



Which WiMAX Are You?

Aperto Networks
4G World, September 2009

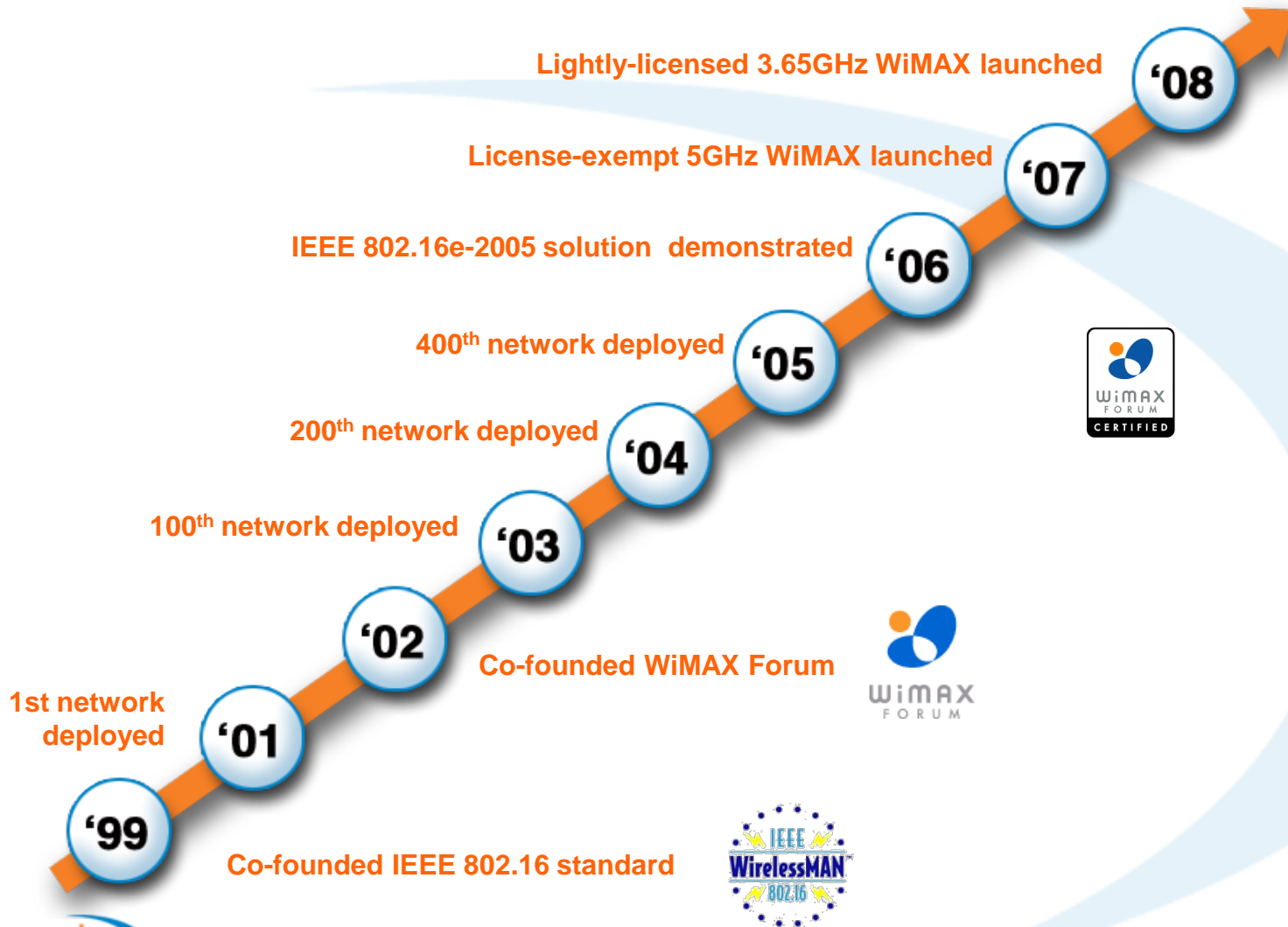
A Decade of Wireless Broadband Leadership.

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- Is There More Than One Kind of WiMAX?
- Some Comparisons By The Numbers
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Aperto WiMAX Leadership



Aperto Awards and Patents



- 16 patents received
 - Link optimization
 - QoS
 - Wireless backhaul
- 7 patents pending

Aperto Customers: 400 Customers/90 Countries/6Continents

Asia



Middle East & Africa



Eastern Europe



Latin America



Western Europe



North America



Aperto Advantage

- Over 400 802.16 customers in more than 70 countries
- One of the most experienced 3.3 GHz WiMAX providers in the world with significant deployments in India, E. Europe, Africa and Indonesia
- More than 10 years of 802.16 experience
- ~ 20 patents for QoS, Air Link Management and Scheduling
- Wide array of technology available include 802.16d and 802.16e technologies
- Well known for outstanding technology, responsive support and helping to engineer and build solid 'carrier class' networks that are cost effective and rock solid
- Founding Board Member and only private company on WiMAX Forum Board
- Hold very first WiMAX certification issued from the WiMAX Forum



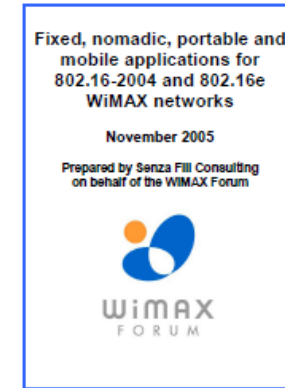
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Which WiMAX Are You
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There is More Than One Type?

There Are Two Types of WiMAX

From the Executive Summary of the WiMAX Forum's own paper, dated November 2005:

“The WiMAX Forum is committed to providing optimized solutions for fixed, nomadic, portable and mobile broadband wireless access.



Two versions of WiMAX address the demand for these different types of access:

- 802.16-2004 WiMAX. This is based on the 802.16-2004 version of the IEEE 802.16 standard and on ETSI HiperMAN. It uses Orthogonal Frequency Division Multiplexing (OFDM) and supports fixed and nomadic access in Line of Sight (LOS) and Non Line of Sight (NLOS) environments.
- 802.16e WiMAX. Optimized for dynamic mobile radio channels, this version is based on the 802.16e amendment and provides support for handoffs and roaming.”

Which WiMAX For What?

Here again is what the Forum says (page 11 & 12 of the same document):

“...the performance of **the two versions of WiMAX can change substantially for specific applications**, because **802.16-2004 is optimized for fixed access** and 802.16e for mobile access, although it can also be used for fixed access. Fixed networks can benefit from the many advantages offered by 802.16-2004 WiMAX Forum CERTIFIED products:

- **Less complex modulation.** OFDM is a simpler modulation technique that is better suited to deployments that do not require support for mobility.
- **License-exempt bands.** Mobile services require licensed spectrum to provide coverage in wide areas. Fixed deployments, however, have often successfully used license-exempt bands in areas where interference levels are acceptable. For this reason, most profiles targeting license-exempt bands are likely to be based on 802.16-2004.
- **Higher throughput.** Higher spectrum bands selected for the 802.16-2004 profiles result in higher throughput. This is a clear advantage, especially when targeting enterprise users with higher traffic levels and with CPEs with outdoor antennas.”

What About E?

Once again, let's see what the WiMAX Forum says (page 12):

- “Support for mobility. 802.16e products are optimized for mobility and will support handoffs at up to 120 kph. Support for power-saving and sleep modes will extend the battery life of mobile user devices.
- Better indoor coverage. The better indoor coverage achieved through subchannelization and the AAS option benefits both fixed and mobile applications, because users are often indoors or not within line of sight. However, while outdoor antennas can compensate for limited indoor coverage in fixed deployments, this is clearly not an option for mobile users with a laptop or a PDA.
- Wider range of form factors for user devices. While outdoor and indoor CPEs, and laptop PCMCIA cards are expected to dominate the 802.16-2004 market, laptop PCMCIA cards, mini cards, indoor modems, PDAs, and phones will be available among 802.16e user devices. This variety allows operators to extend their services to new market segments and to give more freedom to their subscribers.”

802.16d WiMAX – Optimized for Fixed

- When expected application is enterprise-sized scale end connectivity for voice (VoIP) and data (Internet and intranet traffic) and video (distance learning/telemedicine).
 - Requires significant and available upstream capacity, which 802.16d is designed for vs. single user (portable device or indoor residential modem) experience expected of 802.16e.
 - 802.16d permits both symmetric and highly configurable upstream/downstream asymmetry. 802.16e is designed for sub-1mb/s upstream.

Service offerings of the two largest U.S. 802.16e operators:

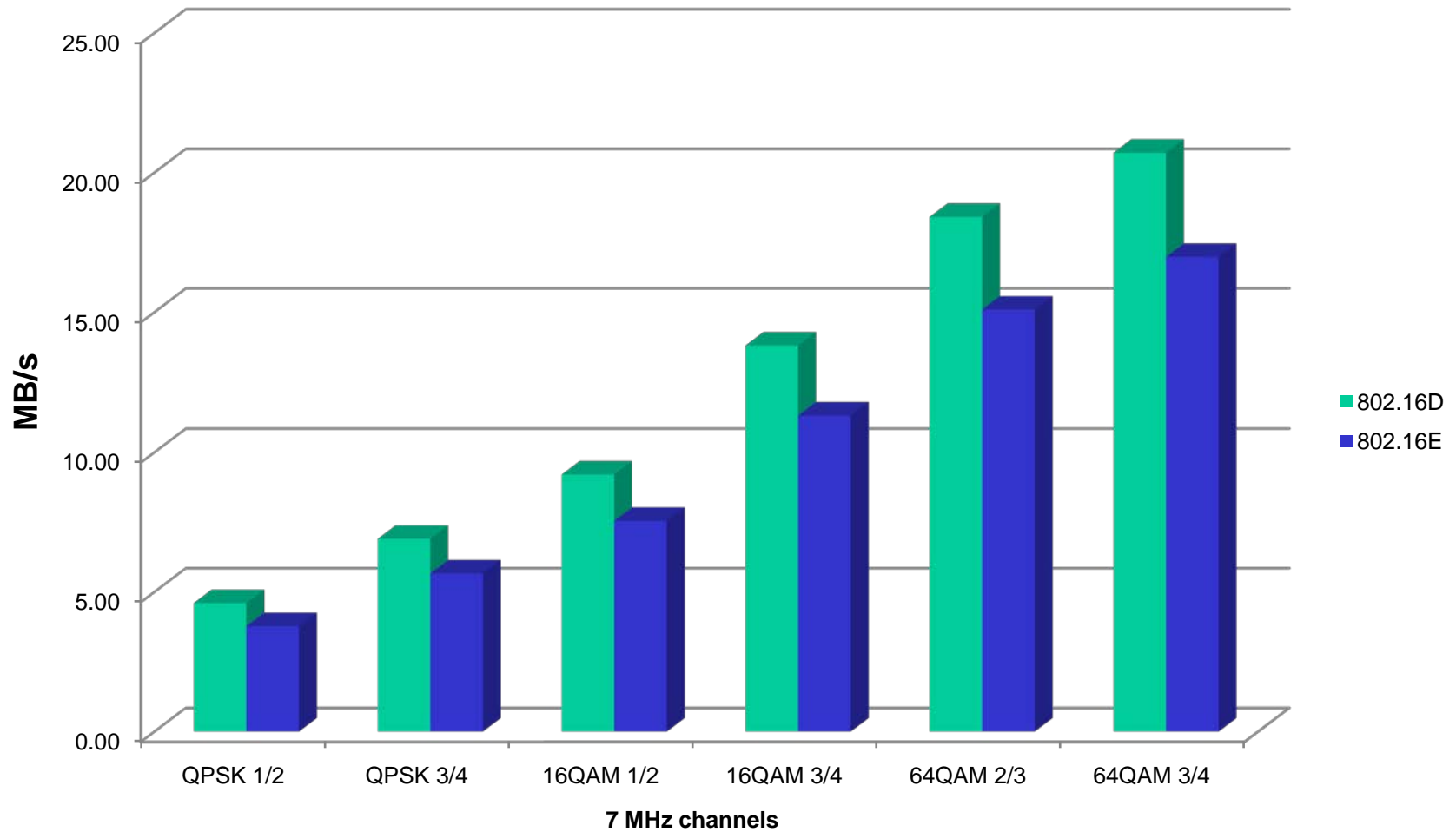
- 1. Clearwire <http://www.clearwire.com/products/gallery.php>:
Up to 2 Mb down/256 k up
- 2. Digital Bridge Communications
<http://www.digitalbridgecommunications.com/OurServices/AtHome/tabid/61/Default.aspx>:
Up to 2 Mb down/768 k up



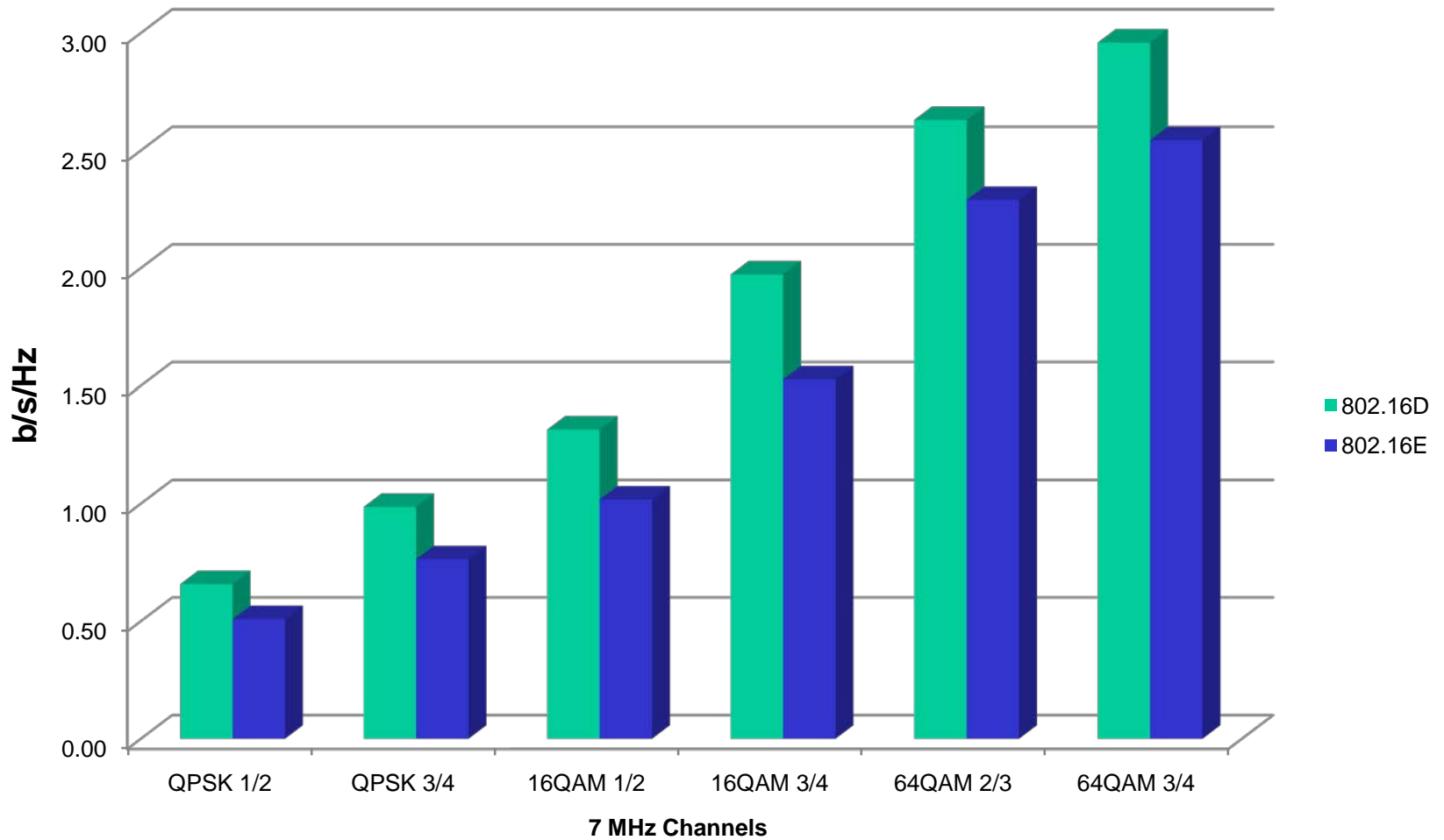
Which WiMAX Are You

Some Comparison By The Numbers

Data Rate - Comparison of 'D' vs 'E'



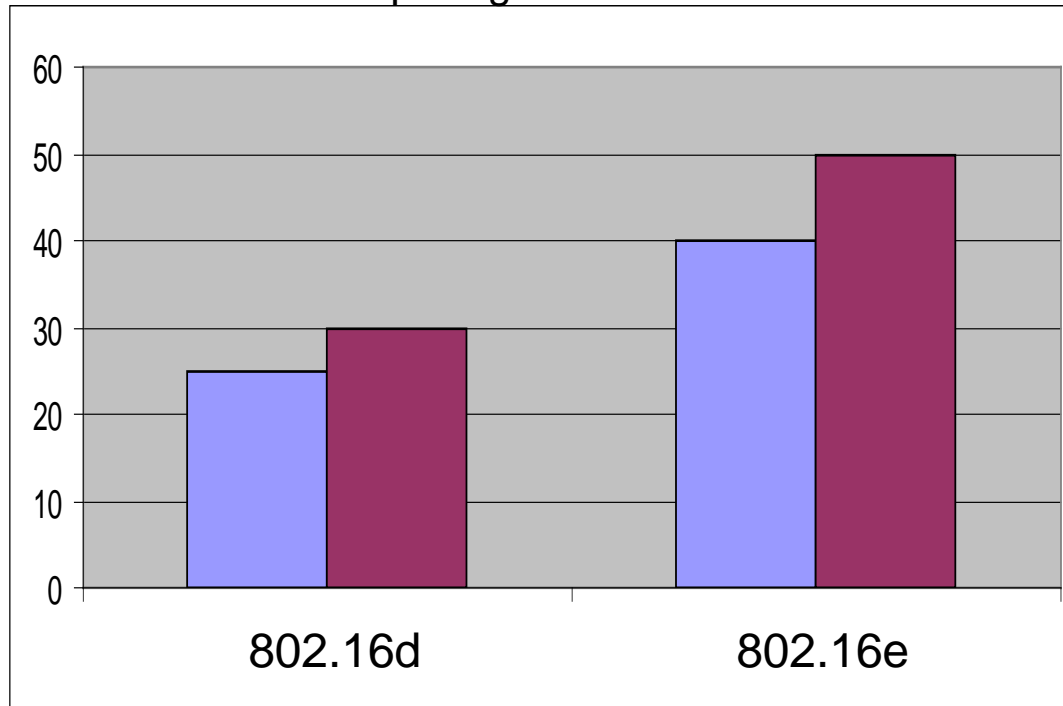
Spectral Efficiency - Comparison of 'D' vs 'E'



Latency Comparison

Latency Range per Standard

Round Trip Ping Times in Milliseconds



“In video conferencing and telephony, noticeable delay makes a conversation impossible, unless a “walky-talky” like protocol is strictly followed. This makes the conversation unnatural and cumbersome. Sub-33ms latency for the video codec is required in these applications.” – EETimes, January 16, 2008

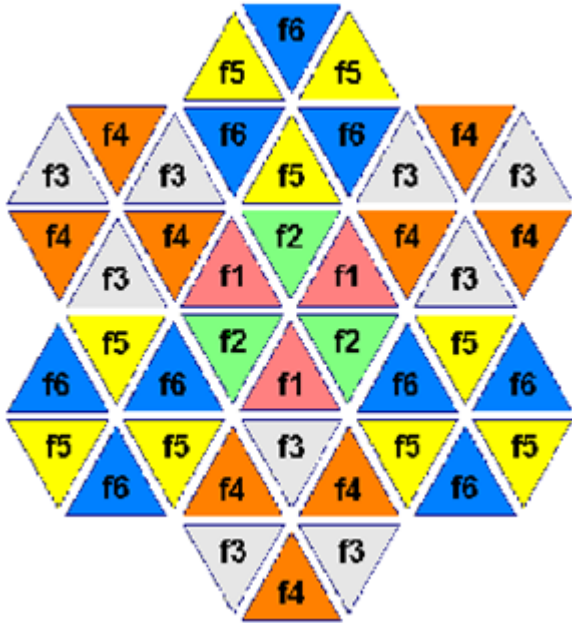
Diversity Cost Comparison

- Diversity may be the one benefit of using E in 3.65 GHz, but at what price?

802.16e Pricing per Cell					
		4TH ORDER		2ND ORDER	
<i>36 mbps aggregate in either case</i>					
ITEMS - BASE STATION	UNIT	QTY	EXT	QTY	EXT
Chassis	\$ 2,600	1	\$ 2,600	1	\$ 2,600
Chassis Power Supply	\$ 520	3	\$ 1,560	3	\$ 1,560
Network Processing Unit	\$ 5,980	1	\$ 5,980	1	\$ 5,980
Power Injection Unit	\$ 624	2	\$ 1,248	2	\$ 1,248
Base Station Cards	\$ 4,680	3	\$ 14,040	3	\$ 14,040
Power Cord	\$ 26	1	\$ 26	1	\$ 26
GPS Radio	\$ 1,040	1	\$ 1,040	1	\$ 1,040
GPS Card	\$ 416	1	\$ 416	1	\$ 416
Timing Cable	\$ 65	1	\$ 65	1	\$ 65
Base Station Radio	\$ 3,380	12	\$ 40,560	6	\$ 20,280
Dual Polarity Antenna	\$ 1,820	6	\$ 10,920	3	\$ 5,460
IF Jumper Cable	\$ 98	12	\$ 1,170	6	\$ 585
Ntwrk Mgmt, inclu. Licenses for 500 CPE	\$ 14,325	1	\$ 14,325	1	\$ 14,325
tal Base Station			\$ 93,950		\$ 67,625
COMMON ACCESSORY - REMOTE ANTENNA TILT ITEMS			\$ 12,708		\$ 8,223
Grand Total			\$ 106,658		\$ 75,848

- Aperto can deliver a complete 3-sector 802.16d cell with 60 mbps capacity, including management for **under \$25k**.

How to Scale Coverage w/o Subchannelization



3.5 - 7.0 MHz Channel Width for Wireless Sectors

7.0 MHz Channel = 20 Mbps B/W per Sector

Range can exceed 20 km for LoS locations

Blanket Coverage

- 6 x 7 MHz Channels using 42 MHz
- Cell Capacity 120 Mbps
- Cover greater area with Base Station





Which WiMAX Are You

A Note About 3.65 GHz

WiMAX in 3.65 GHz

- Many expected E benefits not achievable in 3.65 GHz.
 - There is no ecosystem for 3.65 GHz.
 - There are no indoor modems for 3.65 GHz. FCC allowed power is too low.
 - There is little to no interoperability for 3.65GHz.
 - There are no PC cards, chips in laptops or USB dongles for 3.65 GHz.

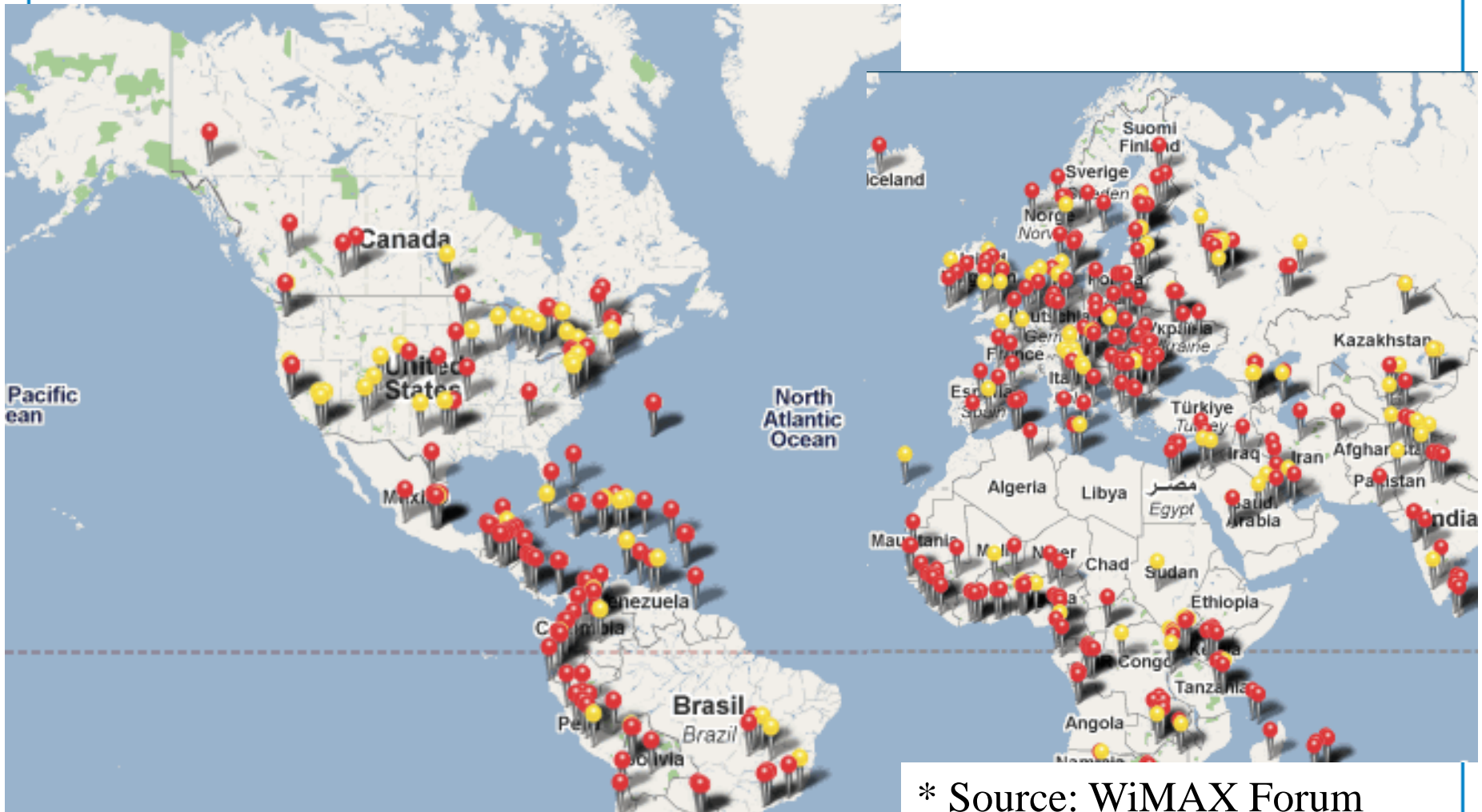




Which WiMAX Are You

So Which WiMAX is Most Widely Accepted?

'D' Deployments in Red*



* Source: WiMAX Forum



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A Word About “Upgrading”

Can an Apple be Upgraded to a Tomato?

I love both, but I'm certain my apple pie won't be improved by using tomatoes instead of apples.



Upgrading

- The standards deploy distinct hardware at the chip level. Neither base stations nor CPE are upgradeable via software, only via forklift. The market knew way back in 2005 that D cannot be upgraded to E.
 - Dec 7, 2005 ... 802.16e doesn't seem to be compatible with 802.16d, there are some ... is no simple upgrade path for 16d base-stations to 16e base-stations.
gigaom.com/2005/12/07/mobile-wimax-standard-approved/
 - 802.16d chips are made by established companies like Fujitsu and Wavesat vs. 802.16e chips being produced by start-ups like Picochip and Design Arts.
- It is still uncertain that 802.16e will be upgradeable to 802.16e:
 - “Part of WiMAX's advantage, Resnick emphasizes, is that the WiMAX Forum **expects** 802.16m will be backwards compatible with 802.16e.” (March 3, 2007). Expects is not the same as “will,” and early on the WiMAX Forum made claims that D would be upgradeable to E as well.



So...

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Which WiMAX Are You

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Summary

- There are two valid WiMAX Forum certified standards
 - 802.16D-2004 ~ Fixed Broadband
 - 802.16E-2005 ~ Mobile Broadband
- Choose 802.16D when:
 - The requirement is Fixed Locations
 - You are connecting enterprises with multiple users behind the CPE
 - You require large upstream for your application, like video
 - You require minimum latency, like voice, especially multi-line enterprise VoIP and video conferencing
 - You want the most efficiency from your bandwidth
 - Lightly licensed or license exempt
- Choose 802.16E when:
 - The requirement is Mobile
 - You own a spectrum license in a broad area
 - Indoor install
 - non-window mount – window mount can use ‘D’



Which WiMAX Are You

Thank You.....Questions?

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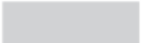
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Product Strategy

Standards	IEEE 802.16-2004; IEEE 802.16-2005
Frequency	2.x GHz, 3.x GHz, 5.x GHz
Base Stations	Macro, Micro
Subscriber Units	Outdoor, Indoor, PC Card, USB Dongle
Radios	SISO, MIMO
Management	Element Managing System

WiMAX Bands

	2.3- 2.4 GHz	2.5- 2.7 GHz	2.7- 2.9 GHz	3.3-3.4 GHz	3.4-3.6 GHz	3.65-3.7 GHz	3.6-3.8 GHz	4.9-5.0 GHz	5.1-5.3 GHz	5.4-5.7 GHz	5.7-5.9 GHz
PM 5000											
PM 4000											
PM 3000											
PM 120											
PM 320											
PM 400											
PM 500											
PM 600											

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PacketMAX: A Decade of Wireless Broadband Leadership

Then add

+

Patented Link Management

+

Quality of Service

+

Advanced Networking Features

+

Carrier-Grade Features

+

Provisioning & Management

+

Solution Flexibility

We start with



The result:

PacketMAX[®]

A Decade of Wireless
Broadband Leadership

PacketMAX Base Stations






PM 3000



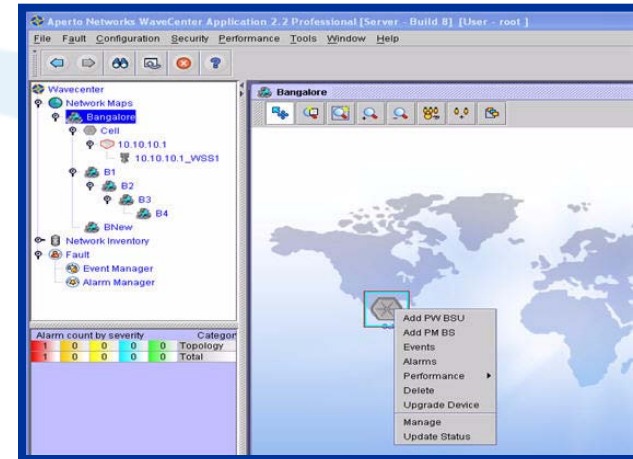
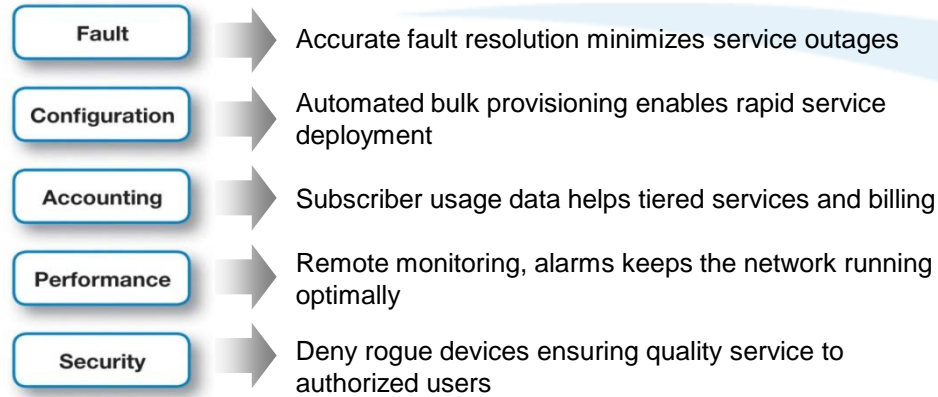
PM 5000



PM 4000

Description	Micro 1U Stackable	Macro 5U ATCA Chassis	Micro 2U Stackable
Indoor Unit	Single Sector	1 to 12 Sectors	1 to 4 Sectors
Bands	2.3-2.7 GHz 3.3-3.8 GHz, 5.15-5.925 GHz		2.3-2.4 GHz 2.5-2.7 GHz 3.3-3.8 GHz
WiMAX Standards			
Management	Common Element Management System 		

Network and Service Management



- Aperto **WaveCenter EMS Pro** – one platform for managing both 16d and 16e elements
- Use existing business and operational support systems for service provisioning and management
- Scalable platform and full FCAPS functionality to extract the maximum potential of PacketMAX