

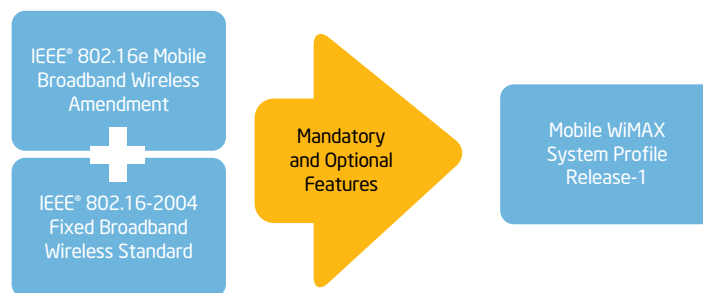


White Paper  
Mobile WiMAX Technology

# Mobile WiMAX Technology for Fixed Broadband Developments

“Mobile WiMAX” refers to a rapidly growing broadband wireless access solution built upon the IEEE 802.16e-2005 air interface standard. Contrary to its name, Mobile WiMAX is equally applicable to fixed, portable and mobile applications.

The WiMAX Forum\* has developed Mobile WiMAX system profiles that define the mandatory and optional features of the IEEE standard necessary to build a Mobile WiMAX compliant air interface which can be certified by the WiMAX Forum.



## Key Benefits of Mobile WiMAX

**Improved Air Interface:** The Mobile WiMAX air interface utilizes Orthogonal Frequency Division Multiple Access (OFDMA) for improved multipath performance in non-line-of-sight environments and high flexibility in allocating resources to users with different data rate requirements.

**High Data Rates:** A variety of antenna techniques are supported by Mobile WiMAX to increase throughput, especially at the cell edge. For example, the use of multiple-input multiple-output (MIMO) antenna techniques combined with flexible sub-channelization schemes, adaptive modulation and variable coding rates enable Mobile WiMAX technology to support peak downlink (DL) data rates up to 46 Mbps per sector and peak uplink (UL) data rates up to 14 Mbps per sector in a 10 MHz channel (DL 2x2 MIMO, 3:1 DL/UL ratio; UL 1x2 collaborative MIMO; 1:1 ratio).<sup>1</sup>

**Quality of Service (QoS):** The fundamental premise of the IEEE 802.16e media access control (MAC) architecture is QoS. Mobile WiMAX QoS features enable operators to optimize network performance depending on the service type (e.g., voice, video, gaming) and the user's service level. The standard defines service flows which can be mapped to fine, granular IP sessions or coarsely differentiated services code points to enable end-to-end IP based QoS. Additionally, sub-channelization and media access protocol (MAP) based signaling schemes provide a flexible mechanism for optimal scheduling of broadcast and unicast traffic on a frame-by-frame basis.

**Scalability:** Mobile WiMAX technology utilizes scalable OFDMA (SOFDMA) and, according to the initial Mobile WiMAX system profiles, has the capability to operate in channel sizes of 5, 7, 8.75, and 10 MHz to comply with various spectrum allocations worldwide.

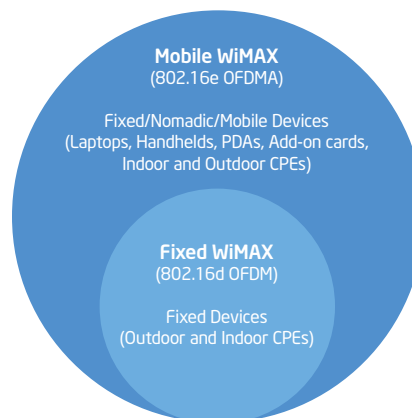
**Security:** Mobile WiMAX technology incorporates the most advanced security features currently used in IEEE 802 wireless access systems. These include Extensible Authentication Protocol (EAP)-based authentication, Advanced Encryption Standard (AES)-based authenticated encryption, Cipher-based Message Authentication Code (CMAC) and Hashed Message Authentication Code (HMAC)-based control message protection schemes.

Mobile WiMAX refers to the broadband wireless access technology based on the IEEE 802.16e and IEEE 802.16d standards. It is optimized from the ground up to be an all IP-based wireless technology suitable for fixed and mobile broadband wireless networks.

**Mobility:** Mobile WiMAX technology supports optimized handover schemes with latencies less than 50 ms to help ensure real-time applications such as Voice over Internet Protocol (VoIP) are efficiently supported without service degradation. Flexible key management schemes help assure security is maintained during handover.

### Mobile WiMAX does not Mandate Mobility

As stated earlier, Mobile WiMAX is equally applicable to fixed as well as mobile environments. This is due to the fact that the requirements for a fixed device are a subset of those for a mobile device. The additional features enabling mobility naturally extend WiMAX broadband wireless access from the fixed to the mobile case.



**Mobile WiMAX is a superset of Fixed WiMAX and supports fixed and mobile deployments simultaneously.**

### Access to the WiMAX Network

Access to the Mobile WiMAX network is possible through a wide selection of devices and form factors which support varying degrees of mobility such as:

- Indoor units, also called CPE or Customer Premise Equipment
- Outdoor units which are mounted outside a building and use high-gain antennas
- PC cards that fit into slots in a notebook/ laptop
- Embedded WiMAX network modules integrated into a notebook / laptop
- Handhelds and PDAs with WiMAX interfaces integrated on the system board.

### Performance Advantages of Mobile WiMAX

Mobile WiMAX is expected to deliver significant improvements over Fixed WiMAX which makes it even more attractive for fixed deployments. In wireless environments, link budget (measured in dB) and spectral efficiency are the two primary parameters used for evaluating system performance. Listed below are some of the improvements in link budget and/or spectral efficiency achievable by Mobile WiMAX which are equally applicable to fixed deployments:

- Convolutional Turbo Coding, Hybrid-Automatic Repeat Request (HARQ) and Frequency- as well as Time-Selective Scheduling adds up to 10 dB to the link margin, significantly increasing cell radius and spectral efficiency (bits per second per Hertz).
- Antenna techniques such as MIMO and AAS<sup>2</sup> can deliver almost a 50% improvement<sup>3</sup> in spectral efficiency over SISO/SIMO implementations as well as link budget improvements.
- Additional improvements to spectral efficiency and the support of users with different QoS come from the use of a two-dimensional (frequency and time) channel aware resource scheduling as well as interference cancellation at the devices.
- Additional reduction of the control overhead is enabled by the use of compressed MAP info.

- Use of sub-MAPs enables the base station to optimize the link to subscribers based upon their location, e.g., whether they're at the cell edge or close-in.
- Mobile WiMAX uses TDD (Time Division Duplex) as its duplexing mechanism which provides significant benefits for asymmetric data flows:
  - i. By their nature, FDD systems have symmetric DL and UL channel allocations. TDD allows the operator to vary DL vs. UL allocations. For example, by using a 3:1 DL to UL ratio instead of a symmetric, 1:1 ratio, the DL data rate can be increased by more than 50%.<sup>4</sup>
  - ii. Because the same channel is used for UL and DL for TDD, it allows for more efficient channel estimation which aids MIMO & AAS techniques.
- Efficient utilization of bandwidth for multicast/broadcast services, and power savings by implementing sleep/idle modes.
- The OFDMA-based air interface is designed to combat inter-cell interference by appropriate resource allocation in different cells. Note that typical multi-cell deployments can use a frequency re-use scheme of one: 1 (cluster) x 3 (number of sectors) x 1 (number of frequencies in the cell). This scheme results in the most efficient use of spectrum.

In summary, the significant performance gains of Mobile WiMAX enabled by the combination of advanced antenna techniques and other performance optimizations can not only improve the end user experience, but also significantly reduce the number of base stations required – and corresponding CapEx – for both capacity and coverage-challenged networks.

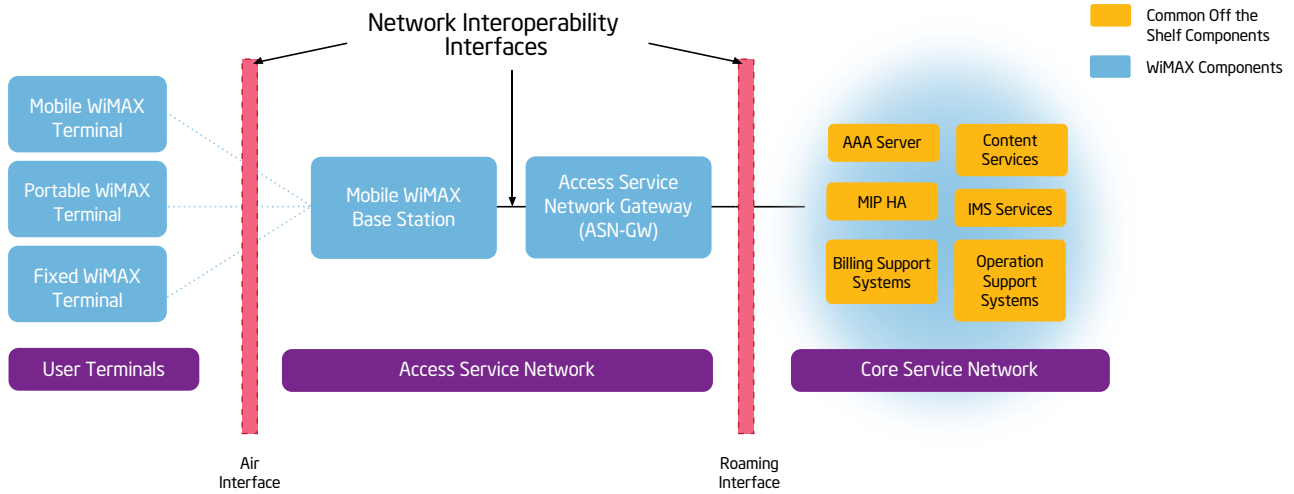
**Mobile WiMAX performance improvements can significantly reduce network deployment capital expenditures.**

<sup>2</sup> Advanced Antenna Systems such as beamforming.

<sup>3</sup> WiMAX Forum, 42.

<sup>4</sup> Ibid.

## Deployment Realities of Mobile WiMAX



### Single WiMAX Standard, Multiple Subscriber Types and Usage Models

Mobile WiMAX allows for the deployment of a single broadband wireless network which can cater to multiple subscriber types with varying needs for mobility. One network providing fixed, portable and mobile usage models best positions the service provider to take advantage of future opportunities as devices, usage models and regulations evolve.

### Prepare for the Future with Mobile WiMAX

Mobile WiMAX includes some of the most advanced, state-of-the-art features available for broadband wireless access systems today. Importantly, laptops with highly cost-effective, pre-integrated WiMAX will adhere to Mobile WiMAX certification profiles, enabling operators to take advantage of interoperable, WiMAX-capable laptops. Mobile WiMAX also allows for the deployment of scalable networks which can grow with the number of subscribers and their needs for mobility.

### Rich choice and flexibility of vendors supporting Mobile WiMAX

Nearly every equipment vendor affiliated with the WiMAX Forum has announced Mobile WiMAX product development and/or availability. This huge ecosystem of vendors results in rich choice, flexibility, and volume economics for Mobile WiMAX deployments.

### Leading Operators Worldwide are Choosing Mobile WiMAX

There are more than 400 WiMAX deployments and trials ongoing today.<sup>5</sup> Large-scale commercial deployment of Mobile WiMAX began in 2007 and is expected to grow significantly in 2008 and beyond.

Mobile WiMAX is a single worldwide standard for fixed and mobile deployments. The huge operator and vendor ecosystem for Mobile WiMAX creates the economies of scale and levels of innovation needed for cost-effective network deployment.

<sup>5</sup> WiMAXCounts.com in collaboration with Maravedis Research, Sept 2007.



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