

WHITE PAPER

For additional information contact Ricky Houghton, 724.586.6005, rhoughton@ibistek.com

Implementing 802.16e WiMAX Technology in Licensed and License Exempt Bands

Wireless operators can now leverage the most current technology for the implementation of urban and rural networks for LANs, WANs or MANs

After years of promise, intense interest and high expectations WiMAX is now a reality and is being deployed worldwide. WiMAX offers operators a viable access solution with many benefits to be realized in a fixed, nomadic or mobile environment. The introduction of WiMAX has afforded operators a more reliable way to launch broadband voice, video and data services. The “early adopter” phase is over, and WiMAX has

proven it’s viable. It has further opened the door to full mobility allowing wireless providers unique selling points to over traditional terrestrial based solutions.

The purpose of this document is to explore the 802.16e IEEE standard as it applies to launching wireless LANs, MANs and WANs. The document will also outline Ibis Tek’s 802.16e solution features, benefits and applications.

Why 802.16e The difference among wireless platforms

There are two 802.16 solutions currently available for deployment. The first version of WiMAX is designated as 802.16d vs. the latest released standard which is 802.16e. In both, there are licensed and licensed exempt bands, and both are compliant with the 802.16 standard. The 802.16e product has recently become the predominant

solution with wider equipment and chipset vendor support.

Current 16e solutions include single cell, PICO base stations and multi-sector/macros base stations. The following chart 802.11 compared to 802.16 and the difference between the d and e solutions:

	WiFi 802.11g	WiMAX 802.16d	WiMAX 802.16e
IEEE Release Date	2003	2004	2005
Standard Frequencies	2 GHz	2 – 11 GHz	2 – 6 GHz
Coverage	Optimized for Indoor	Optimized for Outdoor	Optimized for Outdoor
Line of Sight	√	√	√
Non Line of sight		√	√
Mobile/Nomadic			√
Multicast/Broadcast			√
Modulation	OFDM	OFDM	OFDM/A
Interference Mitigation	Poor	Good	Excellent
Network Orientation	Wireless LAN	Fixed Wireless MAN	Fixed/Mobile Wireless MAN

Features and Benefits of Mobile WiMAX

High Data Rates: The addition of MIMO antenna technology coupled with sub-channelization schemes, advanced coding and modulation allow for peak data rates up to 63 Mbps per sector and peak UL data rates up to 28 Mbps per sector in a 10MHz channel.

Quality of Service (QoS): The basis of 802.16 technologies has been centered on improved QoS. This new technology allows for end-to-end IP based QoS. Additionally, sub-channelization and signaling schemes afford the ability of optimal scheduling of resources over the air on a frame by frame basis.

Pros and Cons among Competing Wireless Technologies

PROS	CONS
<p>802.11g</p> <ul style="list-style-type: none"> ◆ Inexpensive to implement ◆ Backwards compatible with 802.11 a/b 	<ul style="list-style-type: none"> ◆ Frequencies are saturated ◆ Interference – microwave ovens, garage door openers, etc. ◆ No QoS due to contention for bandwidth
<p>802.16d</p> <ul style="list-style-type: none"> ◆ Optimized for distance ◆ Inherent QoS built in ◆ Increased non-line-of-sight performance ◆ Higher throughput than 802.11 	<ul style="list-style-type: none"> ◆ Most chip vendors have stopped developing 802.16d technology ◆ Not compatible with 802.16e ◆ More expensive than 802.11 ◆ Quickly becoming a legacy technology
<p>802.16e</p> <ul style="list-style-type: none"> ◆ Optimized for distance ◆ Inherent QoS built in ◆ Fixed, nomadic and mobile coverage ◆ Sleep/idle modes conserve power ◆ Increased non-line-of-sight performance ◆ Adaptive antenna technology ◆ Priced comparatively to 802.16d 	<ul style="list-style-type: none"> ◆ Not backwards compatible with 802.16d

Scalability: Mobile WiMAX can operate from 2 to 20 MHz. This allows for many diverse and disparate uses and applications throughout the world. Both licensed and license-exempt solutions will begin to emerge with the ability to deliver mobile use.



Security: WiMAX security features are regarded as best in class with EAP-based authentication. In addition to authentication, the solution includes AES-CCM based authenticated encryption. Support for user credentials includes SIM/USIM cards, smart card, Digital Certificates and Username/Password schemes.

Mobility: Mobile WiMAX maintains optimized handover schemes with less than 50 millisecond latencies. This feature allows for applications to perform without service degradation. Flexible management schemes allow for security to be maintained during handover.

Power Management: WiMAX provides two types of power management; sleep mode and idle mode. These two levels of power management allow for conservation of power while not diminishing the effective operation of the solution.

Frequency Reuse: With Mobile WiMAX users operate on sub-channels, which only occupy a small fraction of the whole channel bandwidth.

Smart Antenna Technologies: WiMAX mobile supports a full array of smart antenna technologies including. These technologies allow for increased performance and better non-line-of-sight operation. Supported technologies include:

- Beamforming – The system uses multiple antennas to improve coverage and reduce outage probability.
- Space-Time Code (STC) – allows transmission of signal that provides spatial diversity and reduces fade margin.
- Spatial Multiplexing (SM) – With SM, multiple wireless streams are transmitted over multiple antennas. This allows for higher peak rates and increased throughput.

What to Consider When Launching Wireless Networks

There are many factors to consider when selecting a wireless solution, two primary factors that should be considered when selecting a vendor solution are: (a) make certain the vendor chosen has a vendor/back office management platform that has been proven and (b) make certain that the vendor has a solution that allows customers to be added to the network quickly, become easily supported and add applications in the future.

In the early stages of network deployment, Operators become obsessed with link light installation i.e.; just get a solid link in place and move on. More attention should be paid to back office support as well as technical support of the CPE. Making the right selections up front is critical to long term success.

- Solutions must have the ability to offer VoIP and data at a minimum
- Customers want month to month service without contract commitments. Operators must be able to support pre paid and post paid billing
- The ability to turn on and off service/applications must be simple for the customer
- Offer on-demand services to casual users
- Support retail and wholesale businesses with customized packages / services
- Offer flexible consumer based services, packages and options
- The ability to offer services that differentiate like QoS and Roaming may set you apart from the competition
- Choosing a ratified 802.16e solution that can work with other vendor's products is critical. It may allow to take advantage of additional applications allowing for increased revenue possibilities
- Choose a solution that offers "Future Proof" protection, i.e.; applications that can add value and a clear upgrade path to LTE

Ibis Tek's solution is based on the IEEE 802.16e technology. Ibis Tek offers a full range of high quality solutions for start to finish network architecture plans. Our solution provides true carrier class features and functionality including an Access Service Network (ASN), Network Operation Center (NOC) infrastructure components including billing systems and a wide range of value added services.

Why Launch on 3.65 GHz?

The combination of the FCC's ruling to allow commercial licensed operation on the 3.65 GHz frequency band, coupled with the advent of IEEE's 802.16e, OFDM wireless technology has created a unique opportunity for wireless ISPs / operators.

Application Availability – Applications such as PDAs, notebooks and phones are being designed at the 3.65 GHz frequency level – not 2.4 or 5.8 GHz. These additional applications can provide potential revenue streams for operators in the future.

Interference Mitigation - 3.65 GHz is licensed and not susceptible to the interference by the license exempt 2.4 and 5.8 GHz solutions currently deployed. Since it is licensed, and not considered COTS, it provides a barrier to entry that excludes the incidental user.

Signal Propagation – Better signal propagation is attained at lower frequencies. Operators launching at the 3.65 GHz frequency band will see an improvement with increased signal propagation resulting in fewer base stations / repeater sites decreasing CAPEX costs.

Affordable Licensed Spectrum - The cost of using the 3.65 GHz frequency band is negligible. The FCC views the use as an opportunity, not a commitment by the operator. Operators are free to launch and grow systems at their own pace.

Carrier Class Equipment – The 802.16e solution offers inexpensive service with a true QoS offering. This allows operators to set network priorities at the CPE/user level and truly manage their networks. Base stations come in Femto, Pico and carrier grade.

Signal Propagation – Better NLOS performance with 802.16e

Flexible CPE Offerings - Either indoor or outdoor CPEs are available for deployment. Indoor CPEs are customer installable and have an extremely small footprint. Although flexible, the indoor CPE does not have the power of the external CPE.

Equipment Costs - As the 802.16e become solution becomes more prevalent, the cost of equipment will continue to decrease making it cost effective to implement.

IP Based Core Network - WiMAX can be more easily integrated with other IP-based technologies than non-IP cellular technologies. It accelerates the development of more advanced services, as well as customer provisioning and support.

The 3.65 GHz Spectrum was allocated with the Rural User in Mind . . .

The 3.65 GHz spectrum was designed with the remote / rural based user in mind. The FCC will issue an unlimited number of non-exclusive licenses to non-Federal companies for the 50 megahertz of spectrum allocated for commercial use. According to the FCC, there are four key steps involved in obtaining the right to operate a base station:

- Obtain a non-exclusive license using the Universal Licensing System (ULS) at <http://wireless.fcc.gov/uls/>
- Before registering a base station location, check the ULS for nearby stations
- Be certain to purchase FCC certified equipment with contention-based protocol
- Register each base station using the ULS and pay the \$210.00 licensing fee. You will need to input the FCC's equipment authorization numbers of the product to be used.
- The licenses are non-exclusive and anyone may apply for and obtain a license with not priority given to those entities holding licenses registered earlier.

"I have pushed for flexible licensing approaches that make it easier for community-based providers to get access to wireless broadband opportunities. We adopted rules to make spectrum in the 3650 MHz band available for wireless broadband services. To adopt interest in the band, we adopted an innovative hybrid approach for spectrum access. It makes the spectrum available on a licensed, non-exclusive basis. I have spoken with representatives of the Community wireless network movement, and they are thrilled with this decision and the positive impact it will have on their efforts to deploy broadband networks in underserved communities around the country."

**- Jonathan S. Adelstein, Former
Commissioner of the FCC**

For additional information on this white paper contact Jeff Brown at (724) 524-4110, jbrown@ibistek.com or Ricky Houghton at (724) 431-2344, rhoughton@ibistek.com.