802.16e Mobile WiMAX Testing Tools from BVS

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Clarifying RF

The deployment of next-generation networks such as WiMAX (802.16e mobile) requires the accurate measuring of channel response, frequency re-use, and identifying interference issues. As a result, it is essential for vendors to choose the right signal generation and analysis tool for designing WiMAX devices and implementing WiMAX networks. Proper selection of WiMAX field test equipment is essential for verifying standard based RF measurements and compliance testing. Network operators need to provide reliable and optimized services with proper network planning. Since the infrastructure investment in an advanced wireless technology such as WiMAX is enormous, a pre-deployment effort and investment becomes necessary to optimize the return-on-investment (ROI).

There is no uniform global licensed spectrum for WiMAX, although the WiMAX Forum has published three licensed spectrum profiles: 2.3 GHz, 2.5 GHz and 3.5 GHz. In an effort to decrease cost: economies of scale dictate that the more WiMAX embedded devices (such as mobile phones and WiMAX-embedded laptops) are produced, the lower the unit cost. Similar economy of scale benefits apply to the production of Base Stations. To deploy a base station (BS), the engineer has to complete a site survey to verify signal quality and amount of RF interference within the assigned frequency bands. Interference of base stations from adjacent cells/segments using the same frequency in the survey area must be minimized or else it may degrade the system performance considerably. By analyzing the power spectrum of the received signal, the engineers are able to identify Radio Frequency (RF) propagation issues, adjacent segment/cell interference issues before the installation of WiMAX base stations. Berkeley Varitronics Systems, Inc (BVS) has some very exciting solutions for service providers looking to deploy WiMAX. The BVS Tortoise transmitter and the BVS Yellow Fin WiMAX receiver are packaged together to form a unique WiMAX test and measurement tool.

The Tortoise is a dual-channel transmitter with a resolution of 0.1 dB and accuracy of +/- 0.5 dB. The Tortoise has two independent transmission channels, each with an output power capacity of 45 Watts for CW and 10 – 20 W for modulated signals (band dependent), thus substantially increasing the coverage area.

Figure 1: BVS Tortoise WiMAX Test Transmitter

The BVS YellowFin WiMAX Receiver (YellowFin) is a powerful tool for building, maintaining, and optimizing 802.16e networks. It is a wide-band receiver that ranges from 2 GHz through 5.9 GHz. The YellowFin is a portable device that can be used as a walk around tool or in a vehicle for drive testing. The YellowFin hardware is attached to a Samsung Tablet PC. The controller software runs on this tablet (or laptop if preferred) and communicates through a USB connection. Any data collected is also stored on the master computer.

Figure 2: BVS Yellow Fin WiMAX receiver

The optional Dragnet mapping software also collects data through the tablet PC or laptop. Dragnet is used as a drive-tool to provide coverage analysis of a WiMAX network.

Figure 3: YellowFin WiMAX analysis software

The YellowFin can also be used in conjunction with the BVS Tortoise dual-band transmitter with the WiMAX modulation option for the initial stages of network build-out. CW analysis is good for the initial planning stages of a network by providing basic coverage information. However, a more detailed WiMAX analysis is needed to ascertain the effect of the environment and interference on the modulated signal.

In this way a Tortoise could be placed in a desirable transmitter location while the YellowFin receiver is placed in a drive vehicle for coverage analysis. Any interference issues can easily be seen by a reduction in the CINR (Carrier-to-Interference Noise Ratio) and RSSI (Received Signal Strength Indicator) values. Once a network has been deployed, the YellowFin can also be used in maintaining and optimizing the existing network. Driving the network area may discover any new interference issues. Any rogue transmissions can be detected and located with the use of the optional direction-finding antenna.

When the YellowFin starts up, it begins to scan frequencies previously programmed into the software. While scanning these frequencies it displays any WiMAX preambles that were successfully demodulated during that pass. This is useful in the fact that all of the network frequencies can be programmed and the entire network looked at simultaneously.

An individual frequency can be viewed at any time, displaying the preambles seen and information for these preambles. This information includes the preamble number, the Cell ID and Segment numbers, as well as the current RSSI and CINR values. Each individual preamble for the selected channel can be looked at individually as well. The preamble RSSI will show the relative signal strength at the current moment. The preamble CINR will show the effect of interference on the WiMAX signal. If there is a lot of interference, the CINR will be driven toward 0. If there is a pretty clean signal, the CINR will remain over 20.

The YellowFin software has the ability to display multipath information for each preamble that has been detected. The multipath information screen displays the relative power over time. The time is also displayed in symbols. Multipath components are reflected copies of the direct signal from the transmission source.

These multipath components can be from nearby buildings or from other natural obstacles. When the secondary path is delayed enough to be pushed into the next symbol it can wreak havoc with the demodulation process. WiMAX networks can use different guard intervals to prevent against inter-symbol interference. If the multipath components shown on the YellowFin fall within the network guard interval, multipath interference is reduced. If the non-direct paths fall outside the guard interval, then either the guard interval needs to be increased or other system parameters need to be adjusted.

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Figure 4: BVS YellowFin WiMAX software

The individual spectrum for each preamble can also be seen. This is another way to see any interference that may be occurring. If the preamble is the only one on a specific channel, the resulting spectrum should show every third frequency with power and the other 2 out of 3 frequencies down in the noise floor. If there were other preambles active on the same channel and they used the remaining 2 segments (0-2 are available), then the resulting spectrum would look more like an elongated square wave with individual frequency variations. Any spectrum signatures other than those described above could result in interference issues.

The base YellowFin software access the spectrum analyzer mode of the YellowFin hardware to look at any non-802.16e signals that may be interfering with any WiMAX networks.

BVS DRAGNET WiMAX Signal Coverage Mapping Software

The Dragnet software suite of applications is used for WiMAX coverage analysis. The YellowFin has a built-in GPS receiver, which is used in conjunction with Dragnet to provide real-time information on a live network.

Dragnet is a conglomeration of three applications. BVS Projector is the first of these programs. Projector takes as input an image of the network area to be surveyed. These images can be found easily in GoogleEarth™ . Projector requests GPS information on a number of locations, which can be seen on the image. This information can also be obtained from GoogleEarth™. After enough locations are input into Projector, a geo-coded map can be saved for use during the actual data collection.

Data collection is performed by using the Dragnet Collector application, the second of the three applications in Dragnet. The previously created geo-coded file is input into Collector. The GPS receiver is attached to the YellowFin (usually affixed to the top of the drive vehicle). The desired frequencies and FFT/bandwidth sizes are entered. Once a GPS lock status has been achieved the drive-study can commence.

The entire network area is now driven and the Collector application will correctly map the collected WiMAX data to the correct latitude and longitude. The user can also see if he/she has covered the entire area by use of the visual information on Collector. After the drive-study has been completed the data is saved to a collection data file. The analysis of the data is now performed using the last of the three applications, Analyzer.

Figure 5: BVS Dragnet WiMAX signal coverage mapping software

The Analyzer application is usually used on a desktop back at the office but will run on the provided tablet for a quick-turn analysis.

The projection file created with BVS Projector is input into Analyzer. The collected data file is also input into Analyzer. From here the user can select which frequencies and/or preambles to analyze.

The analysis can be performed on RSSI information as well as CINR information. The desired coverage analysis is selected from simple extrapolation to best square fitting. Then the coverage map may be generated to ascertain whether there are any coverage holes and/or any interference issues.

Any or all of the layers (projection, data, analysis) can be viewed. The resulting analysis can be saved for later retrieval. The analysis may also be exported to an Adobe™ PDF or Microsoft Excel™ format. The analysis can be printed out in color in report format with counts of frequencies and preambles seen. Finally, the analysis layer can be outputted to a KML file. This KML file can be input into GoogleEarth™.

As can be seen, the YellowFin receiver is a portable receiver that has a varied number of uses for WiMAX systems. These uses include but are not limited to coverage analysis, build-out testing with the Tortoise transmitter, rogue transmission detection and location, maintenance and optimization of any WiMAX network.

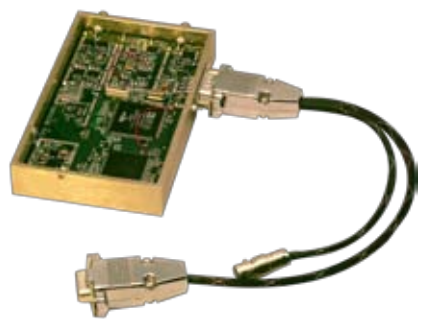

Figure 6: Tortoise Modulator software

The Tortoise Modulator enables the tester to set-up the intermittent transmission of a WiMAX preamble at regular intervals of time. This is possible by creating a file containing Digital to Analog converter samples corresponding to the IEEE 802.16e and frame containing the preamble using the Modulator PC software. This file is then supplied to the Tortoise modulator module in the Tortoise transmitter. The transmitter modulates the transmission signal based on the modulator data to provide a test signal for measurement and analysis by the YellowFin WiMAX Receiver.

The Modulator setup software provides settings for Fixed (FFT size = 512 samples and Channel Bandwidth = 5 MHz) and Mobile WiMAX (FFT size = 1024 samples and Channel Bandwidth = 10 MHz). The frame length settings provided are 5 msec (default), and other optional ones such as 2, 2.5, 4, 8, 10, 12.5 and 20 msec. The cyclic pre-fixes which the user can set are ½, ¼, 1/16 and 1/32. The frame can be generated for a Downlink (DL) packet. The user can set any preamble index from 0 – 113 (as defined by the standard).

Once the required parameters are generated and saved to a file, this file can then be transferred to the modulator module within the Tortoise transmitter. The transmitter power is then modulated according to the parameters in the saved file. The YellowFin can be used to detect the corresponding preamble and the associated Carrier-to-Interference+Noise Ratio (CINR) and Received Signal Strength Indicator (RSSI) values. This can be helpful in coverage analysis in the presence of adjacent cell.

Berkeley Varitronics Systems (www.bvsystems.com) has provided advanced wireless solutions and products to the domestic and international wireless telecommunications industry for over 35 years. BVS has introduced over 50 unique wireless test devices for a variety of applications including the popular Cellular, iDEN, PCS, CDMA, RFID, WiMAX, 802.11b/a/n/g & LTE Technologies. BVS test equipment now enjoy international markets comprised of 40 countries spread across the Asian, European, Australian, Middle Eastern, Canadian, South American territories.

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