Application Note

Anritsu

LTE Downlink Coverage Mapping using a Base Station Analyzer

MT8221B
BTS Master™

Carriers are moving to Long Term Evolution (LTE) to deliver the exponential increases in data traffic that the market is demanding. Primary coverage maps are in most cases being developed with drive test systems that are so expensive and difficult to operate that most carriers have only a few of them. Yet, base station technicians and RF engineers frequently receive reports of coverage problems in areas under their responsibility. They don't want to and in many cases can't wait for a drive-test system to become available. They want to diagnose the problem as soon as possible so they can begin working on a fix.

Anritsu has addressed this problem by providing coverage mapping as part of LTE measurement options for handheld instruments such as the Anritsu BTS Master MT8221B. These instruments are currently used by many technicians and engineers servicing cellular base stations and are therefore readily available to help address coverage problems. By equipping their existing instruments with option 546 (LTE Over-the-Air Measurements), technicians will now be able to perform LTE coverage mapping whenever the need arises. The instrument can automatically measure and save the Sync Signal power from up to 6 Base Stations or sectors, also known as Evolved NodeBs (eNodeBs), every 5-10 seconds. If desired, the modulation quality of the strongest transmitter can also be measured and stored at the same time. Later, users can upload the data to a computer and view it on a map showing the coverage at each measured point with color codes. Users can drill down on each point to see the detailed data.

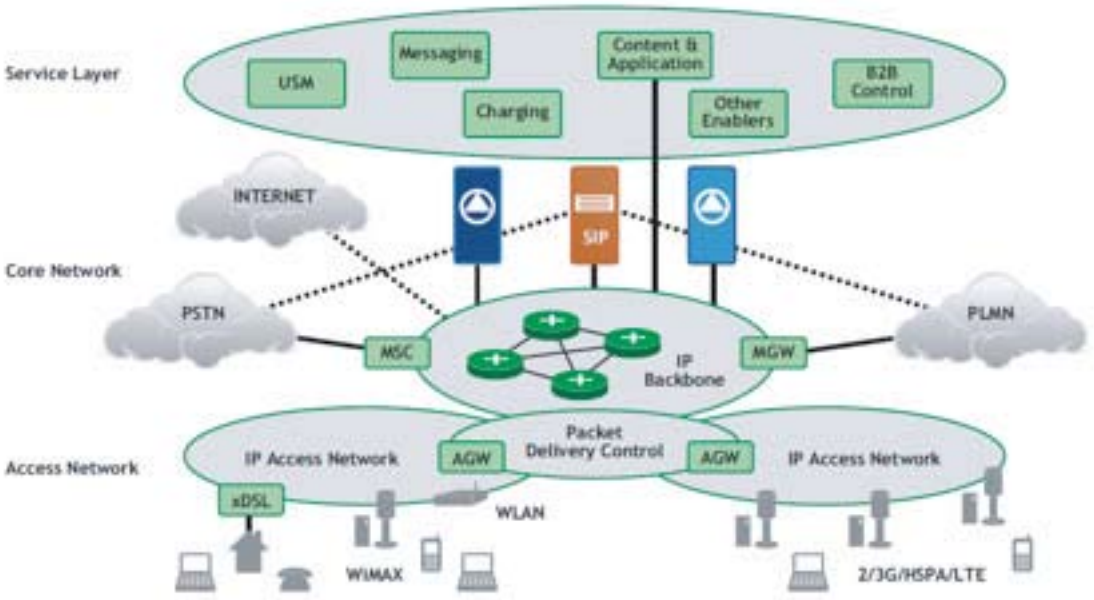

Figure 1: LTE provides mobile access to all-IP core

Most mobile carriers in the United States and many worldwide carriers have announced plans to convert their networks to LTE in order to increase the capacity and speed of their mobile networks. LTE is the mobile access network standard of the Next Generation Network (NGN) that provides a complete range of communications services on a flat all-IP core that interconnects multiple access technologies and provides a consistent user experience regardless of the access method. LTE supports peak data rates of up to 100 Mbps on the downlink and 50 Mbps on the uplink when using a 20 MHz channel bandwidth, a single transmit and two receive antennas at the user equipment (UE) and two transmit and receive antennas at the base station.

LTE uses Orthogonal Frequency Division Multiple Access (OFDMA) for the downlink and Single Carrier Frequency Division Multiple Access (SC-FDMA) for the uplink. OFDMA is a variant of Orthogonal Frequency Division Multiplexing (OFDM) which splits the carrier frequency bandwidth into many small subcarriers spaced at 15 kHz and then modulates each individual carrier using the QPSK, 16-QAM or 64-QAM digital modulation formats. OFDMA differs from OFDM in that multiple users share the bandwidth at each point in time, with each user assigned a set of subcarriers organized into groups called Resource Blocks. OFDMA subcarriers each transport unique data while in SC-FDMA data spreads across multiple subcarriers. Downlink physical signals include the Reference Signal (RS), Primary Synchronization Signal (P-SS) and Secondary Synchronization Signal (S-SS). The RS is used for downlink channel estimation. UEs use the P-SS for timing and frequency acquisition during cell search. UEs use the S-SS in cell search and for finer timing alignment.

A Practical Coverage Mapping Tool

Technicians responsible for installing and maintaining LTE eNodeBs are frequently called upon to address issues such as reports of dead spots or dropped calls. Diagnosing the problem requires that technicians take signal strength and sometimes modulation quality estimates over a wide range of locations. The drive test systems that are used for large scale coverage mapping during the implementation phase are usually too expensive, bulky and complicated for use as a practical troubleshooting tool. Carriers typically have a few of them and they are usually busy or far away when needed to address a troubleshooting area.

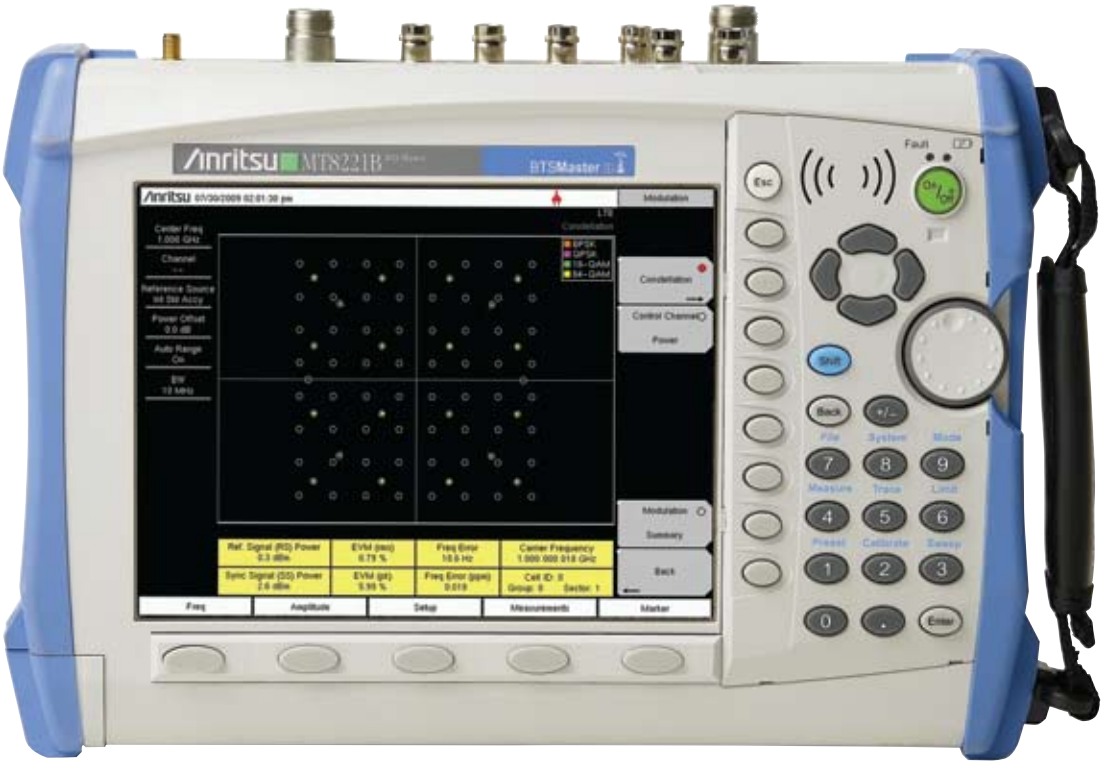

Figure 2: Anritsu BTS Master MT8221B

Anritsu has addressed these concerns by introducing LTE measurement options that enable its MT8221B BTS Master handheld base station analyzer and other instruments to perform LTE coverage mapping as well as broad range of other LTE measurements. The new LTE measurement options provide the first available suite of LTE tests in a handheld measurement solution. The measurement options accurately and easily measure all LTE bandwidths and frequencies. To make coverage mapping as simple as the push of a button, an autosave function lets the instrument make coverage measurements without user intervention—using an affordable, handheld, easy-to-operate instrument that most base station technicians already have and use for other tasks. Besides the BTS Master 8221B, LTE coverage mapping can also be performed with the BTS Master MT8222A, Spectrum Master MS2712E, MS2713E, MS2721B, MS2723B and MS2724B and Cell Master MT8212E and MT8213E.

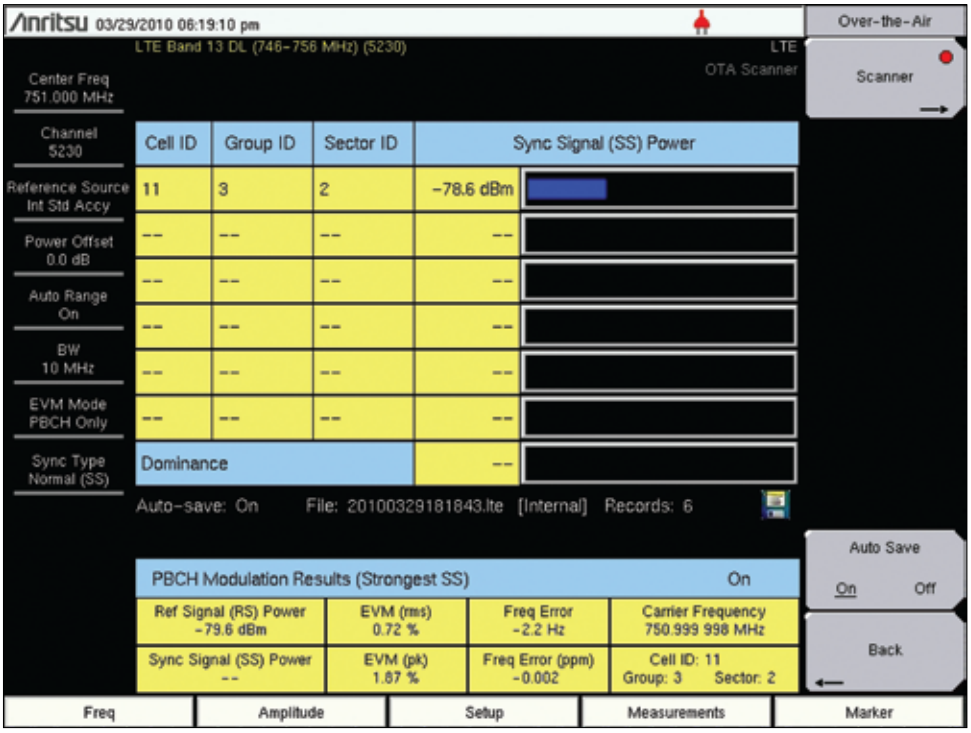

Figure 3: Option 546 Over-the-Air Measurements with modulation option

The Anritsu handheld LTE measurement suite is comprised of several options. Options 541 (LTE RF Measurements), 542 (LTE Modulation Measurements), and 543 (15 & 20 MHz LTE Bandwidths) are used to validate the performance of the complete eNodeB system and troubleshoot problems with LTE signals. Options 542 and 543 also expand the LTE coverage mapping capabilities of Anritsu instruments by providing a wider range of modulation quality, performance and troubleshooting measurements. These options display the different active modulation formats in the LTE signal, as well as measure the Error Vector Magnitude (EVM), carrier frequency and frequency error.

Option 546 (LTE Over-the-Air Measurements) generates the measurements used for coverage maps. In combination with Option 542, Option 546 can be used to validate over-the-air performance. This is especially useful in the case of Remote Radio Head/Unit (RRH/RRU) installations. Option 546 identifies up to 6 different eNodeBs with the cell ID (consisting of sector ID and group ID), and also measures the Sync Signal power of each sector. It then calculates the dominance, which shows the difference in the signal level between the strongest sector and other sectors. Dominance is a useful measurement for determining the level of co-channel interference.

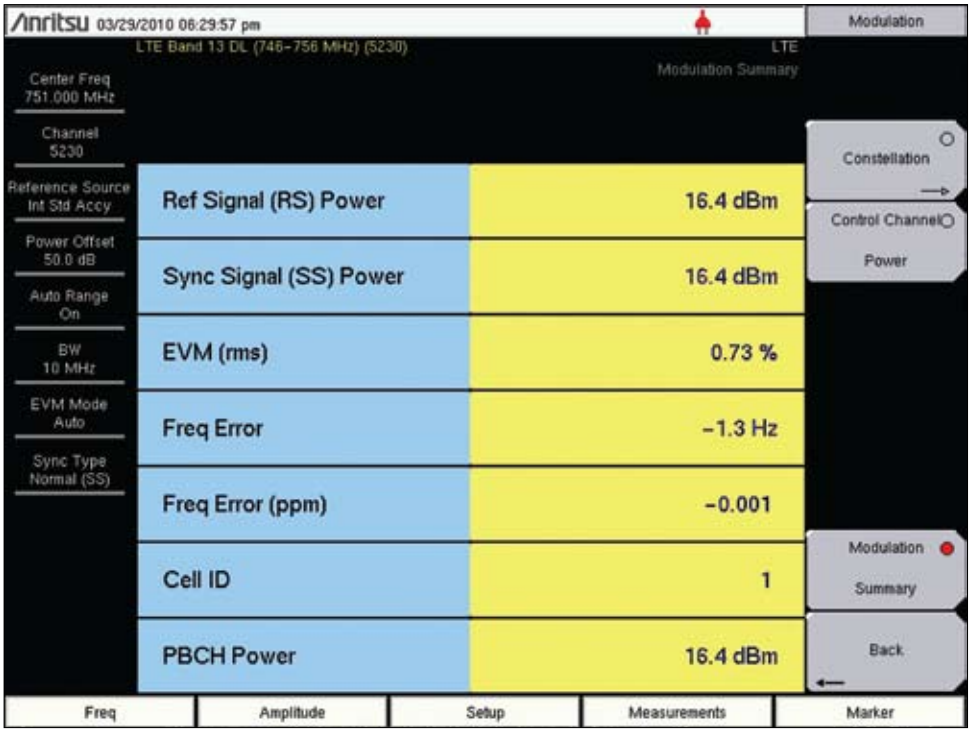

Figure 4: Option 542 LTE Modulation Measurements

A Versatile Base Station Measurement Platform

The MT8221B BTS Master base station analyzer was selected as the primary platform for LTE coverage mapping because it was developed specifically to support emerging 4G standards such as LTE including 20 MHz demodulation capability. It also provides a complete suite of measurement capabilities for measuring all key aspects of base station performance, including line sweep, spectrum measurements, interference hunting, and backhaul verification. When equipped with the new LTE measurement options, the MT8221B BTS Master provides RF and modulation quality measurements for LTE bandwidths from 1.4 MHz all the way through to 20 MHz. No other handheld instrument provides similar LTE coverage and measurement capability.

Another advantage of BTS Master handheld base station analyzers is that they are already widely used by base stations technicians and RF engineers for accurately and quickly testing and verifying the installation and the commissioning of base stations and cell sites for optimal wireless network performance. BTS Masters are also used for on-going maintenance and troubleshooting to keep the wireless network infrastructure running smoothly. The BTS Master MT8221B is small, lightweight and battery operated, making it easy to use anywhere at a cell site. The instrument warms up in less than 5 minutes, making it possible to get started quickly and increasing useful battery life.

How to Perform LTE Coverage Mapping

The BTS Master and other Anritsu handheld instruments equipped with LTE measurement options make it easy to perform LTE coverage mapping. The technician or RF engineer simply connects the receive and GPS antennas to the instrument, tunes to the LTE signal, switches to the OTA measurement, and pushes the Autosave button. The instrument automatically stores the cell ID, group ID and sector ID of every received signal as well as the time and location of the measurement and the sync signal power for each signal. For more detail, the user can enable saving measurements on the dominant signal including the rms and peak Error Vector Magnitude (EVM), and the carrier frequency and frequency error in both Hz and parts per million.

The instrument makes and saves measurements approximately every 5 seconds with modulation measurements disabled, and every 10 seconds with modulation enabled. Sync Signal power is the best single metric for coverage of an area, and capturing just this measurement optimizes the speed of the instrument. The modulation quality can also be captured, which helps determine whether or not the signal is receivable. If the car is traveling at 25 miles per hour and modulation is disabled, the instrument will make a measurement approximately once every 150 feet. The data can be stored in the internal instrument memory or on a USB stick. The user then can transfer the data to a computer in one of several ways -- connecting the instrument to computer using an Ethernet or USB cable, or by removing the USB stick from the instrument and plugging it into the computer. The user then opens the file using the Anritsu Master Software Tools, which is included with the instrument as well as available as a free download from the Anritsu web site. Master Software Tools is then used to export the measurement data to a Google Earth KML file.

Figure 5: LTE coverage map opened in Google Earth

The user then opens the KML file in Google Earth, which is also a free download. When the file is opened the user sees a satellite view of the area whose coverage was mapped. Each point where data was captured appears on the map. The coverage map is color-coded based on the sync signal power. This view helps to identify patterns, such as a deadspot that might be caused because a large building or other obstruction is blocking the signal. The user can mouse over any data point to see more detailed results as shown in Figure 5. Technicians or engineers can also use the instrument to take more detailed measurements while on foot in the critical area. The ability to use a single handheld instrument for LTE coverage mapping as well as base station installation, commissioning, maintenance and troubleshooting for 2G/3G and LTE networks helps improve productivity for more reliable and efficient base station operations.

Notes

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