Mobile WiMAX

Frequently Asked Questions

PacketMAX 5000

PacketMAX 4000

PacketMAX 540

PacketMAX 510

PacketMAX 700

PacketMAX 600

Is 16e the same as Mobile WiMAX?

Mobile WiMAX and Fixed WiMAX are terms coined by the WiMAX Forum to promote interoperability and conformance to the standard by Wireless MAN equipment vendors. Fixed WiMAX and 802.16d are popular names that refer to the 802.16-2004 standard. Similarly, widely used nicknames for 802.16e-2005 are 16e, 802.16e and Mobile WiMAX. Since it is only an amendment, the original document (802.16-2004) has to be read and then the amendments added to it. 802.16e does not automatically imply mobility. In most industry literature, however, the terms 802.16e and Mobile WiMAX are often used interchangeably to mean the same thing.

What is 16e or 802.16e?

802.16 is the name of the working group within the international industry body IEEE that works on development of globally standardized protocols for Wireless MAN or WiMAX. This body of professionals prepares the formal specifications for development of Broadband Wireless Access protocols. The letter next to 802.16 refers to the task group within the body that worked on the specifications. The currently used standard is IEEE 802.16-2004 (aka 802.16d). An amendment to this standard by task group E added support for mobile broadband and was approved in 2005. This is called IEEE 802.16e-2005 (802.16e or 16e for brevity). The standard sets the specifications for modulation, convergence, error-correction and quality-of-service parameters among others. Equipment based on this standard is expected to undergo certification in mid 2008 – allowing commercial deployment of certified networks in late 2008 to early 2009 time frame.

What is the difference between 16d and 16e?

802.16d is optimized for fixed point to multipoint deployments. The amendment that added support for mobility was called 802.16e. There are a number of technical differences between the two versions of the standard. The most notable are the support for Scalable OFDMA, handoff between base stations, antenna diversity techniques, partial sub-channel utilization and added quality of service classes that are available in 802.16e. These enhancements over 802.16d are primarily required to support mobility between sectors and increase indoor signal penetration allowing WiMAX to more effectively address the mass consumer market and laptop PC users.

	802.16d or Fixed WiMAX	802.16e or Mobile WiMAX
Physical Layer	OFDM	SOFDMA
Sub-channelization	DL Only	DL and UL (PUSC and FUSC)
Diversity Technique	SISO	MIMO Matrix A and Matrix B
BTS Handoff	None	Soft Handoff and Hard Handoff
QoS Classes	UGS, rtPS, nrtPS, and BE	UGS, rtPS, nrtPS, ertPS, and BE
Networking	Simple IP	Mobile IP
Target Applications	Fixed and some Nomadic Operation	Mobile operation requiring soft handoff

When will mobile broadband really come about?

The constructs "mobile" and "broadband" have never co-existed largely because the technology has never existed to couple these two constructs together. WiMAX is the first step toward delivering broadband connections to users on the move. Key enabling technologies including MIMO and OFDMA are part of the WiMAX certification profile scheduled for mid-2008 timeframe. Commercial networks built on certified systems may be deployable en masse starting in 2009. While most early networks will suite fixed, nomadic and portable applications, this will be the start of realizing true mobile broadband in the future. Many operators are looking for a way to drive revenue today while building toward the future of mobile broadband. To do this, operators should heavily leverage the existing standard, and already certified products - satisfying today's fixed and nomadic usage scenarios, but with the flexibility to achieve full mobility in the future. The desire for flexibility is driving operator equipment choices today. Therefore some operators are electing to deploy base stations meeting the 16d standard with the ability to accommodate 16e as an overlay network or completely migrate to 16e for true mobile broadband in the future.

What is MIMO?

In simple terms, MIMO (Multiple Input Multiple Output) is a wireless technology where the signal is transmitted using two or more antenna and similarly, there are two or more antenna at the receive end. Special algorithms are applied to extract the message from multiple streams of information arriving at the receiver end. MIMO mitigates the effects of multipath distortion, RF phenomena where different parts of the signal take different paths between the transmitter and receiver. Overall, increases the signal to noise ratio of the transmission, resulting in more reliable link quality and greatly increasing both range and capacity of the wireless system. Beamforming, another advanced antenna system technology, is commonly used to focus the transmitted signal onto one of more subscriber locations efficiently utilizing the power of the transmitter, however MIMO is more widely accepted for increasing the capacity and throughput of the cell. Therefore MIMO is required for WiMAX Forum certification and deployed first by most operators. Many see beamforming as a later possible addition. This figure shows a typical WiMAX subscriber station with dual antennas for MIMO operation.

I hear about equipment supporting Matrix A and Matrix B. What does that mean?

MIMO techniques can be used under different circumstances to achieve increased capacity, reliability, range and coverage. A logical design should include all these features in an adaptive manner. In WiMAX systems MIMO Matrix A refers to the Space Time Block Coding (STBC) technique and MIMO Matrix B refers to the Spatial Multiplexing (SM) technique. In Matrix A, a single data stream is transmitted as multiple redundant data streams orthogonal to each other. This increases the probability that the receiver will identify a strong signal even in the presence of physical path loss. On the other hand, Matrix B will split the signal and transmit each data stream from a different antenna element orthogonal to each other. This technique sends more information in the same time-frequency resource allocated to it, counting on multi-path to ensure that the streams arrive with sufficient delay between them for the receiver to discern the separate spatial signature. Where SNR is high, this approach greatly enhances capacity of the system. At the periphery of the cell, where noise is higher, Matrix A helps to enhance coverage and maintain link quality in presence of lower SNR. Therefore WiMAX systems should support both Matrix A and Matrix B. A common strategy is to switch between diversity and multiplexing.

If I want to roll-out fixed services, should I deploy 16d or 16e?

For rolling out fixed services, the choice of deploying 16d or 16e will depend largely on the number of customers and type of RF conditions served by the service provider. The following table gives a birds-eye view of the comparative performance of 16d and 16e in a fixed application for rural LOS deployments:

Comparison of 16d vs 16e for Rural LOS Deployments		
	802.16d-2004	802.16e-2005
PHY Efficiency	81.3%	64.4%
MAC Frame Efficiency	76.2%	74.8%
MAC & PHY Efficiency	62%	48.9%
Round-trip delay	25 ms	50-60 ms
Typical Cell Radius	5-15 Km typcial; up to 50 Km depending on RF Conditions	<5 Km
Certified Products	Since Jan 2006	April 2008 (2.3 GHz), June 2008 ETA (rest)

Comparison between 802.16d and 802.16e

Typically, 16d offers the following benefits in fixed service scenario:

- Low-cost, high-performance solution to deliver broadband services
- Field-proven, mature technology; one standard globally
- Equipment in both licensed and license exempt spectrum
- Rapidly deploy broadband services in remote and underdeveloped areas
- Operate as a complementary network to 3G, Cable, WiFi, and wire line networks

Many global operators have decided to deploy 802.16d based networks today, with a strong d?e migration program around them. This allows operators to start with 16d revenues immediately and evolve to 16e after the technology continues to mature in future.

Why is 16e better for mobility?

802.16e contains enhancements over the 802.16d standard that facilitates indoor operation and mobile access.
Scalable OFDMA – A scalable physical layer enables optimum performance delivery in channel bandwidths ranging from 1.25 MHz to 20 MHz with fixed sub-carrier spacing for both fixed and portable/mobile usage models, while keeping the product cost low. The concept of scalability was introduced to the PHY in 802.16e.

Sub-Channelization – Sub-channeling concentrates the transmit power into fewer carriers effectively increasing the system gain. Increased gain can be used to extend the reach of the system, overcome the building penetration losses, and or reduce the power consumption of the CPE. This is particularly useful for mobile applications where significant usage will occur indoors—at homes, café and offices.

MIMO – WIMAX PHY layer takes advantage of time diversity through interleaving, frequency diversity through OFDM and spatial diversity through MIMO techniques. Antenna diversity using multiple antenna systems such as MIMO play an important role in the 802.16e specifications for improved link reliability, increases in cell capacity yielding higher data rates and increased coverage.**IP Mobility (Handoff)** – The ability to support seamless handoff is the over-riding concern in designing networks for mobility. Handoff can be base station, mobile terminal or network initiated. In addition to the physical handoff, the NWG has defined an end-to-end infrastructure for IP based network that supports the process of inter-vendor and inter-network handover to ensure continuity of authentication, billing, security and ongoing session.

Power saving mechanisms – Mobile subscriber terminals must be small and light in order to be carried conveniently. To preserve the limited battery-life in such terminals, mobile WiMAX implements Active, Idle, Sleep and Inactive modes depending on activity levels between base station and subscriber units.

What is the expected cell radius in 16e?

In wireless technology, there is always a trade-off between range and capacity. 802.16e is contains many enhancements to enable greater capacity and greater coverage for mobile applications. Sub-channels on uplink and downlink, MIMO antenna techniques and high-power radios are employed to increase subscriber capacity within the same time-frequency slot and reach farther using the same amount of energy. The radio plan for mobile WiMAX must provision for visiting subscribers and higher percentage of indoor consumers, in addition to terrain, interference, tower height, channel bandwidth and other such considerations. The typical cell-radius for mobile WiMAX networks ranges from a couple of kilometers for 16e deployments. On the other hand 802.16d networks operate over much larger distances of up to tens of kilometers, - optimized for fixed and nomadic operations and largely outdoor subscribers.

Do we require a license for deploying a 16e network?

Lower frequencies provide the necessary link budget to support mobile applications. Initial development of 802.16e equipment is being considered for the licensed-bands in 2 GHz and 3 GHz using TDD.. License-exempt spectrum is typically found in high frequency bands. Robust, high-capacity 802.16d networks can be rolled out in high-frequency bands without requiring a license.

What is nomadic, portable and mobile access?

Non-fixed broadband wireless access may be categorized as follows:

Usage Model	SS/MS Mobility	Performance
Nomadic	0 km/hour	Subscriber station is detected andprovisioned by the network without requiring reconfiguration when moved to a different location. Session continuity is not required.
Portable	5 km/hour	Base station link is maintained when subscriber station is moving at pedestrian speed, usually within the sector.
Simple Mobility	60 km/hour	Up to 60 km/h with no performance degradation, 60 to 120 km/h with graceful (non-abrupt) performance degradation; handover supported
Full Mobility	120 km/hour	Up to 120 km/h with no performance degradation; real-time and non-real time applications supported with handover

When will the first mobile WiMAX certified products come out?

In the first phase, the WiMAX Forum has applied its seal of approval on the WiBro products developed in Korea. The first wave of SISO mobile WiMAX products in 2.3 GHz band was certified in April 2008. Only a handful of operators participated in the non-MIMO Wave 1 certification process due to the limited appeal of Wave 1 outside of South Korea. The subsequent certification for mobile WiMAX products in the 2.5 GHz and 3.5 GHz band is expected to be completed by Q2 2008. The Wave 2 feature-set is more comprehensive and better suited to large-scale indoor and mobile commercial deployments globally.

Will certification really ensure vendor interoperability?

The certification process ensures basic link connectivity between different certified vendor equipment and is an important milestone towards standardization of the industry. Some vendors have taken a leadership position driving programs to ensure interoperability beyond the basic connectivity. ApertoWiSE™ is a prime example of such cooperative initiative. Aperto's WiMAX Solution Ecosystem (ApertoWiSE) is a collaborative effort for validating end-to-end solutions before they are deployed. ApertoWiSE matches best-of-breed systems in multi-way interoperability testing of CPE, mobile terminals, ASN gateways and CSN platforms and 802.16e compliant base stations. ApertoWiSE™ allows the operator to select from a variety of certified systems with the assurance that it will optimally interoperate with systems based on the PacketMAX Solutions Architecture – open standards based solution approach driven Aperto Networks.

About Aperto Networks:

Aperto Networks helps leading service providers deliver affordable wireless voice and broadband profitably by building the world's most advanced WiMAX base stations and subscriber units. Aperto fundamentally changes the economics of delivering voice and broadband services through IP-rich, point-to-point and point-to-multipoint networks, allowing carriers to offer a wider variety of services to more customers using less equipment. Its carrier-class WiMAX technology offers industry-leading subscriber density, quality of service, ease of use and reliability. Aperto is a founding board member of the WiMAX Forum as well as a founder and lead contributor to IEEE 802.16 and the ETSI-BRAN standards. Serving more than 400 customers in over 90 countries, Aperto Networks is based in Milpitas, California. For more information on Aperto Networks, go to www.apertonet.com.

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