

Deploying Mobile WiMAX Networks

Using BVS' YellowFin™ WiMAX Analyzer

Recently, BVS released the world's first portable WiMAX test receiver, the YellowFin™ WiMAX analyzer, which utilizes the Samsung Q1 tablet UMPC as an interface (shown in Figure 1).

The YellowFin provides complete spectrum analysis and WiMAX packet demodulation. The full spectrum analysis enables RF field engineers to measure the signals as well as interference through power triggers, peak hold/search, markers and multiple waveform traces. The receiver sweeps the full 2.0 - 5.9 GHz spectrum to within ± 1.5 dB accuracy.

Since the instrument has the unique ability to demodulate packets many essential parameters that are needed to qualify system performance can be achieved; such as Received Signal Strength Indicator (RSSI), Carrier-to-Interference-plus-Noise-Ratios (CINR), Error Vector Magnitude (EVM) versus symbol, frequency offsets, multi-path power delay profile, cell IDs & segments. The optional Direction Finding (DF) antenna allows engineers to pinpoint sources of WiMAX interference, rogue base stations and even nearby hackers. YellowFin™ site survey software (optional) enables users to perform site surveys revealing RSSI and CINR coverage, reliability analysis, overlap and dead spots on any WiMAX network.

Introduction to WiMAX

WiMAX, the Worldwide Interoperability for Microwave Access, is described by the WiMAX Forum as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL". WiMAX is designed to provide wireless service with higher data rate, longer range, more efficient use of the bandwidth. The availability of spectrum for WiMAX services is primary in the 2.5 GHz band in the USA and in the 3.5GHz band in some other countries. BVS YellowFin™ WiMAX analyzer operates from 2.0-5.9 GHz, which can be effectively used to measure and monitor a WiMAX network.

Mobile WiMAX (IEEE 802.16e) is based on Orthogonal Frequency Division Multiple Access (OFDMA) technology and also supports an enhanced OFDMA modulation method known as Scalable OFDMA. The Cyclic Prefix for mobile WiMAX is from 1/32, 1/16, 1/8 to 1/4 of the symbol.



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Figure 1
YellowFin WiMAX Analyzer

The cyclic prefix is a repeat of the end of the symbol at the beginning, which allows multipath to settle before the main data arrives at the receiver. WiMAX supports channel bandwidths of 5 MHz, 7 MHz, 8.75 MHz, and 10 MHz and can optionally support channel bandwidths ranging from 1.25 MHz to 20 MHz. WiMAX supports adaptive modulation and coding in both downlink and uplink with variable packet size. The channel bandwidth scalability, variable length of cyclic prefix, and adaptive modulation and coding technologies enable mobile WiMAX to provide

higher performance than today's wide area wireless technologies. The implementation of these advanced technologies and the deployment of mobile WiMAX networks requires accurate measurement of channel response, interference, frequency reuse, and so on.

WiMAX Network Deployment

A site survey measures terrain based fading, which is also called large scale fading [2]. This fading can be suppressed by increasing transmission power or diversity techniques. After a site survey with YellowFin™ site survey software, the RF coverage can be validated and the base station transmission power can be verified. However, the performance of wireless systems also depends on small-scale fading, such as Rayleigh fading and Rician fading. Typically small-scale fading is caused by delay spread, which will not only distort the received signals but also cause inter-symbol interference [3]. Therefore the small-scale fading has a significant impact on system performance and specific signal processing techniques have to be used to mitigate this fading [3]. The effects due to small-scale fading must be addressed to successfully deploy mobile WiMAX networks. Demodulation techniques can be used to measure the impact of small-scale fading by extracting the parameters necessary for the demodulation signal processing algorithms. BVS YellowFin™ WiMAX analyzer demodulates the preambles to measure RSSI, CINR, multi-path power

delay profile, carrier-frequency offset, cell ID, and segments.

The demodulation process reflects the impact of small-scale fading because of the verified base station transmission power. The loss due to small-scale fading will be represented in the RSSI measurement and the level of interference will be measured by CINR. Although OFDM technology can be used to successfully suppress frequency-selective fading [3], it will be subject to inter-symbol interference if the delay is greater than the length of cyclic prefix. The multi-path power delay profile will give guidance to the length of the cyclic prefix required. To correctly demodulate the preambles, BVS YellowFin™ WiMAX analyzer applies frequency-offset compensation, timing-offset compensation, delicate calibration, and other important techniques to minimize the impact due to the instrument, such as non-ideal filters in the RF front end. Due to the use of a high accuracy TXCO clock, the BVS YellowFin™ WiMAX analyzer can make the required frequency measurement with an accuracy of less than 2 ppm. Therefore, the measurement data shows the upper-bound performance that a mobile WiMAX system can achieve.

To deploy a base station, the engineer has to take a site survey to verify signal quality and amount of interference within the assigned frequency. The RSSI measures the total signal quality and the CINR shows the level of the interference. The interference can degrade the system performance considerably. The CINR is the ratio of the desired signal to the interference plus noise. The carrier is the desired signal, and the interference can either be noise or co-channel interference or both. In order for the signal receiver to be able to decode the signal, the signal must fall into an acceptable CINR range. The CINR for different frequency factors (1 or 3) is also evaluated. For frequency reuse factor 3, the CINR is the estimate of the CINR over the modulated subcarriers of the preamble; for frequency factor 1, the CINR is the estimate of CINR over all the subcarriers of the preamble [4]. The CINR is estimated using the method similar to that of the EVM. The EVM represents the ratio of the magnitude of the error vector to the magnitude of the reference waveform. Signal spectrum and the EVM measurement can be used to measure the signal quality in the subchannels. If another base station uses the same frequency in the survey area, the BVS YellowFin™ WiMAX analyzer can pinpoint its location with a DF antenna based on signal strength. By utilizing spectrum analysis, the engineers are able to identify and eliminate potential interference issues before the installation of WiMAX base stations. The application software is shown in Figure 2.

References

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- [3]. B. Sklar, Digital Communications: Fundamentals and Applications, 2nd Edition, Prentice Hall, 2001.
- [4]. IEEE Std 802.16e2005 and IEEE Std 802.162004/Cor 12005(Amendment and Corrigendum to IEEE Std 802.162004), "IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands and Corrigendum 1", February 2006.

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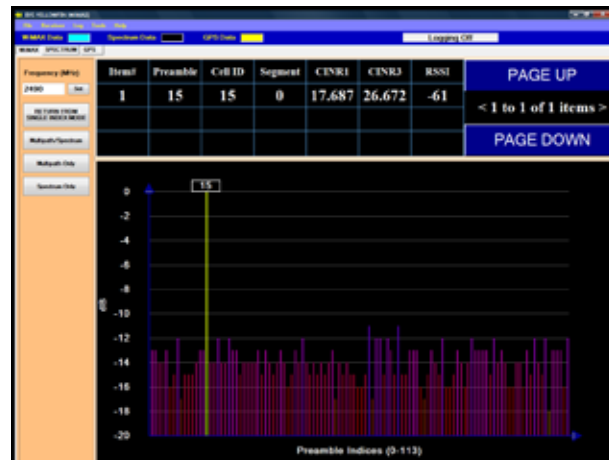


Figure 2(a) shows that the preambles with index 15 is detected. The RSSI of the signal is -61 dBm and its CINR for reuse factor 3 is 26.7 dB and that for reuse factor 1 is 17.7 dB.

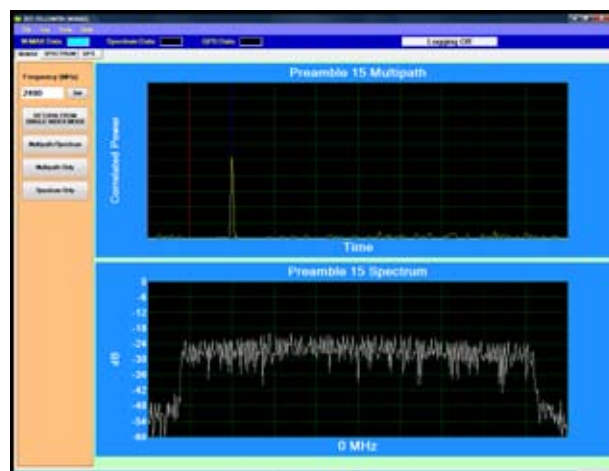


Figure 2(b) shows the multipath profile and spectrum of WiMAX signals.

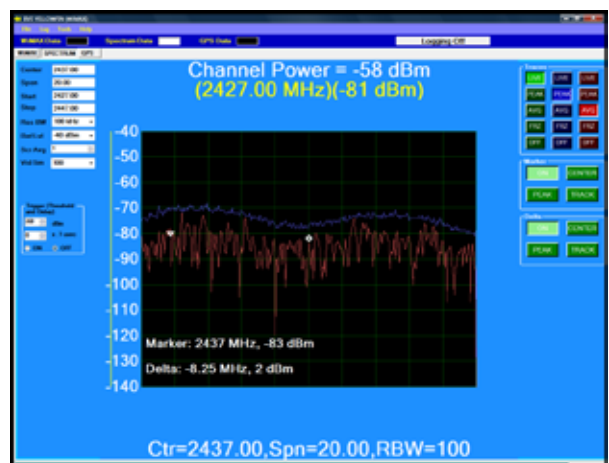


Figure 2(c) shows the analysis of the spectrum.

Conclusions

BVS YellowFin™ WiMAX analyzer provides complete spectrum analysis and WiMAX packet demodulation. The full spectrum analysis allows RF engineers to measure and study the signals and interference. The packet demodulation enable RF engineers to measure important parameters for system performance, such as RSSI, CINR, frequency offsets, multi-path power delay profile, ID cells & segments, and so on. Therefore, BVS YellowFin™ WiMAX analyzer is an efficient tool for deploying mobile WiMAX networks and monitoring the system performance.