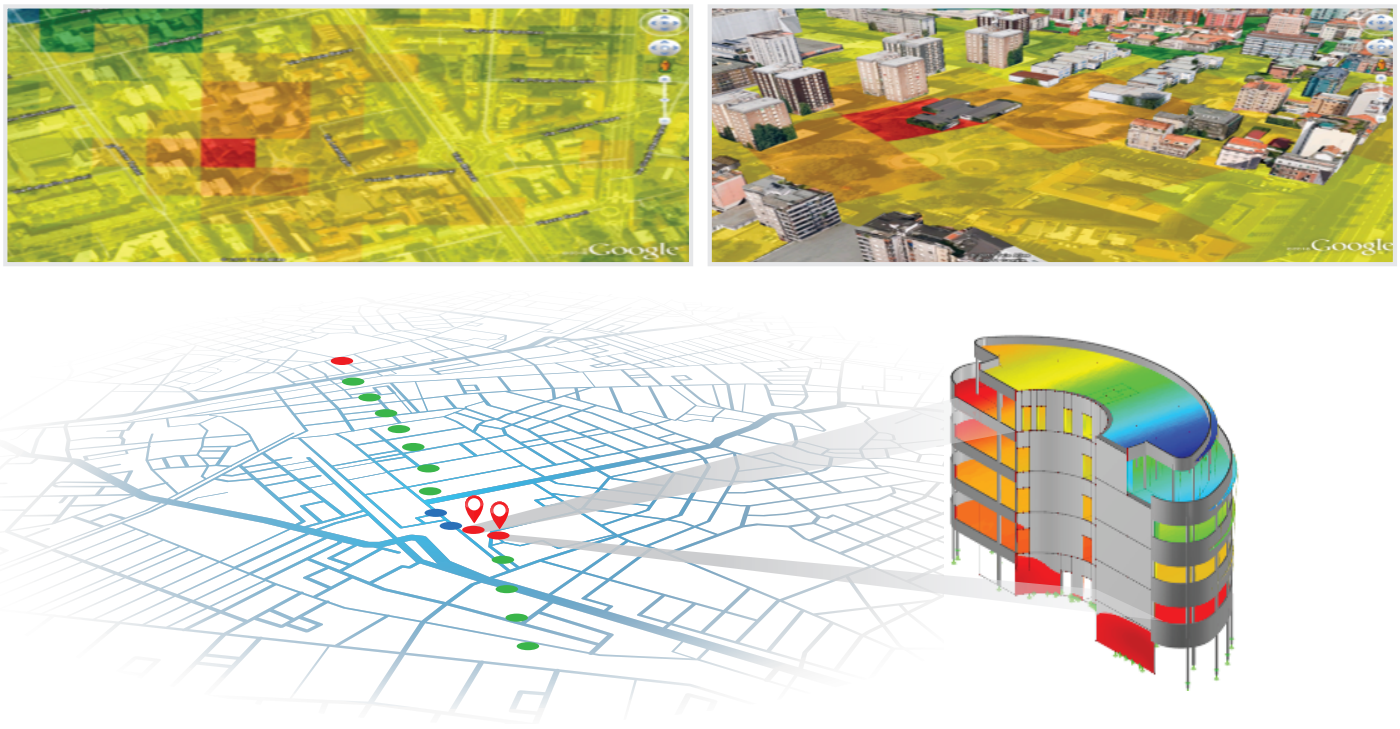


Figure 4: VIAVI LI solution example identifying poor service areas

Installation and Commissioning

Failure to maintain quality standards during cell site construction can delay revenue realization and can significantly impact subscriber experience, causing potential for churn. To prevent this from happening, all cell site deployments must follow a strict high standard of quality. All cables and connectors, whether coax, fiber, or twisted pair, must be thoroughly certified, and every active and passive component in the antenna and cable system must be properly tested and performance-validated.

Service providers work very closely with network equipment manufacturers (NEMs) and contractors to ensure all cell sites are installed with the highest quality and all fiber, coax and RF interfaces are tested and validated to ensure maximum ROI and QoS.

VIAVI Solutions offers comprehensive wireless installation and commissioning solutions designed to streamline workflows and simplify operations with centralized inventory and test equipment management, and consistent presentation of results. Our instruments and meters offer high durability, ease of use, fast and accurate results, a best-in-the-industry warranty, and are approved by most tier-1 service providers.

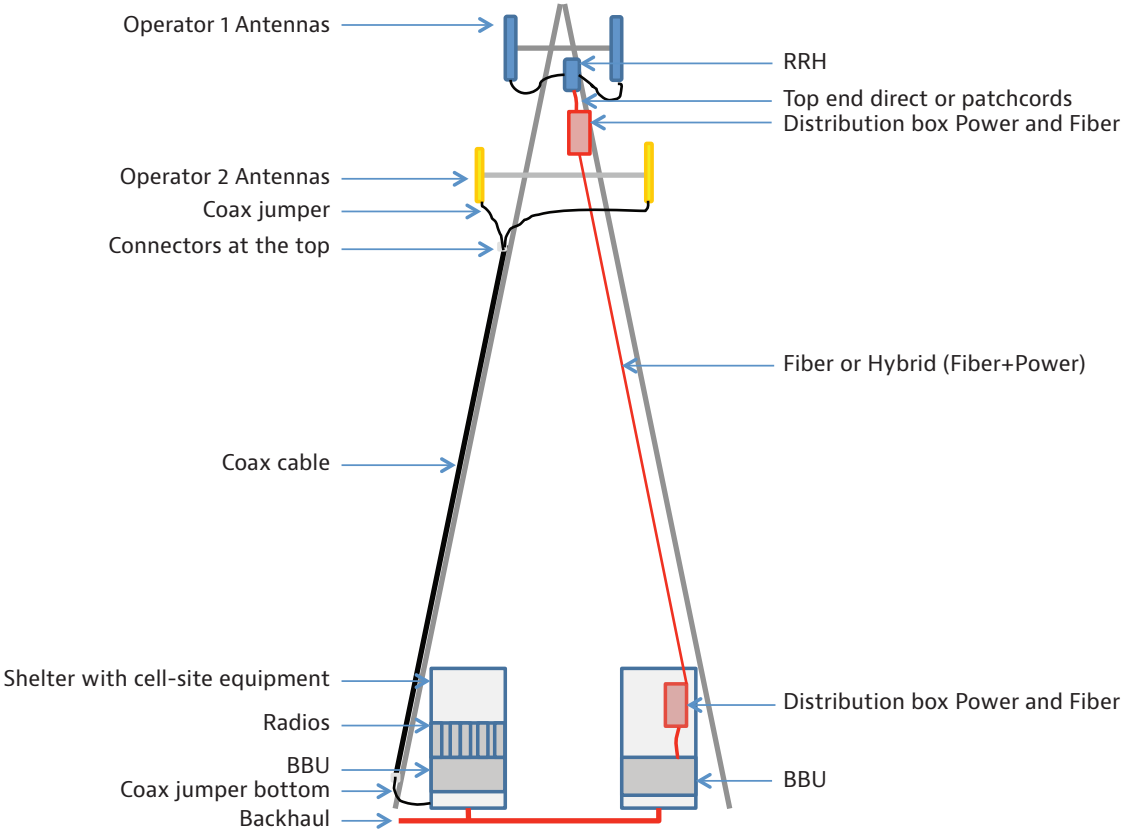


Figure 5: Common cell site structure and components

Cell Site Deployment Tests Explained

The following table describes the distinct role of each test, as well as the VIAVI enhancements that provide unique, valuable advantages:

Cell Site Installation	Description	VIAVI Advantage
Inspect before you connect	· Fiber connector end face inspection, cleaning, and certification	· Complete jobs faster, correctly, and on time—the first time · Eliminate subjective guesswork with pass/fail analysis results · Easily generate certification reports · Test solutions are approved by major service providers · Wizard like UI simplifies test configuration and results interpretation. · VIAVI offers a best-in-the-industry warranty that gives you peace of mind and demonstrates our commitment to our customers
Fiber Certification	· Insertion Loss measurements (IL) · Optical Return Loss measurements (ORL) · OTDR testing	
Fronthaul Validation	· CPRI Installation Test · BBU Emulation Test · Link characterization of CWDM/DWDM routes · BERT test	
Cable and Antenna system verification	· Return Loss · VSWR · Distance to Fault (DTF) · Insertion Loss	

RF Validation

Once the network is built and basic functionality testing is completed, comprehensive system and node-level testing along with inter-operability testing is essential to ensure network accessibility and availability is per design specification. As part of RF testing, it is necessary to validate the RF environment to ensure cells are deployed in the optimal locations and that they are optimized for most efficient operation.

Performing a cell-level drive test or walk test (AKA shakedown) and a system level test can help validate RF performance of the network. Emergency services need guaranteed communications, both outdoor and indoor, so validation of RF coverage and service capability within complex buildings (malls, airports, skyscrapers, stadiums) is also a must-have. Typical RF validation tests will include:

- RF layer tests to ensure that the deployed equipment will not interfere with other existing 700 MHz LMR, PSCR systems
- Service coverage validation
- Outdoor and indoor scenarios (Ingress and egress handover verification).
- Intra-cell and Intercell handover verification
- Public-safety application tests (video, data)
- Performance tests (throughput, latency etc.)
- Load test cases to validate first responder priority service access and regular user pre-emption.

Network Maintenance and Performance Management

As discussed earlier, modern wireless networks have evolved from networks that used to rely mostly on macrocells to heterogeneous networks (HetNets) which employ diverse types of cell sites such as small cells, distributed antenna systems, pico cells, and C-RAN. This is done to provide the right mobile experience in terms of capacity and coverage. Managing HetNets with several types of physical interfaces and technologies adds to the overall complexity of maintaining a mobile network.

Once a network goes into production, operators constantly monitor, troubleshoot and optimize network performance to ensure they are getting the best ROI on their investment and the network is delivering the best QoS for the users. Not doing so can cause customer dissatisfaction, which can ultimately result in customer churn and lost revenue. The stakes are much higher in a public safety network where inferior service quality and missing guaranteed SLA targets for first responders can have catastrophic outcomes.

However, network maintenance and performance management can become extremely expensive if proper network management solutions are not used. The sheer scale and size of modern wireless networks demands workflow automation in maintenance processes and solutions. Operators are looking for effective test solutions that allow them to improve their workforce efficiency and safety, and at the same time reduce operational expenses like training and maintenance.

Generally, maintenance is performed by operations teams or managed service partners. Operations function is typically divided into three key areas:

RF Optimization Function: Responsible for monitoring network key performance indicators (KPI), performing drive test, collecting network call logs and analyzing and troubleshooting performance issues and identifying internal and external interference issues etc.

Network switch operations: Monitoring network alarms, troubleshooting network issues and implementing SW and HW changes as required.

Network field operations: Generally responsible for maintaining and troubleshooting cell-sites.

VIAVI works closely with mobile service providers and operators of wireless networks to create comprehensive test solutions for maintaining HetNets. Our solutions cover every aspect of HetNet deployment and maintenance, from fiber installation to RF optimization, and everything in between. Below is a summary of some of the maintenance solutions used by service providers around the world to quickly troubleshoot and manage mobile network performance.

VIAVI Location Intelligence Solution Suite

VIAVI's Location Intelligence solution captures, locates, stores and analyzes data from all subscriber events, giving operators a rich source of app-ware insight to significantly improve network performance and enrich the QoE. This subscriber-centric, app-aware intelligence creates a true understanding of the customer experience enabling monetization of the network and delivering automated network optimization.

CellAdvisor Base Station Analyzer

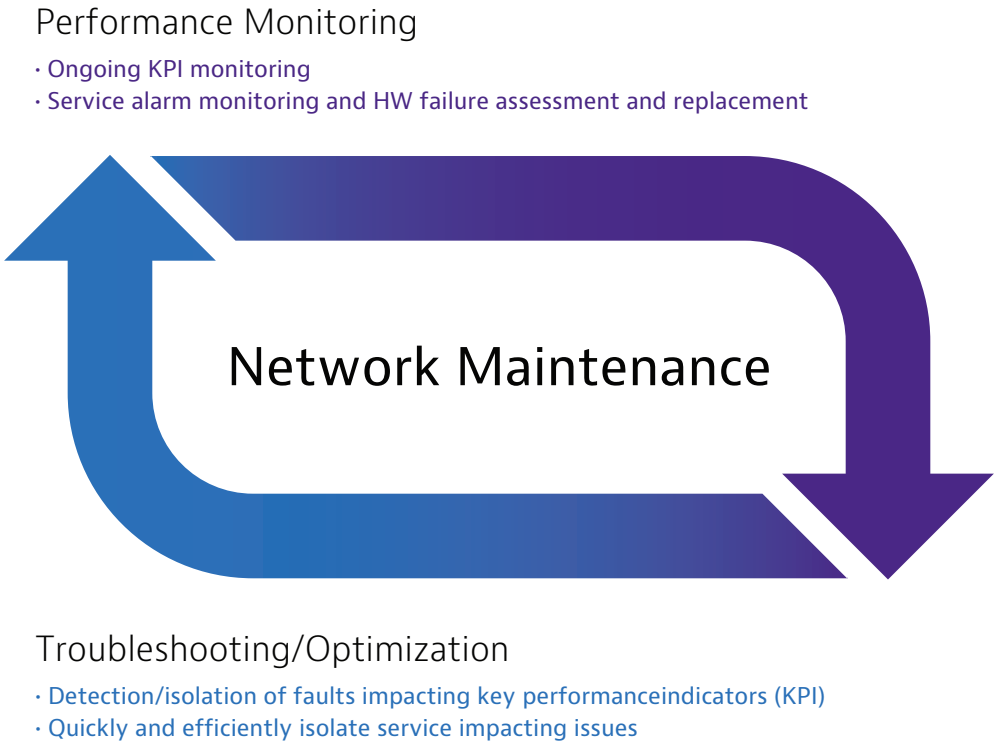
The CellAdvisor Base Station Analyzer is the optimal test tool for installation and maintenance of cell sites, supporting RFoCPRI and narrowband IoT testing, spectrum and interference analysis, and much more.

VIAVI Interference Hunting Solution

InterferenceAdvisor is the industry's best interference locating solution, allowing one engineer to quickly and easily identify any interference source, even in an urban environment. Investing in InterferenceAdvisor to deliver exceptional QoS can pay off quickly by improving customer retention and loyalty.

T-BERD®/MTS-5800

The T-BERD/MTS-5800 handheld network tester is the industry's smallest handheld instrument and can test throughout the service life cycle, including fiber characterization, service activation, troubleshooting, and maintenance. It also supports integrated timing and synchronization tests and fiber fronthaul test for both CPRI/OBSAI protocols.



Conclusion

Without rigorous testing of the whole network—RF, access, and core—operators cannot have confidence that a mobile network will work when it is most needed during emergencies when loading will be at its highest. VIAVI can help service providers gain the confidence from the point of inception throughout the network life cycle.

VIAVI has a portfolio of solutions addressing all components that must be tested in a network. Our heritage, people, knowledge, experience, and ethics make us the ideal partner to ensure successful deployment of emergency systems for public safety.

Related Links:

VIAVI RFoCPRI Page

VIAVI CellAdvisor

VIAVI T-BERD/MTS-5800

VIAVI FiberChek

VAIVI Interference Hunting

VIAVI Location Intelligence

VIAVI CapacityAdvisor

References:

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https://www.firstnet.gov/

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