Communications Research Centre Canada
An Agency of Industry Canada

Centre de recherches sur les communications Canada
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WiMAX Activity in Canada

by
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Communications Research Centre (CRC) Canada
An Agency of Industry Canada
3701 Carling, Ottawa
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Executive Summary

The need for broadband communication services to support rapidly emerging, feature-rich, high bandwidth applications has never been greater. Nowhere is this more apparent than in broadband access, where technologies such as digital subscriber line (DSL) and cable modems have successfully delivered fixed broadband access, but only to limited areas of the world where existing infrastructure is available. Because of this, fixed wireless access, which is more rapidly deployable and has much lower rollout costs, has emerged as a very important technology in telecommunications. As well, consumers are demanding more services, with ubiquitous broadband service being the ultimate goal, regardless of location, technology platforms or devices used. Mobile broadband wireless access technologies will play a major role in this area. (See Annex 1 for an examination of the evolution of communications to broadband and Annex 2 for select definitions.)

Worldwide Interoperability for Microwave Access (WiMAX) technologies are the front runners in the areas of fixed and mobile broadband wireless access (BWA). The following highlights clearly indicate the leading role Canada plays in WiMAX:

- Canadian companies produced two of the first four WiMAX certified products;
- Canada boasts a large number of private sector players, ranging from equipment manufacturers to broadband service providers;
- The country has an avant-garde outlook on national spectrum policies and standards related to the WiMAX bands of interest;
- The Canadian government's Communications Research Centre (CRC) conducts world-class public sector research.

As the federal government's primary laboratory for advanced telecommunications R&D, CRC is an important component of the Information and Communications Technology (ICT) sector in Canada. For more information, visit www.crc.ca.

Introduction to WiMAX

WiMAX is a standards-based technology that enables the delivery of both fixed and mobile BWA services. It is based on the IEEE[1] 802.16 BWA standard (see Annex 3 for history and features), which has produced the specifications for broadband wireless metropolitan area networking (wirelessMANs). As with many IEEE standards, 802.16 is very comprehensive and allows for a large number of possible product implementations. The key to the success of many technologies based on IEEE 802 standards is to establish a subset of common configurations and features so that equipment standardization, cost-effectiveness and vendor interoperability can be achieved. The goal of the industry-led WiMAX forum is to ensure equipment compatibility and interoperability by establishing a comprehensive equipment certification process based on specific WiMAX profiles (see Annex 4 for profile descriptions).

[1] Institute of Electrical and Electronics Engineers

WiMAX Architecture

To address the needs of both fixed and mobile broadband wireless access, WiMAX technologies have adopted a point-to-multipoint (PMP) configuration comprised of base stations (BSs) with omnidirectional coverage (cells) and subscriber stations (SSs) at end users with either directive (fixed) or omnidirectional (mobile) antennas. A layout of overlapping base stations is normally required to provide acceptable coverage for an entire city or area of interest, whether it is for fixed or mobile service (Figure 2).

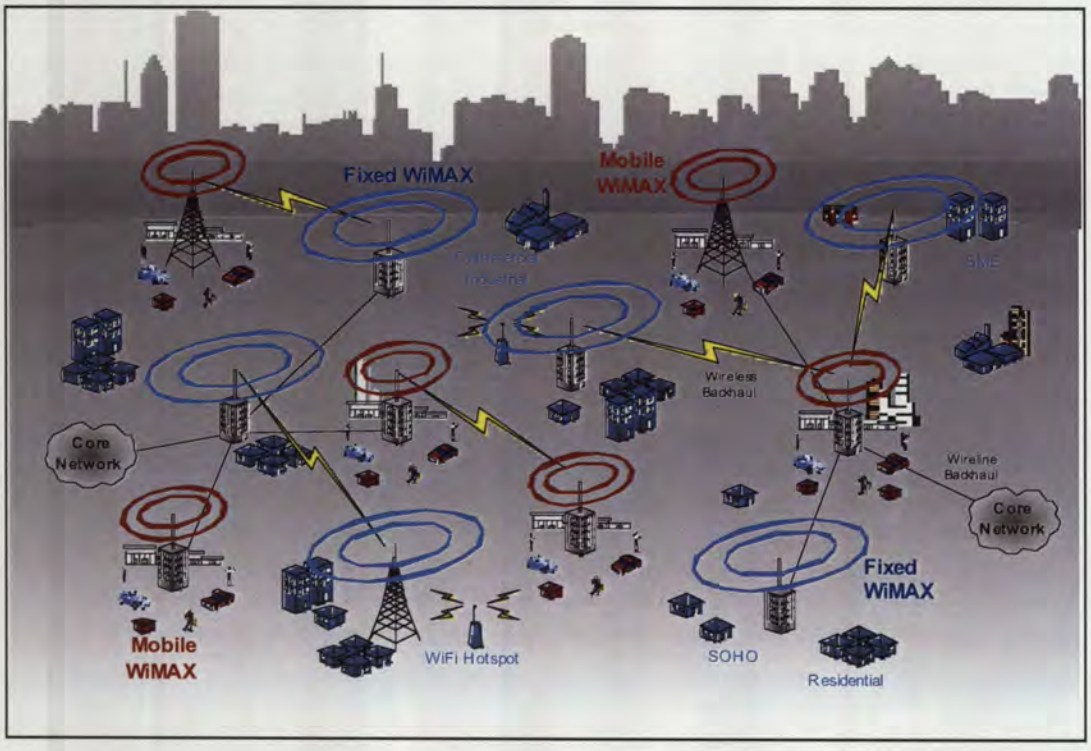


Figure 2 – WiMAX Network Architecture

Fixed WiMAX can be used to provide broadband access for city cores, residential areas, small office home office (SOHO), small to medium enterprises (SMEs) and commercial / industrial / business sectors of municipalities to name a few. It can also be used to backhaul mobile WiMAX, WiFi hotspots and cellular traffic onto the core network, or as a replacement for T1 / E1 services. Links between the fixed WiMAX cells (inter-cell links) and core network links can either be wireline or point-to-point (PTP) wireless. Mobile WiMAX can be used to provide advanced mobile and portable broadband access to feature-rich, triple play devices such as smart phones, pocket PCs and personal digital assistants (PDAs).

The line-of-sight (LOS) range of fixed WiMAX systems operating in the 3.5 GHz band can be as great as 50 km, but ranges of 2-10 km are more typical in non LOS environments, depending on demographics, service availability, capacity needs and CPE location (indoor / outdoor). For mobile WiMAX systems in the 2.5 GHz band, typically 1-5 km is achievable, again depending on a number of deployment considerations. The single channel capacity of fixed and mobile WiMAX systems is as high as 40 Mbps, with multiple channels deployable on a per cell basis to increase capacity.

Canadian Activity in WiMAX

Canada, for its part, has been a pioneer of many WiMAX developments over the years and continues to play a key role. The main areas of involvement are product development, network service provision, public sector research and a leading role in national regulatory activity.

Canadian Product Development

Many Canadian manufacturers are involved in WiMAX product implementation for both fixed and mobile systems. Development strategies range from WiMAX chipset design, to components and modules, to full blown products. The following is a list of manufacturers with WiMAX activity based in Canada (listed alphabetically).

BelAir Networks Inc.
www.belairnetworks.com

BelAir Networks has developed an 802.16-based backhaul module operating in the 2.3 and 2.5 GHz bands that fits into the BelAir100 and BelAir200 mesh products. This product cannot be WiMAX certified as no fixed profiles exist at these frequencies. BelAir is also developing mobile WiMAX modules for both access and backhaul operating in the 2.3, 2.5 and 3.5 GHz bands. These products will be available by the end of 2007.

EION Inc.
www.eionwireless.com

Eion Inc. has a commercially available fixed WiMAX platform named Libra MAX operating in the 3.4 to 3.6 GHz band. This product line includes base stations and an outdoor subscriber station. Other products available later in 2007 include 3.3 GHz and 3.6 GHz variants of the above, and an indoor subscriber station. Eion also has a mobile WiMAX development strategy.

LOGUS Broadband Wireless Solutions Inc.
www.loguswireless.com

LOGUS Broadband Wireless Solutions is presently developing a WiMAX base station named Beaver that supports both fixed and mobile functionality.

Nortel Networks
www.nortel.com

Nortel Networks, with its head office in Canada, is involved in WiMAX on both the fixed and mobile fronts. On the fixed front, Nortel currently offers the WiMAX 1000 portfolio of products. On the mobile front, Nortel is presently developing its WiMAX 5000 portfolio, which is a MIMO-based 802.16e 2005, product implementation available in the second half of 2007. MIMO (Multiple in Multiple out) is an advanced antenna technology supported by WiMAX mobile. The WiMAX 5000 solution includes base stations, network management, network gateways and mobile subscriber stations ranging from PCMCIA cards to ultra-mobile smart phones with VoIP capability. In its first release, four frequency bands will be supported: 1.5 GHz, 2.3 GHz, 2.5 GHz and 3.5 GHz, with more to follow.

PMC-Sierra Ltd.
www.pmc-sierra.com

PMC-Sierra's Canadian offices are actively participating in the development of their WiMAX related modules used in their wireless products. These include single-chip common public radio interfaces (CPRI), open-base station architectures (OBSAI) and RF solutions.

Redline Communications
www.redlinecommunications.com

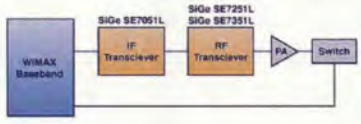
Redline Communications was one of the first four companies to have their product WiMAX certified in January 2006. They offer a full range of fixed WiMAX products (base and subscriber stations) available in the 3.3 to 3.8 GHz band known as the RedMAX series. Redline is also developing a mobile WiMAX solution, with products available once the mobile 802.16e-2005 certification process begins.

SR Telecom Inc.
www.srtelecom.com

SR Telecom's symmetryMX fixed WiMAX product line includes base stations and subscriber stations operating in a variety of frequency ranges. The company also has a mobile WiMAX product line called symmetryMXe.

SiGe Semiconductor, Inc.
www.sige.com

SiGe is a fabless semiconductor company. They presently offer three WiMAX related integrated circuits: an IF transceiver, an RF transceiver operating in the 2.3 to 2.7 GHz band and an RF transceiver operating in the 3.3 to 3.8 GHz band.



SIGPRO Wireless Inc.
www.sigprowireless.com

SIGPRO Wireless is presently developing their FLEXIUM-GX digital baseband modem system-on-a-chip (SoC) that will support mobile WiMAX.

SOMA Networks Canada Corporation
www.somanetworks.com

SOMA Networks are developing the FlexMAX mobile WiMAX line of products including a series of base stations and subscriber stations. The majority of the software for these products is being developed in its Canadian facilities. SOMA Networks plans on having among the first certified products in the first half of 2007.

Trackcom Systems International Inc.
www.trackcom-sys.ca

Trackcom Systems International is developing the RIC 101 point-to-point 802.16-2004 based product operating in the 2.4-2.483 GHz and the 4.9-5.9 GHz bands. Trackcom also has plans for a similar product operating in the 2.4 to 2.7 GHz and 3.4 to 3.8 GHz bands.

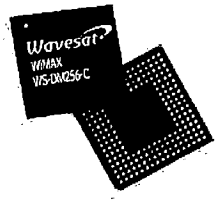
Tranzeo Wireless Technologies Inc.
www.tranzeo.com

Tranzeo Wireless Technologies are finalizing a series of 3.5 GHz WiMAX subscriber stations called the TR-WMX, with first products available in April 2007.

Vecima Networks Inc.
www.vecimanetworks.com

Vecima Networks has a fixed WiMAX product line called VistaMAX (yet to be certified) available in the 3.3 to 3.8 GHz range with a 4.9-5.9 GHz product in development. They are presently working with a number of Canadian service providers to provide WiMAX coverage in select cities. Vecima is also actively developing a mobile WiMAX brand of product available by the end of 2007.

Wavesat Inc.
www.wavesat.com



Similar to Redline, Wavesat Inc. had one of the first four WiMAX products certified in January 2006. The product was a fixed wireless subscriber station based on the Wavesat DM256 WiMAX chipset operating in the 3.5 GHz band. This same chipset is fully featured and can therefore also be used for base station development as well. On the mobile front, Wavesat is presently developing their mobile WiMAX-based U-Mobile chipset expected for release in Q4 of 2007. The U-Mobile chip will be based on the WiBro profile followed by a 2.5 GHz profile but will only work in the subscriber station mode.

Canadian Service Providers

Many Canadian service providers have either deployed live WiMAX networks or are in the process of doing so. To date, all such network undertakings are of the fixed variety, with very little information on future plans for mobile WiMAX networks. This should in no way be construed as a lack of interest in the latter technology, but rather that the release of this document precedes actual mobile deployment activity.

Canadian companies that have existing fixed WiMAX deployments in Canada include, but are not limited to:

Company	Website	Frequency Band	Network Locations
ABC (Allen Business) Communications Ltd	www.abccomm.com	3.5 GHz	British Columbia
High-Speed FX Communications Inc.	www.highspeedfx.com	3.5 GHz	Ontario
NETAGO Wireless	www.netago.ca	3.5 GHz	Alberta
Northwestel Inc.	www.nwtel.ca	3.5 GHz	B.C., Yukon
Sogetel Inc.	www.sogetel.com	3.5 GHz	Quebec

Canadian companies that plan to deploy fixed WiMAX networks in their respective Canadian markets include, but are not limited to:

Company	Website	Frequency Band	Network Locations
Chatham Internet Access	www.ciaccess.com	3.5 GHz 2.3 GHz	Ontario
Comcentric Networking Inc.	www.cni.on.ca	3.5 GHz	Ontario
Mipps Inc.	www.mipps.net	3.5 GHz	-
Pathcom Wireless Inc.	www.pathcom.ca	3.5 GHz	West and North
RipNET Limited	www.ripnet.com	3.5 GHz	Ontario
Source Cable & Wireless Ltd.	www.sourcecable.ca	3.5 GHz	Ontario

In addition to the above, one of the largest broadband wireless access services in Canada is presently based on pre-WiMAX technologies, but it is important. Inukshuk Wireless is an equally owned partnership between Bell Canada and Rogers Communications, two of the largest telecommunications companies in Canada. The network's footprint currently covers 20 centres across the country and will eventually cover 45 cities and approximately 100 un-served areas and communities. Inukshuk operates in the 2.5 GHz band but holds spectrum in the 2.3, 2.5 and 3.5 GHz bands.

Canadian Research Activities

CRC, an agency of Industry Canada, is the largest public sector telecommunications research establishment in Canada. Various groups within the CRC are involved in 802.16 working group activities. As well, WiMAX specific research includes product development, testing, evaluation and optimization, and RF coverage analysis. For more information, visit http://www.crc.ca/en/html/wiselab/home/home.

Canadian Regulatory Activities of Interest

This section describes spectrum policies in Canada related to frequency bands which could be used for WiMAX-based fixed and mobile applications. Industry Canada is responsible for setting regulatory spectrum policies and standards. It is important to note that Industry Canada does not designate spectrum for specific technologies such as WiMAX, but WiMAX can be used in applicable bands, subject to compliance with the technical limits set forth.

2.3 GHz Band

The spectrum in this band, identified for Wireless Communications Service (WCS), consists of two 15 MHz blocks from 2305-2320 MHz and 2345-2360 MHz and is intended for fixed and mobile services. It has been regionally licensed in Canada through an auction process to a large number of licensees.

2.5 GHz Band

The spectrum in the 2150-2156 MHz, 2500-2596 MHz and 2686-2688 MHz bands is presently designated as Multipoint Communications Systems (MCS) for fixed services. The channelization in the middle block is in 6 MHz increments. In 2006, Industry Canada adopted new policy provisions for this band which permit existing licensees to offer mobile services as long as one-third of their spectrum is returned to Industry Canada. Accordingly, Industry Canada will be implementing a new band plan for this band.

2.6 GHz Band

The spectrum in the 2156-2162 MHz, 2596-2686 MHz and 2688-2690 MHz bands is presently designated as Multipoint Distribution Systems (MDS) and can be used for broadcasting and fixed broadband services. The channelization of the middle block is 6 MHz, and licensing has been done on a regional basis to a significant number of broadcast undertakings. As mentioned above in the 2.5 GHz band, existing licensees are permitted to offer mobile services as long as one-third of their spectrum is returned to Industry Canada, and any un-assigned spectrum in the 2596-2690 MHz block is available for the development of mobile and fixed broadband service. Again, Industry Canada will be implementing a new band plan for this band.

3.5 GHz Band

The 3.5 GHz band in Canada, identified for Fixed Wireless Access (FWA), consists of 175 MHz of spectrum ranging from 3475-3650 MHz. This spectrum is regionally licensed as three 25+25 MHz blocks and a single 25 MHz block. The following table describes the specific license blocks.

Table 3 – 3.5 GHz License Blocks

Spectrum Block	Lower Frequency (MHz)	Upper Frequency (MHz)
D/H	3475-3500	3575-3600
E/J	3500-3525	3600-3625
F/K	3525-3550	3625-3650
G	3550-3575	N/A

A number of the spectrum licensees in Canada are deploying broadband wireless service using pre-WiMAX and WiMAX equipment.

3.65-3.7 GHz Band

In August 2006, Industry Canada proposed to establish licensing provisions for the new Wireless Broadband Service (WBS) in the 3.65-3.7 GHz band. WBS is intended to accommodate fixed and mobile services.

4.9 GHz Band

Canada has addressed the principal issues governing the implementation of public safety services in the band 4940-4990 MHz, including eligibility, licensing, technical and service rules.

5.8 GHz Band

The spectrum from 5.725-5.85 GHz is available for license-exempt (unlicensed) point-to-multipoint or point-to-point wireless services.

Annex 1: Evolution of Communications to Broadband

The global telecommunications industry and market have evolved greatly over the past decades, with many new technological advancements fundamentally changing the way people communicate. Two of the most significant advances in recent years were the advent of wireless cellular telephony and the digitization of communications, both of which have contributed greatly to the explosive growth of communication networks. The first was significant in that it enabled a vast proliferation of voice communication devices to most segments of society worldwide. The underlying technology that enabled this service was wireless, configured in a point-to-multipoint cellular network architecture to effectively deliver a quality, accessible service.

The second highly disruptive development in telecommunications – the digitization of communications – has impacted the industry on many fronts over the years. For example, the Internet (and any data communication networks for that matter) has been fundamentally made possible by digital communications. More recently, and possibly more significantly, it has also enabled the delivery of "triple play services" over a single network fabric. "Triple play services" in telecommunications is the marketing term for the provision of high speed Internet, video and voice over a single network connection.

This aggregation of traffic types onto a common network fabric has driven operators to offer a full complement of services to their customers in a single package. By doing so, they have created the need to provide broadband connectivity to each customer on their network in order to support these high bandwidth applications. For the most part, fixed service providers such as telephone companies and cable operators have led the way on the broadband front with DSL and cable modems respectively, but mainly in areas of the world where appropriate infrastructures already exist (cities in developed countries).

Most potential users worldwide, however, remain without broadband service since the existing copper and / or cable infrastructures are poor or non-existent. Because of this limited broadband service rollout, fixed wireless service providers have recognized the potential business opportunity in this area and are fast emerging as significant players. Moreover, they have the advantage over tethered technologies, such as wireline and cable, of reaching a large number of customers in a relatively short period of time and with much lower rollout costs. This allows them to tap into the potentially large access markets in many underserved countries around the world. This is the area where WiMAX fixed access products play a major role.

Along with the continuing growth of fixed broadband services, consumers are demanding feature-rich services "anytime, anywhere." Network and service providers are confronted with yet another challenge – offering a more ubiquitous triple play broadband service to

their customers, irrespective of location, technology platform or customer equipment. For example, an end user will come to expect full access to applications and services from the same communication device / interface whether they are in the office, car, home, cottage, airplane, train, or other cities / countries for that matter.

In such a world, an end user's communication experience will be greatly enhanced by being able to take their broadband service with them wherever they go. The first part of this equation is satisfied by providing fixed broadband access to a user's home and office. A second part is satisfied by the user's ability to gain network access in public areas, hotels and remote office locations through wireless hotspots and private enterprise networks (nomadic), albeit with limited portability and mobility. The last area that requires the most development is to provide broadband wireless access over a multitude of mobile and / or portable wireless platforms, ideally off the same device.

Depending on where an end user is located at any given time, this will be possible over a variety of technologies such as cellular, wireless LAN, broadband mobile, Bluetooth and Ultra Wideband. Of these, the emerging area of broadband mobile is where mobile WiMAX is ideally positioned to play a major role.

These advancements in the way telecommunication services will be delivered to customers are not without their challenges. Most importantly, the various realms of wireless and digital multimedia must converge to deliver applications and services seamlessly over multiple communication platforms onto a single device. Secondly, triple play applications need to be developed for not only computer monitors and televisions in the fixed area, but for smart phones, pocket PCs and PDAs in the mobile area as well. Next, the proper wireless technologies must be in place at the right areas in order to seamlessly provide a ubiquitous service to end users. Finally, service providers will need to coordinate amongst themselves to resolve many issues such as billing and coverage demarcation limits. Once the above challenges are addressed, the result will be a very rich wireless service environment that successfully answers the needs of broadband access.

Annex 2: Definitions

Broadband – The definition of broadband is a moving target that tends to change with time and the context in which it is used, so the following example is provided to illustrate its meaning: high speed internet access as delivered by DSL and cable modem technologies is considered a broadband service, whereas voice communication is narrowband.

Access – Telecommunication networks are traditionally made up of three hierarchical layers: the core, edge and access layers (Figure 1). The core layer of the network consists of large nodes interconnected by very high speed data links, where the size of the nodes and links is driven by the size of the network. The edge layer of the network is comprised of mid-sized nodes that groom and tandem traffic from network users to core nodes or to other edge nodes as required. The access layer is where base stations, customer premises equipment, subscriber stations and end user devices reside, and where all network communication begins and ends.

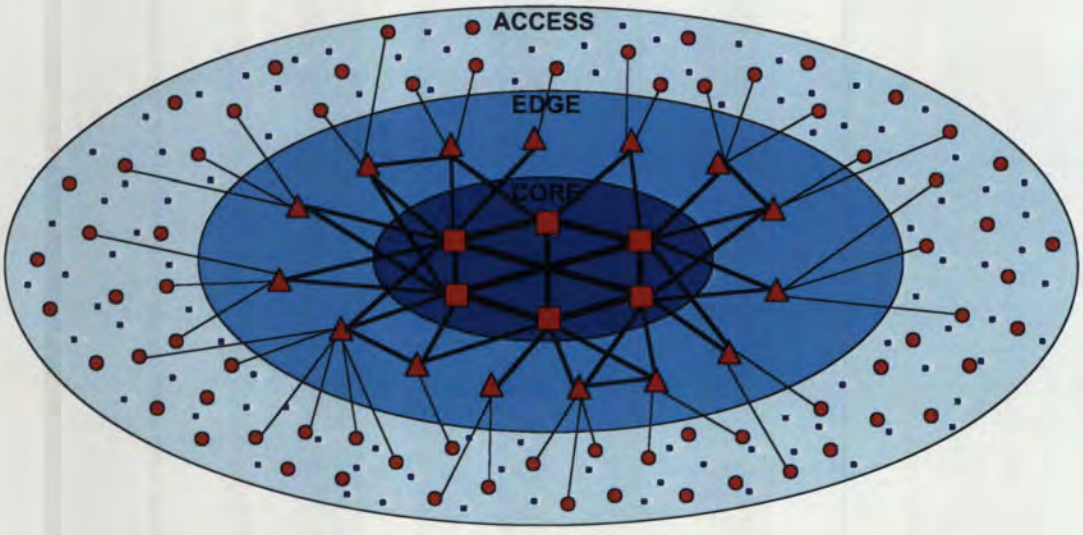


Figure 1 – Telecommunications Network

Broadband wireless access – By extension, it is the delivery of feature-rich broadband applications to end users by means of high bandwidth access devices that operate on fixed and / or mobile wireless platforms. This capability is important because broadband service is still very limited in its rollout worldwide.

Annex 3: 802.16 Standard

WiMAX products are actually based on the second generation of the 802.16 standard, where lower frequency fixed and mobile broadband technologies are defined and specified. It is of interest, however, to briefly describe the original standard as many valuable lessons were learned during this phase.

802.16 Standard - First Generation

The first effort of this IEEE working group was well intended but met with challenges that limited the commercial success of the standard's first generation products:

- The necessity for line-of-sight (LOS) deployment conditions as a result of systems operating in high frequency bands ranging from 10 to 66 Gigahertz (GHz). This deployment restriction limited the number of potential customers that service providers could reach and prevented the possibility of incorporating mobility into such systems;
- The lack of an industry-led entity responsible for ensuring the interoperability of 802.16-based equipment;
- Relatively high product implementation costs at the frequency bands of choice. This challenge was further exacerbated by the lack of economies of scale;
- Complex installation procedures (the LOS criterion, customer premises antenna alignment due to high directivity, frequency-specific customer premises equipment).

The above considerations, in parallel with the high technology industry downturn that began in 1999, created insurmountable barriers that greatly hampered the success of this first generation of 802.16-based technologies.

802.16 Standard – Second Generation

Despite these past setbacks in developing a broadband wireless solution, there remains a greater than ever need to provide broadband connectivity to users in all segments of society. As such, the 802.16 standard has continued to evolve on two fronts. The first was the release of the 802.16-2004 standard (June 2004), which deals with fixed and nomadic wireless solutions and includes all superseded standards such as 802.16a, c and d. The second development was the release of a single document that includes both the 802.16e-2005 and the 802.16-2004/Cor1-2005 standards (February 2006). This document complements 802.16-2004 rather than supplants it. The 802.16e-2005 component of this document adds the specifications for mobility, while the 802.16-2004/Cor1-2005 contribution corrects errors, inconsistencies and ambiguities in the 802.16-2004 standard. In developing this second generation standard, the IEEE 802.16 working group has remained very cognizant of the previous impairments that ultimately hindered the success of the initial 802.16 thrust.

802.16-2004

The IEEE 802.16 2004 standard, along with the amendments captured in 802.16-2004/Cor1-2005, serves as the basis for fixed WiMAX. The most noteworthy features of this revised 802.16 standard are:

- Operation in the 2-11 GHz frequency range, thereby supporting non-LOS and limited portability system configurations;
- An orthogonal frequency division multiplexing (OFDM) multi-carrier processing technique;
- LOS and non-LOS wireless implementations;
- A migration strategy for portability and mobility (802.16e);
- 1.75 to 20 MHz channelization;
- Adaptive modulation.

802.16e-2005

As previously mentioned, the IEEE 802.16e-2005 portion of the standard, along with pertinent sections of 802.16-2004, focuses on wireless systems that feature portability and mobility, and serves as the basis for mobile WiMAX. The standard features are:

- Operation in frequencies below 6 GHz;
- A scalable orthogonal frequency division multiple access (S-OFDMA) multi-carrier processing technique;
- LOS and non-LOS wireless implementations;
- Improved support for the multiple input multiple output (MIMO) antenna technology and adaptive antenna systems (AAS);
- Sub-channelization;
- Scalable channel bandwidths from 1.25 to 20 MHz with corresponding FFT sizes;
- Better indoor coverage.

From these two lists of features, it is clear that the 802.16 standards body has carefully considered previous 802.16 specifications while producing the new specifications.

Annex 4: WiMAX Profiles

The primary function of WiMAX is to create workable design profiles based on the 802.16 standard for equipment certification. By doing so, vendor interoperability and economies of scale can be realized.

Fixed WiMAX Profiles

The forum initially concentrated on profiles for 802.16-2004 (along with 802.16-2004/Cor 1-2005). The following table lists the five existing WiMAX profiles for fixed access operation.

Table 1 – Fixed WiMAX Profiles

Frequency Band (MHz)	Duplexing	Channel Bandwidth (MHz)	IEEE Standard
3400-3600	TDD	3.5	802.16-2004
3400-3600	FDD	3.5	802.16-2004
3400-3600	TDD	7	802.16-2004
3400-3600	FDD	7	802.16-2004
5725-5850	TDD	10	802.16-2004

TDD: Time Division Duplexing FDD: Frequency Division Duplexing

The above profiles can be applied to point-to-multipoint and point-to-point configurations, while featuring adaptive modulation using a variety of modulation schemes (64 QAM, 16 QAM, QPSK, and BPSK). In most administrations around the world, the 3.5 GHz band is licensed whereas the 5.8 GHz band is reserved for license-exempt applications (similar to 802.11a and UNII products).

To date, twenty-nine WiMAX certificates have been issued for products ranging from chipsets / reference kits to base stations to customer premises equipment. Of the first four issued on January 19, 2006, two of them were from Canadian manufacturers Wavesat and Redline.

Mobile WiMAX Profiles

Mobile WiMAX focuses on wireless systems that feature portability and mobility. Essentially, it defines the features required to deliver a true broadband service at speeds up to 120 km/hr while maintaining comparable service availability to broadband wireline access technologies. The following table lists the current mobile WiMAX profiles.

Table 2 – Mobile WiMAX Profiles

Channel Bandwidth (MHz)	FFT Size S-OFDMA	2.3-2.4 GHz	2.305-2.320, 2.345-2.360 GHz	2.496-2.690 GHz	3.3-3.4 GHz	3.4-3.8 GHz
1.25	128					
3.5	512		TDD			
5.0	512	TDD	TDD	TDD	TDD	TDD
7.0	1024				TDD	TDD
8.75	1024	TDD				
10.0	1024	TDD	TDD	TDD	TDD	TDD
20.0	2048					

FFT: Fast Fourier Transform

The above profiles will understandably evolve over time as new frequency bands become available and new requirements are identified. All frequency bands listed above are generally licensed spectrum in most countries. At the time of the writing of this document, no mobile WiMAX product certificates had been issued, but the first is expected to be available in second half of 2007.

WiBro

WiBro is a term often associated with mobile WiMAX. Essentially, it is the service name for mobile WiMAX in Korea and is based on the 2.3 GHz WiMAX profile with an 8.75 MHz channel bandwidth.