RF Handheld Testers Guarantee Traffic Stability Under Olympic-Sized Stress Conditions

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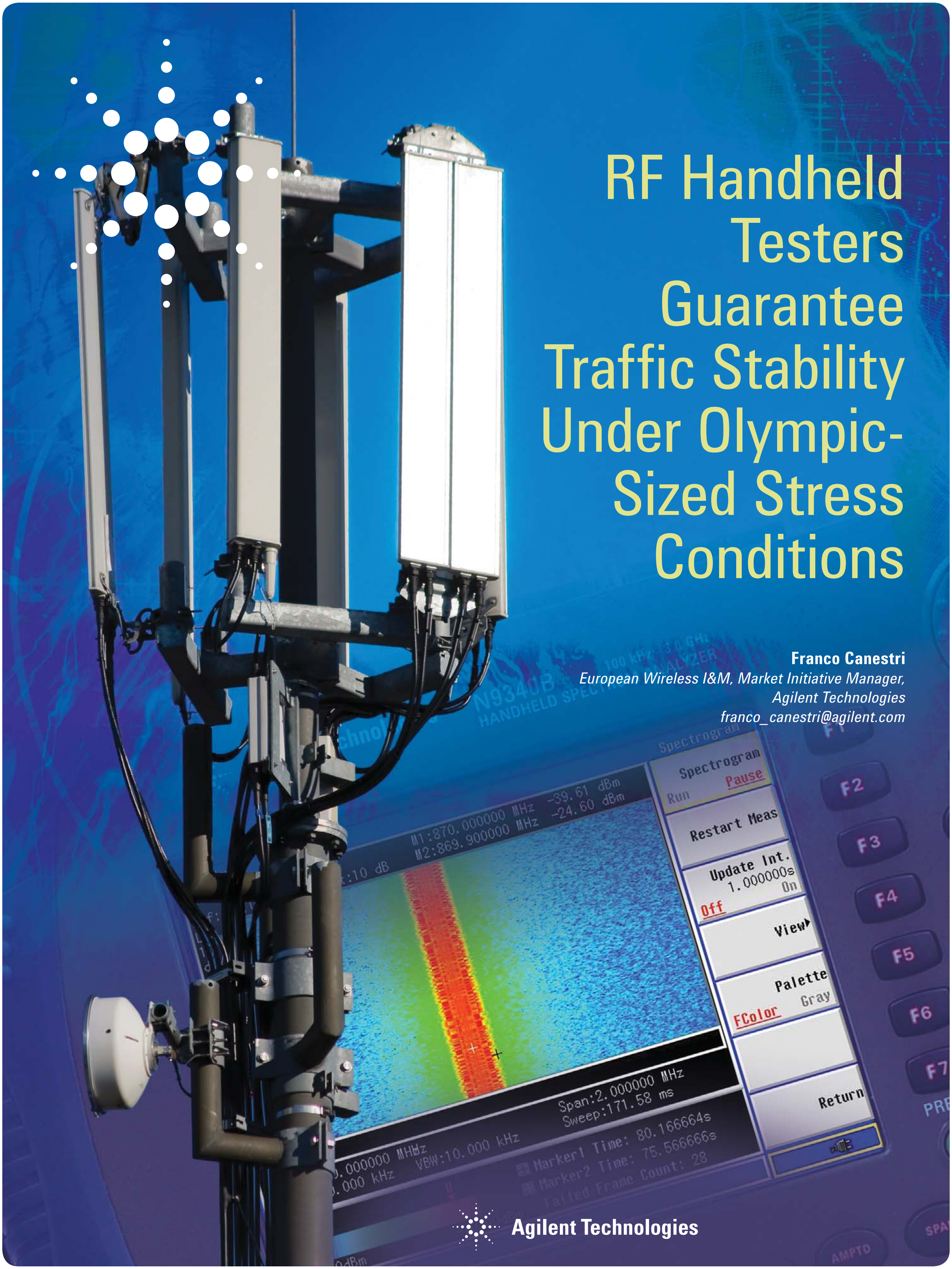

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Today's wireless service providers (WSPs) face a critical challenge — optimizing a network's signal transmission quality during long periods of time and in remote locations where RF base stations are beyond the reach of a control center. The challenge is greater when the network is under stress, such as during high traffic flow. Traffic overflow is prone to occur during mass events such as the 2008 Olympics where WSPs provided coverage to the large number of visitors arriving in the region all at once. They also had to continue to support coverage to the large population of China.

One way for WSPs to ensure the necessary level of optimization is through the adoption of installation and maintenance (I&M) processes. Successfully implementing these processes requires the use of suitable I&M tools, such as the handheld signal analyzer and cable and antenna tester (CAT). Both instruments are today essential for remotely ensuring optimized installation and operation of wireless networks in the field.

Monitoring RF networks

The great influx of people into China to attend the 2008 Beijing Olympics tested the current mobile telephony infrastructure and made appropriate network testing — especially in the field — absolutely critical. Such testing is necessary to ensure continuity and stability of service at a high level of signal quality and bandwidth. Because the Olympics were watched online by a very large worldwide audience, the risk of network downtime had to be avoided at all costs. Whether at the WSP's central location or in the most remote field locations, the network transmission quality and sustainability had to be kept under tight control around the clock.

I&M routines play a critical role in ensuring service continuity and stability. Figures 1 and 2 highlight, step-by-step, the procedures to be implemented in the physical design, creation and installation of an RF wireless network's hardware infrastructure (e.g., antennae, base stations and cabling) in the outdoor environment. Continuity testing ensures that end-to-end connectivity is established and the logical setup is correct, while long-term monitoring tests ensure network stability and verify its ability to deliver long-term, error-free operation. When performed without the proper equipment, these test routines can prove overly complex and cumbersome.

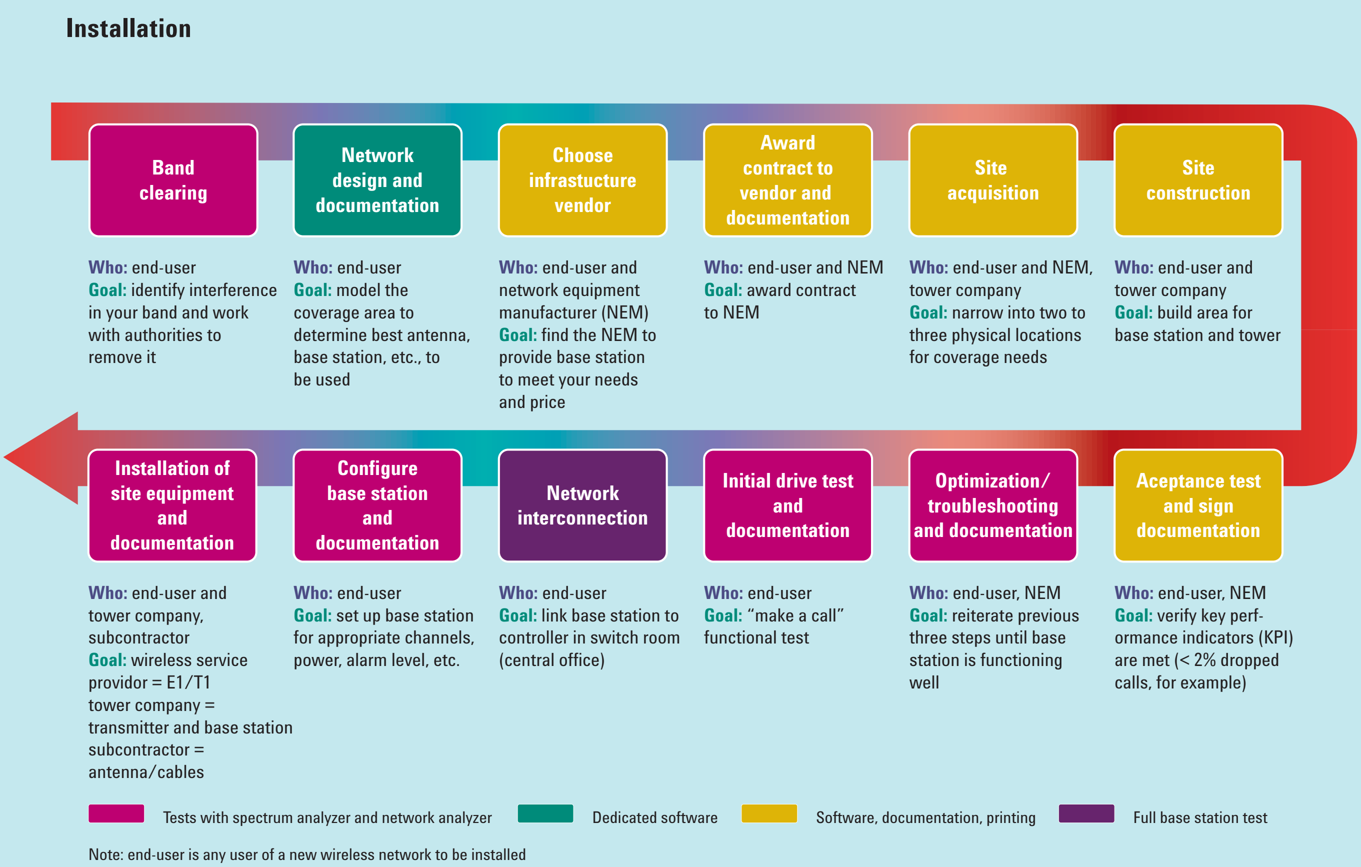

Figure 1. The flow of network installation routines

Among the I&M routines used for RF wireless networks, four are especially important:

- Configuring the hardware elements and software algorithms in a base station
- Testing the network interconnections of the hardware parts and their respective optimizations
- Conducting initial drive tests whereby a vehicle travels into the field to check the quality of received base station signals prior to authorization of network operation
- Final optimization, troubleshooting and documentation for acceptance tests

RF wireless networks are not the only emerging application requiring I&M procedures and each market segment (e.g., aerospace/defense, mobile and general purpose) is driven by its own unique set of needs (Figure 3). Therefore, all I&M procedures demand high levels of precision, reliability and timely execution to accommodate the emerging range of field applications.

Identifying suitable I&M solutions

According to a recent study, the current worldwide market for 3- to 4-GHz handheld signal analyzers is estimated to be around US$100 million. As a handheld solution, these simple, general-purpose tools are well suited to address the needs of the large population of users in wireless I&M applications and, in particular, RF networks. A prime example is the LAN-remote controlled spectrum analyzer, which offers a fast and efficient way to monitor key network parameters over long period. The data obtained from this instrument can later be recalled and analyzed using computer-assisted algorithms to provide an immediate and intuitive overview of the situation during installation of a network's hardware components. Because such instruments can be used to ensure broadcasting service quality in the field — during long periods of time and in critical situations — they are uniquely qualified to address the critical I&M routines previously detailed.

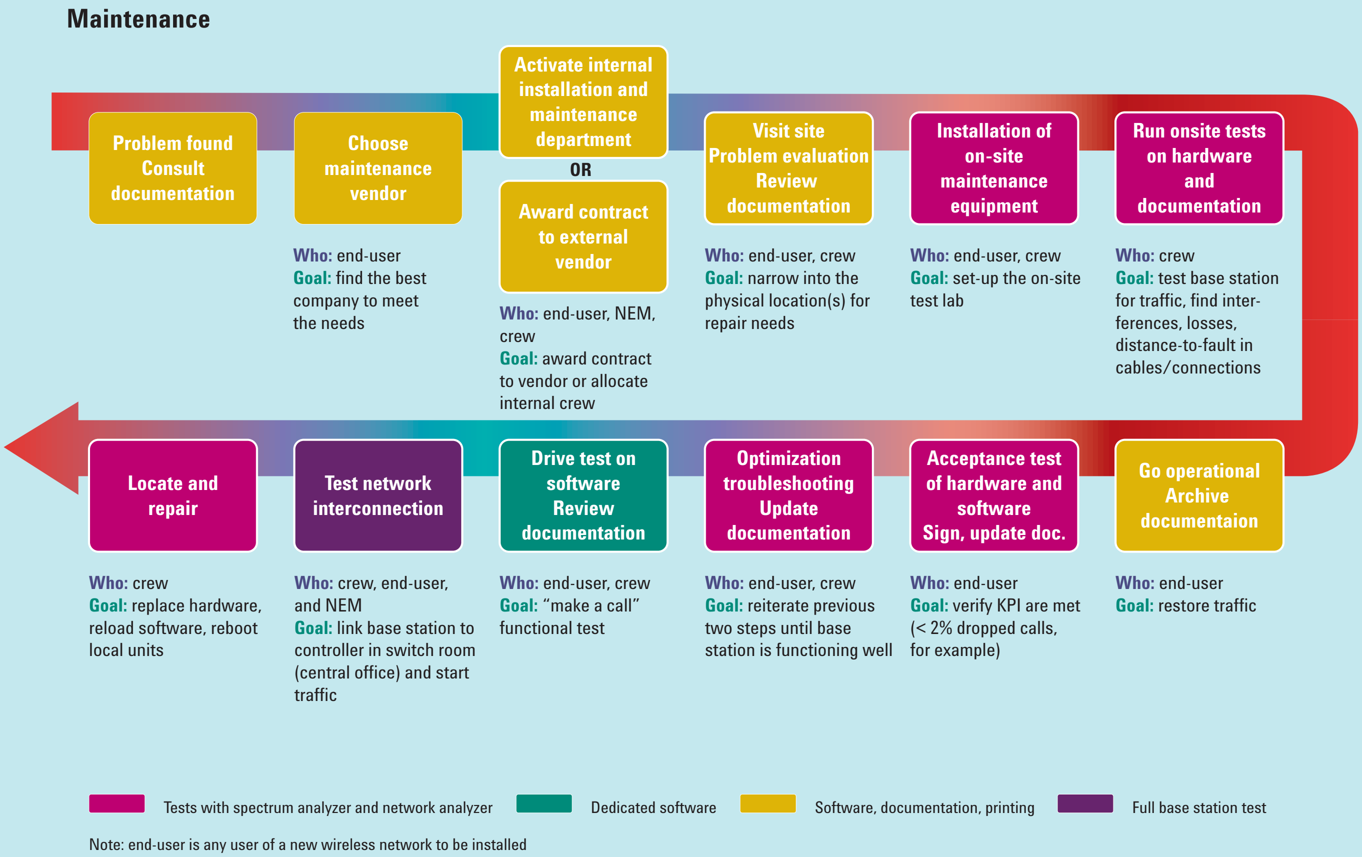

Figure 2. The flow of network maintenance routines, used as a main living document for multiple needs

Figure 3. Drivers in key installation and maintenance markets

Installation	Maintenance	
Sites and documentation are classified Highest accuracy and reliability in acceptance tests Fastest evolution of software and hardware Increase protection of data management	Super-fast maintenance procedures Preventive maintenance Constant data monitoring Increasing satellite/antenna accuracy Protection and classified issues	**Aerospace and defense**
Multiple technologies, challenging installation and maintenance procedures Base station becomes smaller, but more complex Operating frequency is getting higher	More complex functional tests are needed More applications More cell maintenance More antennas in a single site	**Mobile**
Five- to seven-year replacement period Basic technology only, preference on desk-tops	Low budget for repair	**General purpose** Education Low-cost NEMs
Low-cost bundles Fast throughput in production at lowest up-front investments	Longest warranty at best conditions Low-cost repair – extended warranty	ESMOG environmental medical telemetry Palmtop terminals Emergency services

When selecting an appropriate signal analyzer, I&M companies and subcontractors often look for a number of key features:

- Portability
- Light weight
- Ruggedized
- Superior testing quality
- Modern connectivity for easy data transfer
- Battery operated
- Low cost

The Agilent N9340B handheld spectrum analyzer is an example of one solution that effectively meets these requirements. In addition to these features, it differentiates itself with a range of measurement and monitoring capabilities that prove especially useful in wireless network I&M applications. The first such capability, the spectrogram, allows the service provider's field engineer to monitor transient signals that cause traffic interruption and disturbances, whenever and wherever desired. In the LAN-remote-controlled spectrum analyzer, color-coded spectrogram functionality saves data in both the frequency and time domains and collects sudden transient signals that interfere with the main carrier, causing severe and very costly interference to regular WSP traffic.

A spectrogram measurement and spectrum trace from an Agilent N9340B handheld spectrum analyzer is shown in Figure 4. The color-coded image of a recorded transient signal is depicted on the screen, with frequency range and monitoring time displayed on the horizontal and vertical axes, respectively. Color coding denotes the power associated with the recorded signal.

By activating and moving a marker on the spectrogram, either vertically (indicating a past moment in time) or horizontally (indicating a different frequency), the engineer can easily mark a portion of the signal of interest. With a single keystroke, the engineer can then toggle between the spectrogram and the actual spectral trace recorded at the moment of interest. In the left-most graphics in Figure 4 (the spectrogram), it is easy to find the intermittent interference signals at 1.806993478 GHz. A marker is placed on one interference signal. Using the spectrum trace view on the right, it is then possible to view the spectrum trace at that specific time. A spectrogram, therefore, is a powerful tool for the handheld spectrum analyzer, allowing the user to capture interference, especially intermittent signals.

Another useful capability for implementing I&M procedures is the spectrum emission mask (SEM), defined relative to in-channel power, which allows the engineer to monitor out-of-channel emissions. For added measurement flexibility, the user can specify a range of parameters including the main channel, out-of-channel frequency bands and tolerance limits.

Other important signal analyzer capabilities include the electrical field strength measurement and USB power sensor support, as well as demodulation analysis, which allows the engineer to see the service customer's actual demodulated signal. These capabilities, together with the ones previously cited, enable the engineer to perform a global field-test session on a signal for the purposes of monitoring, at very narrow resolution bandwidth (e.g., just a few hertz), the presence of disturbances next to the main carrier. When disturbances are identified, corrective measures can then be quickly and properly deployed.

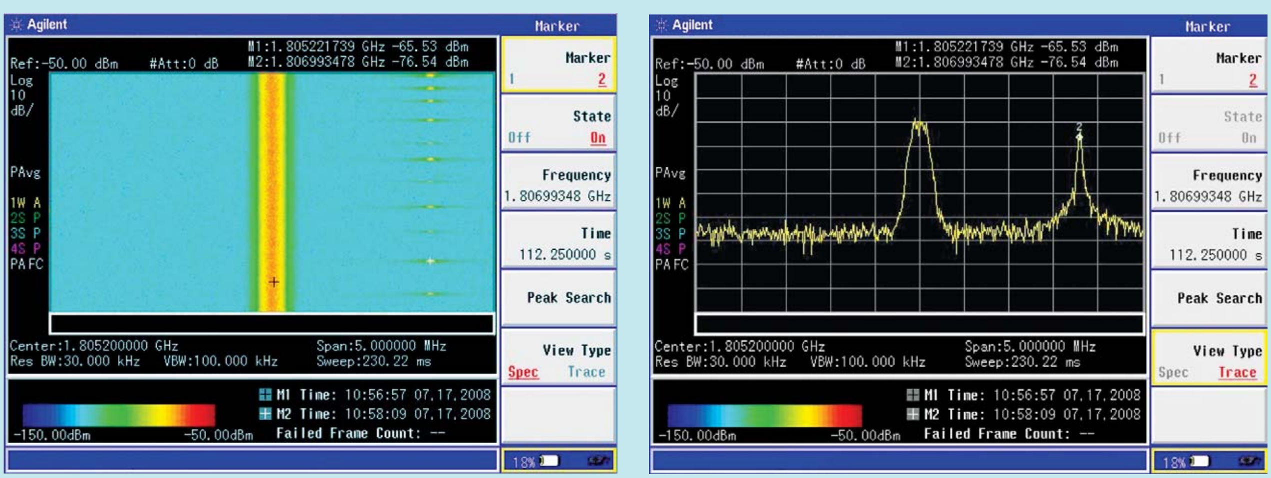

Figure 4. Spectrogram functionality as implemented in an Agilent N9340B handheld spectrum analyzer

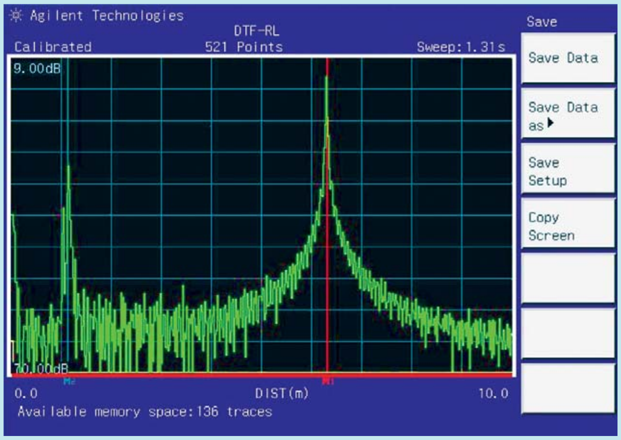

Figure 5. Example measurement screen from a cable and antenna tester system

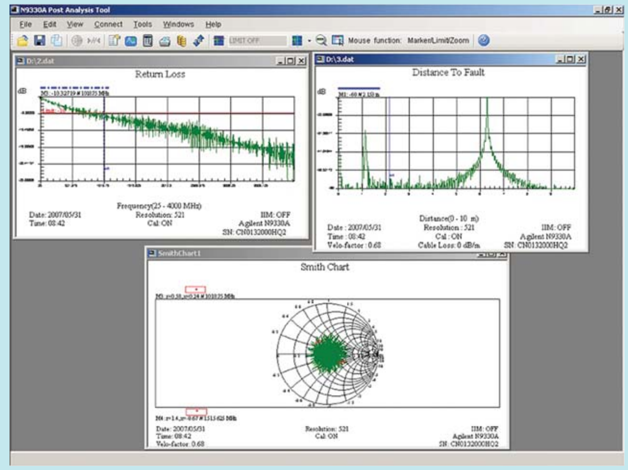

Figure 6. The Agilent Technologies N9330A post-analysis tool

Analyzing the CAT's role

The handheld cable and antenna tester plays a vital role in guaranteeing the quality of transmitted signals in the field to support wireless communications traffic. Working together with the handheld signal analyzer, it completes the full set of tools required to provide optimized hardware installation of cables and parts of the antennas (Figure 5).

One basic requirement for the ideal CAT is the ability to measure return loss in the field. Return loss is a measure of the signal reflection characteristics of the cable and antenna system. In S-parameter terms, it is referred to as an S_{11} measurement. To make the measurement, the handheld CAT (e.g., the Agilent N9330B) uses a signal generator to generate a swept RF signal which is sent to the cable and antenna system under test. A portion of the incident power is reflected back to the source from each transmission fault and the antenna. The ratio of the reflected voltage to the incident voltage is called the reflection coefficient — a complex number containing both magnitude and phase information. By measuring the signal reflection, the handheld CAT can identify the parameters of the cable and antenna system.

Another key requirement of the ideal CAT is to provide the return-loss measurement in both the frequency and time domains. In the frequency domain, the CAT uses an inverse Fourier transformation of the time domain signal to identify the fault point location. It also supports standing wave ratio (SWR), return loss and cable loss tests. SWR and cable loss are two measurements which can be derived from the return-loss measurement. In the time domain, the CAT supports return-loss and cable-loss tests. These frequency- and time-domain test functions have today become the standard in test for the cable and antenna system.

Processing the data

All I&M wireless network procedures require the utilization of a fast and agile post-processing and reporting tool (Figure 6). The Agilent N9330 PC software offers powerful post-analysis of test data. In addition to providing a good user interface, the PC-based post-analysis tool can provide Smith chart displays and analysis functions. It also supports powerful printing functions that make report writing convenient. A database function even provides an organized file management feature.

Conclusion

The successful implementation of I&M routines is critical to ensuring around-the-clock service continuity and network stability over an extended period of time and under stress conditions. Use of proper test equipment such as the handheld signal analyzer and CAT, coupled with a suitable post-processing tool, can aid in this process by greatly simplifying the engineer's performance of these typically complex and cumbersome test routines.

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