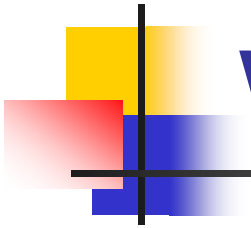
What is WiMax?

- WiMax (Worldwide Interoperability for Microwave Access) is a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL.
- The technology is specified by the Institute of Electrical and Electronics Engineers Inc., as the IEEE 802.16 standard.

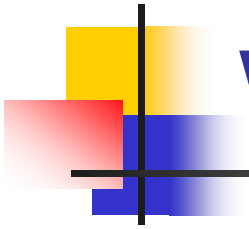
WiMax Forum

- It is a non-profit industry body dedicated to promoting the adoption of this technology and ensuring that different vendors' products will interoperate.
- It is doing this through developing conformance and interoperability test plans and certification program.
- WiMAX Forum Certified™ means a service provider can buy equipment from more than one company and be confident that everything works together.



WiMax Technology

- WiMAX is expected to provide fixed , nomadic, portable and, eventually, mobile wireless broadband connectivity without the need for direct line-of-sight (LOS) with a base station.
- In a typical cell radius deployment of three to ten kilometers, WiMAX Forum Certified™ systems can be expected to deliver capacity of up to 40 Mbps per channel, for fixed and portable access applications.
- Mobile network deployments are expected to provide up to 15 Mbps of capacity within a typical cell radius deployment of up to three kilometers.



Why is it Interesting?

- Simultaneously support hundreds of businesses with T-1 speed connectivity and thousands of homes with DSL speed connectivity.
- Promise of potential low cost and flexibility in building broadband networks.
- Scalability, as extra channels and base stations can be added incrementally as bandwidth demand grows.
- Support for both voice and video as well as Internet data.
- Semiconductor vendors envisage WiMax-enabled chips appearing in PCs in 2006 and in notebook computers and PDAs by 2007

Wi-Fi: The Predecessor of WiMax

- Wi-Fi (Wireless Fidelity) is a set of technologies that are based on the IEEE 802.11a,b, and g standards.
- Wi-Fi is considered to be one of the first widely deployed fixed broadband wireless networks.
- The Wi-Fi architecture consists of a base station that wireless hosts connect to in order to access network resources.
- As long as the users remain within 300 feet of the fixed wireless access point, they can maintain broadband wireless connectivity.

Wi-Fi Standards

Standard	Throughput	Range	Frequency
802.11a	Up to 54 Mbps	Up to 300 ft	Between 5 and 6 Ghz
802.11b	Up to 11 Mbps	Up to 300 ft	2.4 Ghz
802.11g	Up to 54 Mbps	Up to 300 ft	2.4 Ghz

Strengths of Wi-Fi

- Simplicity and ease of deployment given that it uses unlicensed radio spectrum which does not require regulatory approval.
- Cost of rolling out this wireless solution is low.
- Users are able to be mobile for up to 300 feet from the access point.
- There are many Wi-Fi compatible products that are available at a low cost and can interoperate with other network technologies. Wi-Fi clients can work seamlessly in other countries with minimal configuration.

Weaknesses of Wi-Fi

- Limited level of mobility.
- Susceptible to interference.
- Designed technically for short-range operations and basically an indoors technology.
- Security is a concern.

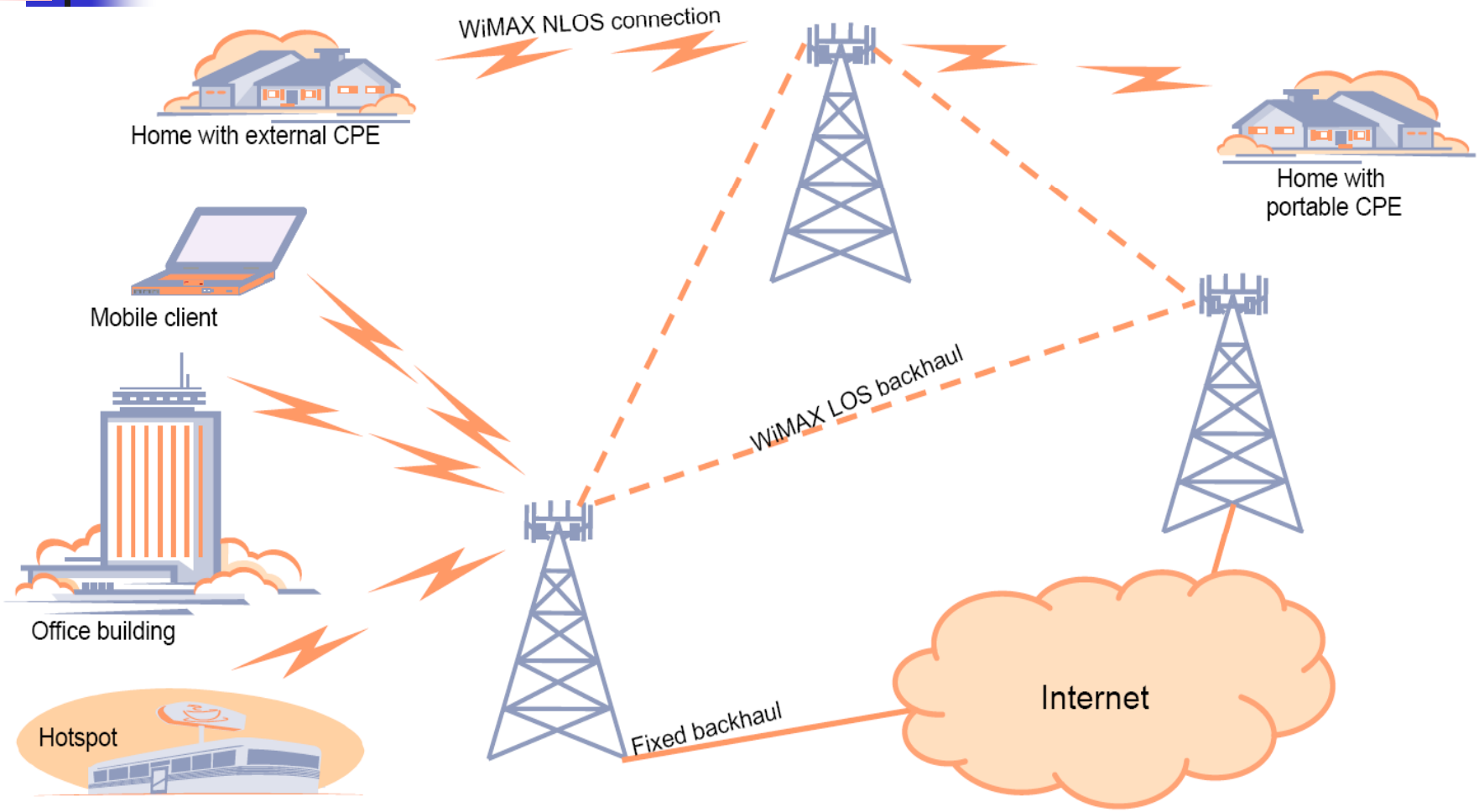
Relation of Wi-Fi and WiMax

- WiMax eliminates the constraints of Wi-Fi.
- Unlike Wi-Fi, WiMax is intended to work outdoors over long distances.
- WiMax is a more complex technology and has to handle issues of importance such as QoS guarantees, carrier-class reliability, NLOS.
- WiMax is not intended to replace Wi-Fi. Instead, the two technologies complement each other.

WiMax Standards

	802.16	802.16a	802.16-2004	802.16e-2005
Date Completed	December 2001	January 2003	June 2004	December 2005
Spectrum	10-66 GHz	< 11 GHz	< 11 GHz	< 6 GHz
Operation	LOS	Non-LOS	Non-LOS	Non-LOS and Mobile
Bit Rate	32-134 Mbps	Up to 75 Mbps	Up to 75 Mbps	Up to 15 Mbps
Cell Radius	1-3 miles	3-5 miles	3-5 miles	1-3 miles

WiMax is well suited to offer both fixed and mobile access



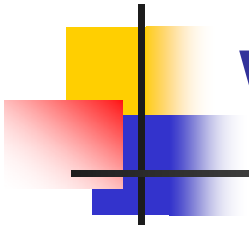
How WiMax Works

- WiMax can provide 2 forms of wireless service:

  - Non-LOS, Wi-Fi sort of service, where a small antenna on a computer connects to the tower. Uses lower frequency range (2 to 11 GHz).

  - LOS, where a fixed antenna points straight at the WiMax tower from a rooftop or pole. The LOS connection is stronger and more stable, so it is able to send a lot of data with fewer errors. Uses higher frequencies, with ranges reaching a possible 66 GHz.

- Through stronger LOS antennas, WiMax transmitting stations would send data to WiMax enabled computers or routers set up within 30 (3,600 square miles of coverage) mile radius.



WiMax Rollout

- WiMax Forum anticipates rollout of its technology in 3 phases:

  - Phase 1: Fixed Location, Private Line Services, Hot Spot Backhaul.

  - Phase 2: Broadband Wireless Access/Wireless DSL

  - Phase 3: Mobile/Nomadic Users.

WiMax Spectrum

- Broad Operating Range
- WiMax Forum is focusing on 3 spectrum bands for global deployment:
- Unlicensed 5 GHz: Includes bands between 5.25 and 5.85 GHz. In the upper 5 GHz band (5.725 – 5.850 GHz) many countries allow higher power output (4 Watts) that makes it attractive for WiMax applications.
- Licensed 3.5 GHz: Bands between 3.4 and 3.6 GHz have been allocated for BWA in majority of countries.
- Licensed 2.5 GHz: The bands between 2.5 and 2.6 GHz have been allocated in the US, Mexico, Brazil and in some SEA countries. In US this spectrum is licensed for MDS and ITFS.

Benefits of Licensed and License-Exempt Solutions

Licensed Solution	License-Exempt Solution
Better QoS	Fast Rollout
Better NLOS reception at lower frequencies	Lower Costs
Higher barriers for entrance	More worldwide options

Technical Similarities and Differences Between Licensed and License-Exempt Bands

- Both solutions are based on IEEE 802.16-2004 standard, which uses OFDM in the physical (PHY) layer.
- OFDM provides benefits such as increased SNR of subscriber stations and improved resiliency to multi-path interference.
- For creating bi-directional channels for uplink and downlink, licensed solutions use FDD while license exempt solutions use TDD.

Time Division Duplexing (TDD)

Description	A duplexing technique used in license-exempt solutions, which uses a single channel for uplink and downlink.
Advantages	Enhanced flexibility, easier to pair with smart antenna technologies, asymmetrical.
Disadvantages	Cannot transmit and receive at the same time.
Usage	“Bursty”, asymmetrical data applications, environments with varying traffic patterns, where RF efficiency is more important than cost.

Frequency Division Duplexing (FDD)

Description	A duplexing technique used in licensed solutions that uses a pair of spectrum channels, one for the uplink and another for the downlink.
Advantages	Proven technology for voice, designed for symmetrical traffic, does not require guard time.
Disadvantages	Cannot be deployed where spectrum is unpaired, spectrum is usually licensed, higher cost associated with spectrum purchase.
Usage	Environments with predictable traffic patterns, where equipment costs are more important than RF efficiency.

Challenges to Overcome in WiMax Deployment

- **RF Interference:** Disrupts a transmission and decreases performance. Common forms are multi-path interference and attenuation. Overlapping interference generate random noise.
- **Infrastructure Placement:** The physical structure that houses or supports the base station must be RF friendly. A metal farm silo, for example, may distort signals, or a tree swaying in the wind may change signal strength. Obstacles such as trees and buildings frequently block signal paths. High RF activity in the area can cause interference.

Solving the challenges in WiMax Deployment

- Proper network design and infrastructure placement are critical for solving the challenges.

  - Subscriber Site Survey, Statistics Gathering, coordination of RF use with neighbouring providers.

  - Antennas (Type, Tilt Angles, Array Gain, Diversity Gain)

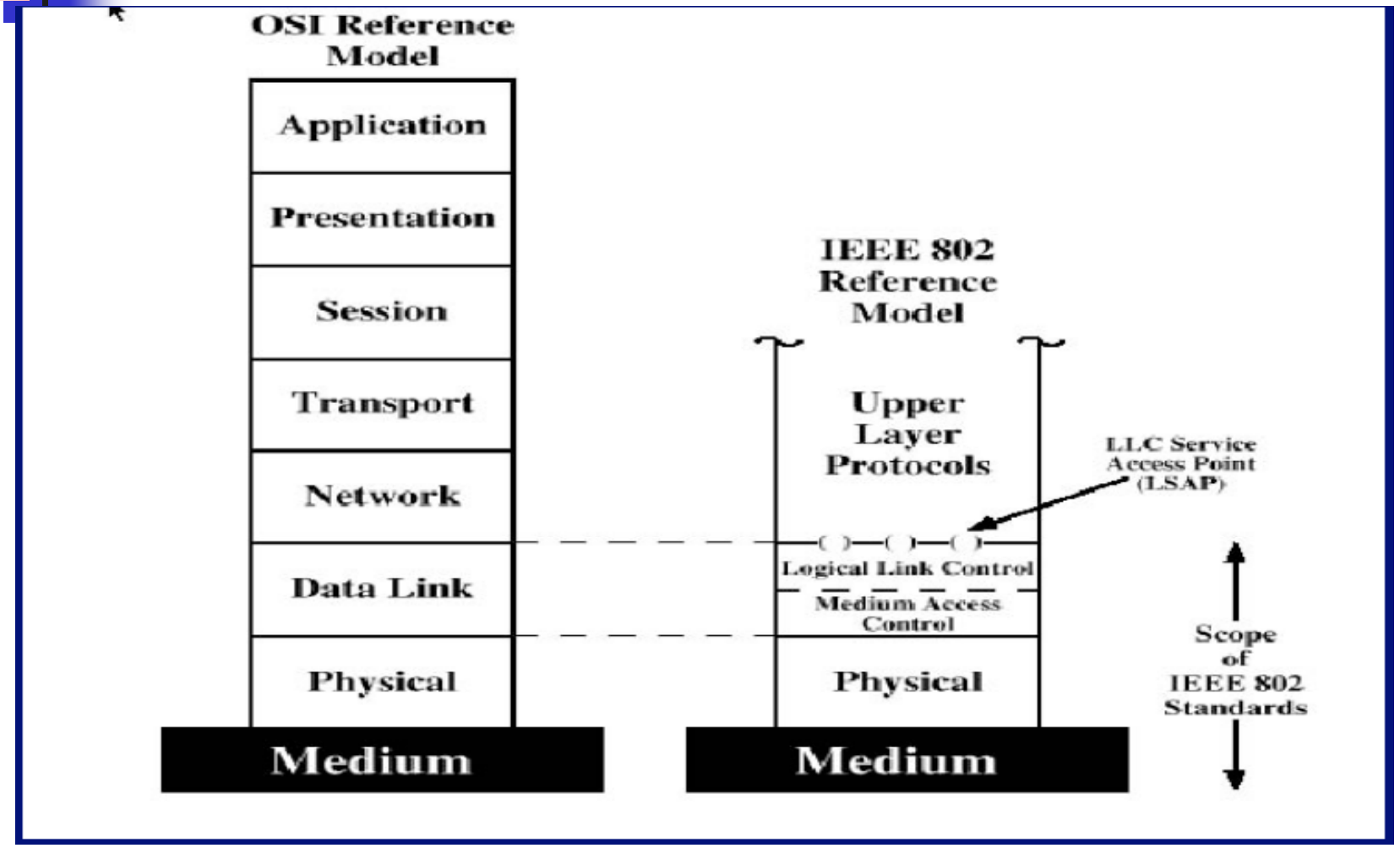
  - Proper design and deployment of the provider's NOC.

  - Well deployed base station or cells with 24/7 access, RF friendly structure, and shielding from weather elements.

Orthogonal Frequency Division Multiplexing (OFDM)

- All profiles currently defined by the WiMax Forum specify the 256-carrier OFDM air interface.
- Allows digital signal to be transmitted simultaneously on multiple RF carrier waves. Adaptable to NLOS schemes.
- Resistant to multi-path effects.
- Spectrally efficient technique to transmit wireless digital data.
- Able to deliver higher bandwidth efficiency.
- There are some obstacles in using OFDM in transmission system in contrast to its advantages. A major obstacle is that the OFDM signal exhibits a very high Peak to Average Power Ratio (PAPR).

Scope of 802 standards



PHY Layer Features of IEEE 802.16-2004

Feature	Benefit
256 point FFT OFDM waveform	Built in support for addressing multi-path in outdoor LOS and NLOS environments.
Adaptive Modulation and variable error correction encoding per RF burst	Ensures a robust RF link while maximizing the number of bits/second for each subscriber unit.
TDD and FDD support	Addresses varying worldwide regulations when one or both may be allowed

PHY Layer Features of IEEE 802.16-2004(Continued)

Feature	Benefit
Flexible Channel Sizes (Can be an integer multiple of 1.25 MHz, 1.5 MHz, and 1.75 MHz with a maximum of 20 MHz.	Provides the flexibility to operate in many different frequency bands with varying channel requirements around the world.
Designed to support smart antenna systems.	Smart antennas can suppress interference and increase system gain. They are becoming important to BWA deployment as their costs come down.

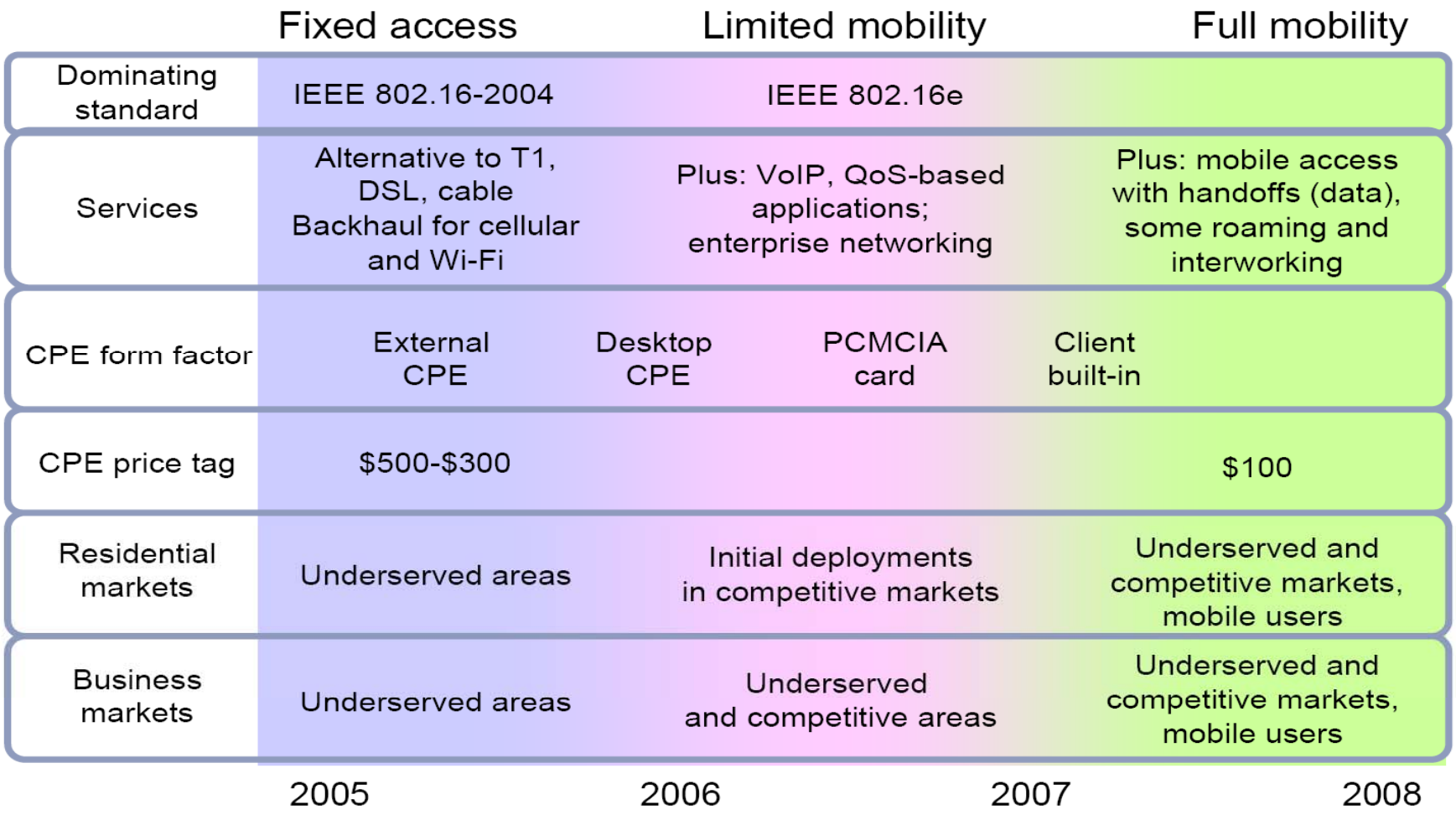
MAC Layer Features of IEEE 802.16-2004

Feature	**Benefit**
TDM/TDMA Scheduled Uplink/Downlink frames.	Efficient bandwidth usage
Scalable from 1 to hundreds of subscribers	Allows cost effective deployments by supporting enough subscribers to deliver a robust business case
Connection-oriented	• Per Connection QoS • Faster packet routing and forwarding

MAC Layer Features of IEEE 802.16-2004 (Continued)

Feature	Benefit
QoS	• Low latency for delay sensitive services • Optimal transport for video, Data prioritization
ARQ	• Improves end-to-end performance by hiding RF layer induced errors from upper layer protocols
Adaptive Modulation	• Enables highest data rates allowed by channel conditions, improving system capacity
Security and Encryption	• Protects user privacy
Automatic Power Control	• Minimizes self interference

WiMax Evolution Path Leads to Mobile Access



802.16e-2005 Standard (Mobile Wireless MAN)

- Ratified in December, 2005
- It is an extension of the IEEE 802.16-2004 standard
- It covers MAC and PHY layers for Combined Fixed and Mobile Operation in Licensed Bands.
- It will enable a mobile user to keep their connection while moving at vehicular speed (75-93 miles/h).

WiMax Mobility Issues

- Device availability is a major issue
  - Market introduction may be delayed
  - High initial costs will limit adoption growth
- In some markets spectrum availability is limited
  - Bands < 3 GHz is better suited for mobile access
  - Licenses for fixed WiMAX may not allow service provider to offer mobile services
- Current demand for WiMax is mostly for fixed services.
  - Underserved Regions, Developing Markets

WiMax Mobility Issues (Continued)

- Demand for wireless data is growing, but still it is limited

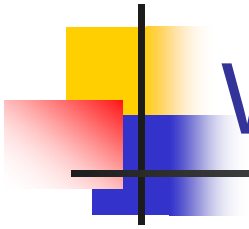
  - Mobile operators may see need for a data-only technology when demand is higher

  - Demand may drive additional spectrum allocations for wireless mobile data service

- WiMax is not going to supplant other wireless technologies

  - It will not replace Wi-Fi in the LAN

  - Cellular technologies may still be needed for voice and data in the WAN



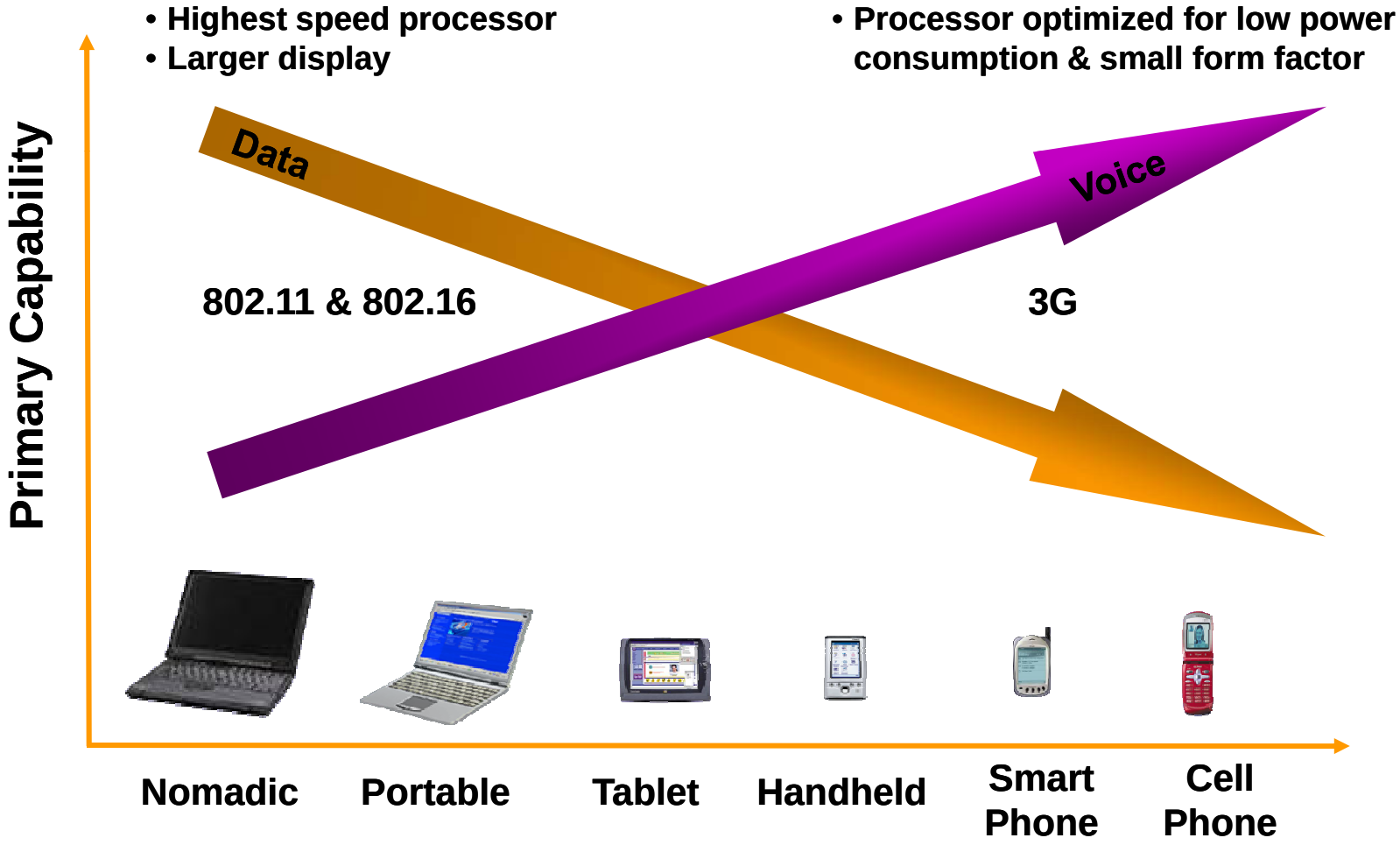
WiMax Mobility Issues (Continued)

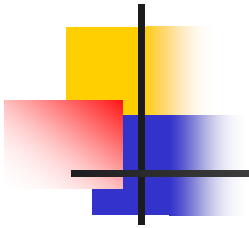
- Competing technologies have a time-to-market advantage

  - Many mobile operators have invested heavily in 3G systems.

- Multiple technologies will co-exist as they meet different needs
- Mobility may become a powerful differentiating factor when competing with DSL or Cable

Wireless Device Continuum





ITU Definitions

- **Fixed wireless access (FWA)**
  - Wireless access application in which the location of the end-user termination and the network access point to be connected to the end-user are fixed.
- **Mobile wireless access (MWA)**
  - Wireless access application in which the location of the end-user termination is mobile.
- **Nomadic wireless access (NWA)**
  - Wireless access application in which the location of the end-user termination may be in different places but it must be stationary while in use.

Fixed and Nomadic Mapping

Based on ITU-R Definitions

	Fixed	Nomadic
Use	▪ Service limited to installed area ▪ No roaming between service areas or operators	Location of end user terminal may change but stationary when in use
Device	Standalone outdoor subscriber station	▪ Indoor modems ▪ Laptops

WiMax Applications

- According to WiMax Forum it supports 5 classes of applications:

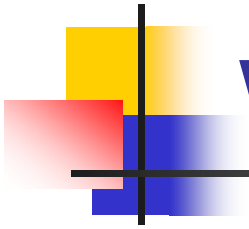
1. Multi-player Interactive Gaming.
2. VOIP and Video Conference
3. Streaming Media
4. Web Browsing and Instant Messaging
5. Media Content Downloads

Application Classes

		BANDWIDTH		LATENCY		JITTER	
Class	Application	Guideline		Guideline		Guideline	
1	Interactive Gaming	Low Bandwidth	50 kbps	Low Latency	< 25 msec	N/A	
2	Voice Telephone (VoIP) Video Conference	Low Bandwidth	32064 kbps	Low Latency	160 msec	Low Jittering	<50 msec
3	Streaming Media	Low to High Bandwidth	5 Kbps - 2 Mbps	N/A		Low Jittering	<100 msec
4	Instant Messaging Web Browsing	Moderate Bandwidth	10 kbps - 2 Mbps	N/A		N/A	
5	Media Content Download	High Bandwidth	> 1~2 Mbps	N/A		N/A	

Market Models

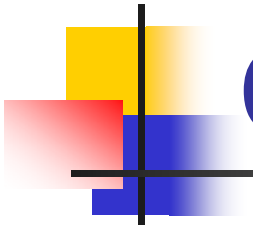
	WiMAX Benefits
Small Wireless ISPs	Lower Network CapEx
Hot Spot Providers	Lower backhaul OpEx
Wireline / ILECs	DSL fill-in. Cost effective coverage of low density areas
Cellular Operators	Nomadic/Mobile broadband data services competitive with wireline
Cable Providers	Broadband data service to businesses
Large ISPs	Alternative last mile to compete with ILEC broadband services
New Entrants (e.g. Utilities, Railroads, Retailers)	Leverage existing assets to deliver broadband service
Satellite	Need alternative last mile for uplink



WiMax Advantages in a Nutshell

- Robust, reliable carrier class “last-mile” technology with QoS
- For many types of high-bandwidth applications

  - at the same time, across long distances
- Enabling new applications that improve daily life

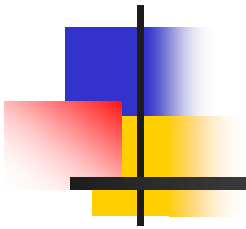


Conclusions

- It is expected that WiMax becomes the dominant standard for Wireless MAN in the world market, at least, in fixed broadband networks.
- WiMax products will have to be delivered to the market needs and those for the end-users will have to be extremely easy to install.
- Focus is too often on technologies
  - Subscribers pay for services, not technologies
  - Technologies enable services, but should not be a burden on users
  - Broadband capabilities are important, but bandwidth is not the only meter to assess service

WiMax Success Factors

- It is crucial that WiMax becomes an important building block to enable fixed/mobile convergence and to ensure its success.
- Ability to offer ease of use is crucial to the success of WiMAX service providers
- Success of WiMAX may depend on the ability to combine fixed and mobile access over the same infrastructure



End of Presentation

Thank You.