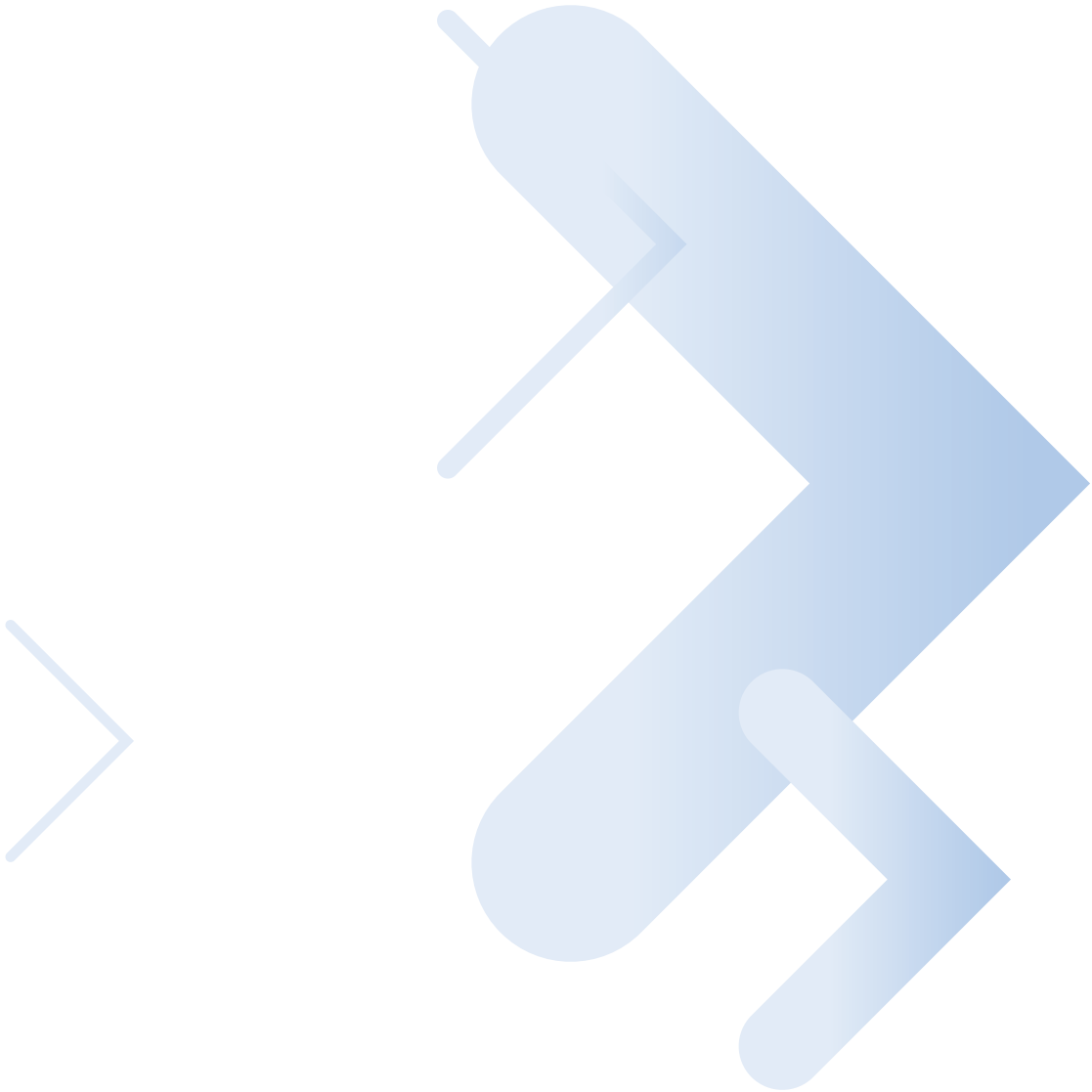
WHITE PAPER

WiMAX and WiFi Together: Deployment Models and User Scenarios

Co-authored by Motorola and Intel



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Introduction:
Broader Broadband with WiMAX and WiFi

By distributing high-speed Internet access from cable, Digital Subscriber Line (DSL), and other fixed broadband connections within wireless hotspots, WiFi has dramatically increased productivity and convenience. Today, nearly pervasive WiFi delivers high-speed Wireless Local Area Network (WLAN) connectivity to millions of offices, homes, and public locations, such as hotels, cafés, and airports. Worldwide, more than 223 million homes have WiFi connections, and there are over 127 million WiFi hotspots.[1] The integration of WiFi into notebooks has accelerated the adoption of WiFi to the point where it is nearly a default feature in notebooks. Over 97% of laptops ship with WiFi integrated,[2] and an increasing number of handhelds and Consumer Electronics (CE) devices are adding WiFi capabilities.
WiMAX takes wireless Internet access to the next level, and over time, could achieve similar attach rates to devices as WiFi. WiMAX can deliver Internet access miles from the nearest WiFi hotspot and blanket large areas—Wide Area Networks (WANs), be they metropolitan, suburban, or rural—with multi-megabit per second mobile broadband Internet access.[3] Although the wide area Internet connectivity offered by 2.5 and 3G cellular data services has been mobile, these services do not provide the broadband speeds to which users have become accustomed and that WiMAX can deliver.

In the last few years, WiMAX has established its relevance as an alternative to wired DSL and cable, providing a competitive broadband service offering that can be rapidly and cost effectively deployed. Now, Mobile WiMAX, as defined in the Institute of Electrical and Electronic Engineers (IEEE) 802.16e-2005 standard, adds broadband connectivity on the move. Mobile WiMAX, based on scalable Orthogonal Frequency Division Multiple Access (OFDMA) technology,[4] is capable of simultaneously supporting fixed, portable, and mobile usage models.[5] With scalable OFDMA, operators no longer need to choose between fixed or mobile services.
Together, WiMAX and WiFi are ideal partners for service providers to deliver convenient, affordable mobile broadband Internet services in more places. Both are open IEEE wireless standards built from the ground up for Internet Protocol (IP)-based applications and services. By combining WiMAX and WiFi access together, service providers can deliver high-speed Internet connectivity that subscribers desire in more places. And WiMAX and WiFi technology synergies enable seamless integration into laptops, CE devices, and a new category of devices called "mobile Internet devices."

This paper explores the complementary nature of WiMAX and WiFi, as well as illustrates how service providers can leverage these technologies to offer wireless broadband Internet connectivity and compelling new services at affordable prices and in more locations. It also focuses on the synergies between the IEEE 802.11a/g/n Orthogonal Frequency Division Multiplexing (OFDM) and IEEE 802.16e-2005 OFDMA air interfaces.

Note: In this paper, WiMAX means the scalable OFDMA air interface as defined in IEEE 802.16e-2005. Commonly referred to as "Mobile WiMAX," IEEE 802.16e-2005 is ideally suited—and is being deployed—not only for mobile, but also for fixed and portable applications.

WiMAX/WiFi Synergies

Although both WiMAX and WiFi provide wireless broadband connectivity, they have been optimized for different usage models: WiFi for very high-speed WLAN connectivity and WiMAX for high-speed Wireless WAN (WWAN) connectivity. By combining WiMAX and WiFi technologies, service providers can offer their subscribers a more complete suite of broadband services in more places. Table 1 illustrates how WiMAX and WiFi complement each other from an implementation and deployment perspective.
The IEEE 802.11 and IEEE 802.16 standards are referred to as WiFi and WiMAX, respectively. The draft IEEE 802.11n standard is a new high-throughput enhancement designed for digital home and office applications. IEEE 802.16e-2005 is the mobile enhancement to IEEE 802.16-2004 and is designed to support wide area mobility via scalable OFDMA technology. Both of these technologies leverage OFDM and advanced antenna innovations to attain high-broadband data rates and improved signal reception.
WiMAX and WiFi networks use IP-based technologies to provide connection services to the Internet. This standards- and IP-based network approach, combined with certification of equipment by the WiFi Alliance* and the WiMAX Forum,* provides compelling benefits to service providers and users:

- A common user experience for wireless broadband services, which is a critical enabler in attaining rapid user adoption.
- An open network philosophy where any certified WiMAX or WiFi device is able to connect to any WiMAX or WiFi network that supports the same certification profile, improving today's business models for delivering mobile broadband services.
- Vendor agreed-upon certification profiles, facilitating volume production and global economies of scale.
- Wireless client and network equipment subjected to extensive interoperability and conformance testing, enabling an open and competitive multi-vendor environment.
- An all-IP based network infrastructure, enabling cost-effective deployments for operators and open Internet services for users.

1 Source: ABI Research, August 2007.
2 Source: Intel Corporation.
3 The service level provided to an individual WiMAX subscriber is determined by the service level agreement with the service provider.
4 OFDMA is an access technology that allows multiple users to transmit at the same time using subchannelization. The term "scalable OFDMA" refers to the ability to implement OFDMA in various channel bandwidths but maintain the same subcarrier spacing.
5 In a portable usage model, the user is fixed while using the service but can change locations in between sessions.

Table 1: WiFi and WiMAX Comparison

WiFi (IEEE 802.11 a/g/n)	WiMAX (IEEE 802.16e-2005)	Synergy Impact
Market		
Deployed in local coverage areas, such as public hotspots, homes, and businesses.	Deployed in wide coverage areas, including metropolitan areas for mobile broadband wireless as well as rural or remote areas for last-mile connectivity and portable service.	"Best-connected" model: users connect to WiMAX or WiFi depending on their location, coverage, and Quality of Service (QoS) requirements.
Products certified by the WiFi Alliance.	Products certified by the WiMAX Forum.	Interoperable clients and access points enable global roaming and multi-vendor competition.
Embedded in 97% of laptops and many handheld and CE devices.	Customer Premise Equipment (CPE) and PC cards available today; embedded in laptops and handheld devices starting in 2008.	Integration into devices is expected to reduce device subsidies and lower Cost Per Gross Add (CPGA).[1]
Characteristics		
Provides fixed and portable solutions.	Provides fixed, portable, and mobile solutions.	Full range of services in the home and office, as well as on the road.
Operates in license-exempt spectrum. Current solutions use the 2.4 and 5 GHz bands.	Operates in licensed spectrum. Current solutions use the 2.3, 2.5, and 3.5 GHz bands.	Service providers can leverage both types of spectrum; for example, license exempt for best effort local area traffic and licensed for wide area and QoS sensitive traffic.
Short range with up to 100 meters for a single access point.	Metropolitan area mobile coverage of up to several kilometers for a single base station. Longer range (up to several miles) for fixed & lower-density deployments.	Economical coverage of large areas; for example, WiFi hotspots in cafés, hotels, and airports, and WiMAX for blanket coverage outside of hotspots.
OFDM air interface, as defined in IEEE 802.11a/g/n.	Scalable OFDMA air interface, as defined in IEEE 802.16e-2005.	Similar technologies mean cost savings at both the silicon and device levels.
Devices connect via a WiFi access point to the operator's IP network and to the Internet.	Devices connect via a base station to the operator's IP network and to the Internet.	Common IP network components, such as authentication servers, service platforms, and access gateways, can be used.
Implementing Multiple Input/Multiple Output (MIMO) in IEEE 802.11n to achieve higher data rates.	Certified WiMAX Release 1, Wave 2 clients support both MIMO and beamforming.[2]	The opportunity for devices to share antenna components, thus reducing the cost of integrated devices.
Options		
Evolution to mesh networks in metropolitan areas.	Evolution to multi-hop relay to improve range and data rates.	The options for providing extended coverage and services economically are further expanded.
Access points that include WiFi for access and WiMAX for network connectivity.	Leverages digital advances so that the entire base station can now be mounted on tower tops.	Deployment expense is expected to continue downward on a steady cost-reduction curve.

WiFi (IEEE 802.11 a/g/n)	WiMAX (IEEE 802.16e-2005)	Synergy Impact
Voice over Internet Protocol (VoIP) is supported with enhancements IEEE 802.11e, k, and r.[3]	VoIP is supported by the extended real-time polling class of service.	Both specifications support VoIP; however, operations in license-exempt spectrum limit QoS assurance.
IEEE 802.11n high throughput will support digital home applications, such as Video over IP.	WiMAX provides high data rates and QoS classes to support broadcast and multi-cast video.	A full range of services across both WiMAX and WiFi networks can be offered.

WiMAX/WiFi Deployment Models

In the last few years, WiMAX has established its relevance as an alternative to wired DSL and cable, providing a competitive broadband service offering that can be rapidly and cost effectively deployed. Current deployments include US-based Clearwire* offering service in more than 420 municipalities,[6] VTR Global,* Chile's largest multi-channel television and residential broadband Internet access provider, and Worldmax,* a start-up company that is wholesaling personal broadband connectivity in The Netherlands.

Building on fixed services by adding broadband connectivity on the move, Mobile WiMAX networks based on scalable OFDMA technology are now capable of simultaneously supporting fixed, portable, and mobile usage models. With scalable OFDMA, operators no longer need to choose between fixed or mobile services.

WiMAX is being deployed today in cities and dense residential areas to provide mobile broadband Internet. The cost-effective integration of WiMAX into devices, such as notebooks, CE devices, smart phones, and mobile Internet devices, drives new opportunities for service providers to:

- Target both tech-savvy business users requiring mission-critical mobile connectivity and consumers seeking an economical, wide area mobile Internet experience that extends their home WiFi experience.
- Deliver advanced mobile broadband Internet services that require high throughput and QoS to support video and VoIP applications.
- Market innovative, compelling devices that create demand for mobile Internet services, while lowering device subsidies.
- Offer bundled fixed, portable, and mobile wireless broadband services to subscribers for maximum user flexibility.

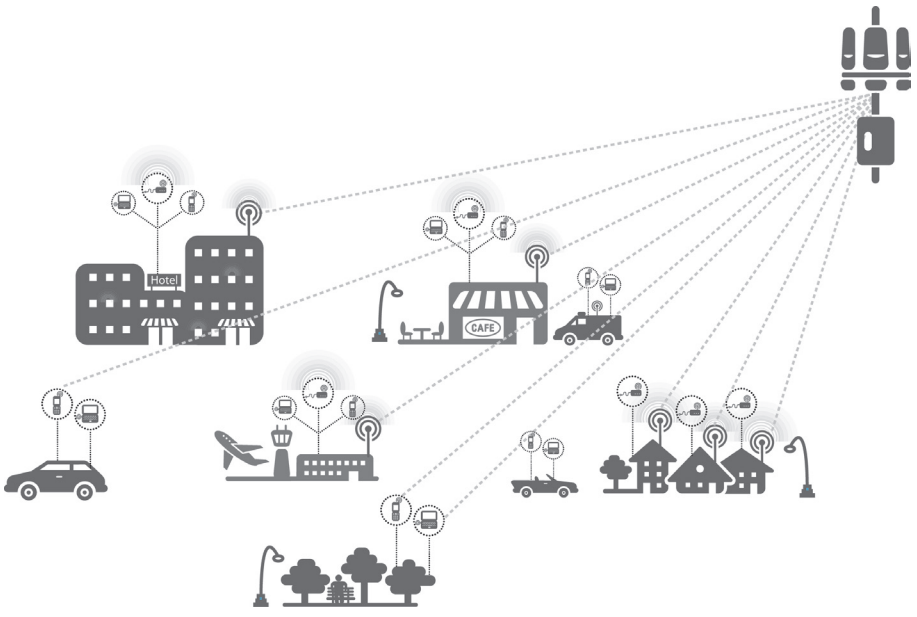
Over the past few years, service providers have been increasingly leveraging WiFi to expand their broadband footprint and offer alternative pricing models. For example, British Telecom (BT) Openzone* offers plans for short-term, renewable, and annual contract usage. Because of the complementary nature of WiMAX and WiFi, service providers are now starting to couple them together to further extend deployment options. The following sections showcase these new deployment models.

Broadband on the Go

WiMAX enables service providers to offer "on the go" broadband Internet connectivity beyond WiFi hotspots. Users get frustrated when they subscribe to a WiFi hotspot service but then find themselves in a hotspot which requires payment to a different service provider. This inconsistent access is a primary reason users avoid signing up for monthly WiFi hotspot service contracts in the first place.

For service providers, WiMAX provides the ability to expand broadband services by offering subscribers coverage when not in range of a hotspot. With the integration of both WiMAX and WiFi into mobile devices, service providers can even offer transparency of service between WiFi in hotspots and WiMAX in the broader metropolitan areas. (See Figure 1)

Figure 1: Using Handheld Devices in Mobile, Portable and Public Hotspot Environments



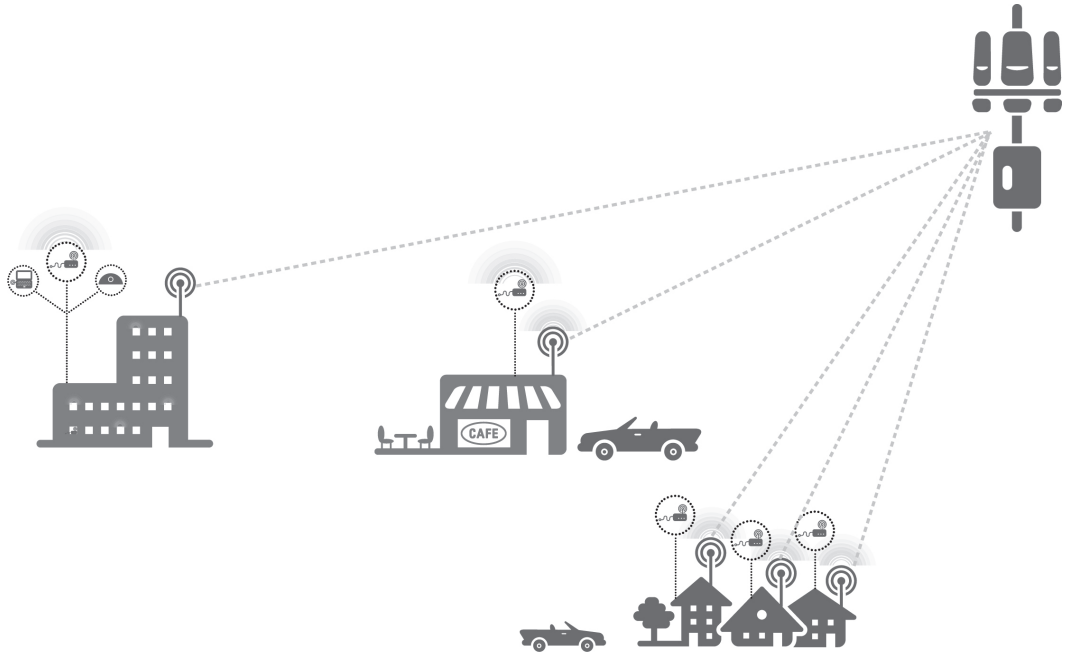
The high usage of WiFi hotspots at airports and hotels suggests the demand for broadband connectivity in even larger areas with a high density of Internet users. Deployment of WiMAX in these areas, whether they are dense urban areas, campuses, or travel corridors, extends broadband connectivity beyond hotspots to deliver the utility and value of mobile Internet services to subscribers.

Last-Mile Broadband

WiMAX offers traditional wire line service providers cost-effective ways to expand their broadband service offerings to underserved areas. Using WiMAX, wire line operators can cover rural and less dense environments where the cost of expanding DSL and cable wiring is prohibitive, as well as urban areas where it can be difficult to add wired connections to existing Multiple Dwelling Units (MDUs), such as apartment high rises or office buildings. WiMAX is also appealing to new entrants or mobile service providers that want to include services to the home as one of their offerings.

Service providers have already expanded their CPE offerings to include the functionality of a WiFi access point. This provides consumers with the advantage of sharing the broadband connection and the convenience of anywhere connectivity within the home. Now, vendors are integrating WiMAX and WiFi in a single CPE, where WiMAX provides the backhaul and WiFi provides the in-building coverage. CPEs with integrated WiMAX and WiFi provide an alternative solution for rapid deployment of broadband connectivity to homes and public hotspots. (See Figure 2) Another market for integrated WiMAX and WiFi CPE with potentially strong Average Revenue Per User (ARPU) is temporary deployments, such as trade shows, construction sites, and emergency sites.[7]

Figure 2: Hotspots throughout the City with Large WiMAX Zones

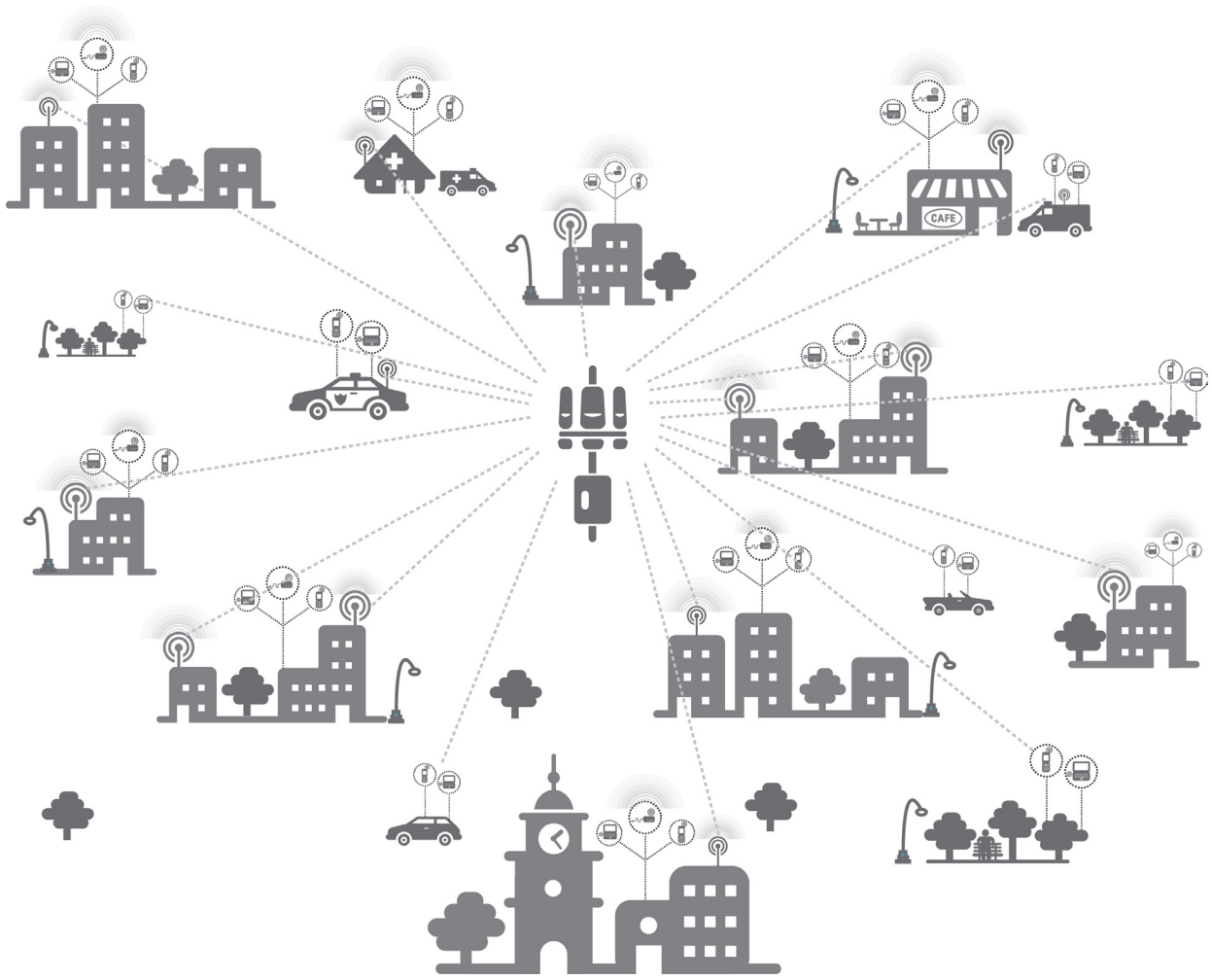


By deploying networks based on IEEE 802.16e-2005, operators can ultimately offer fixed, portable, and mobile WiMAX services. Hence, even if an operator uses WiMAX primarily in a "fixed" model to reach homes now, it can opt to offer portable and mobile applications to its customers at a later date. This may be of particular interest to service providers that have spectrum licenses which restrict usage models to fixed and portable only. These service providers can deploy a WiMAX network that conforms to the IEEE 802.16e-2005 radio specifications but exclude the higher layer mobility/handover capabilities. In this way, their subscribers can still take advantage of integrated WiMAX and WiFi devices for stationary and portable use. If at a future date regulations change, these service providers can upgrade to a full mobility service without requiring an overhaul of their radio access network.

Broadband Campus Coverage

Many enterprise, government, and educational organizations have deployed WiFi in buildings for their work force and students. WiMAX allows a service provider to offer broadband connectivity beyond individual buildings to provide blanket coverage of an entire campus. The integration of WiMAX and WiFi onto a common device platform enables users to connect to either in-building WiFi or campus-wide WiMAX networks, allowing them to stay connected as they move. Using this dual-mode model, network administrators can also reduce the number of WiFi access points needed to attain full campus coverage, thereby reducing maintenance costs. (See Figure 3)

Figure 3: WiMAX Provides Hotspot Backhaul and Wide-Area Campus Coverage



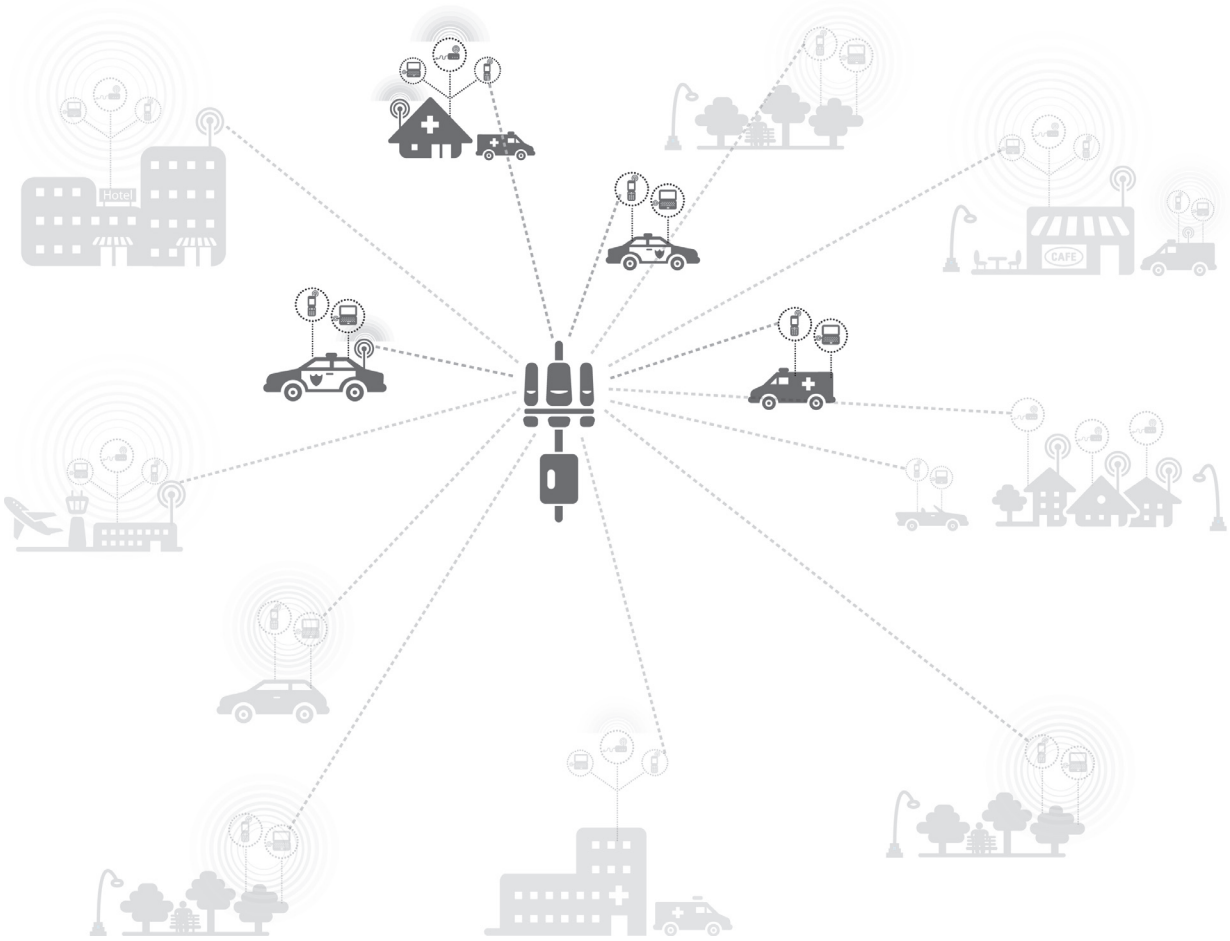
New business models are starting to emerge to facilitate the connectivity between privately owned WiFi in-building networks and service provider-owned WiMAX networks. For example, a service provider that owns the spectrum license may allow an enterprise to deploy WiMAX cells on campus as part of a sub-licensing agreement. For example, the service provider could sub-lease the spectrum to the enterprise and allows it to deploy a WiMAX base station for employee or student usage; or, the campus could enter into an agreement where its users could automatically access the service provider's WiMAX network where campus WiFi doesn't reach.

Citywide Broadband

Municipalities are deploying IEEE 802.11 mesh networks to offer low-cost broadband connectivity across the city, but these networks can be costly. For standalone WiFi hotspots and interconnected WiFi mesh networks, provisioning power and wired connections to each of the many access points required to cover a wide area can be expensive, both in terms of capital expenditures and operational costs. These costs include the installation of a physical wired high-speed connection to each WiFi access point and the monthly service fee for the connection.

A cost-effective alternative is to use WiMAX to "backhaul" the WiFi mesh portals to the Internet wirelessly. In addition to using WiMAX to interconnect WiFi mesh portals, the same WiMAX network can provide an overlay solution enabling the service provider to offer a two-tier service to subscribers, where subscribers connect based on their mobility, bandwidth, and QoS requirements. For example, when in close proximity to a WiFi mesh access point, users connect via WiFi for high-bandwidth streaming; when users are in an area not covered by the mesh network or need higher QoS for a video session, they connect via WiMAX. (See Figure 4)

Figure 4: WIMAX Provides Mesh Portals Backhaul and Overlay for QoS



Because WiFi operates in the license-exempt band, it is not possible to control or limit interference from other sources. As a result, services that require QoS, such as VoIP, can be problematic outdoors. On the other hand, because Mobile WiMAX operates in licensed spectrum, an overlay WiMAX solution can provide complementary QoS for sensitive applications, such as real-time voice and video. WiMAX QoS facilities can also provide higher priority to certain types of users, such as public safety personnel, first responders, and police. (It should be noted that in this scenario, the service provider managing the municipal mesh network would need to enter into a spectrum sub-licensing agreement with local license holders or acquire a regional spectrum license.)

Mobile Broadband Internet User Scenarios

The Internet continues to grow not only in number of subscribers and amount of traffic, but also in the types of traffic and the quantity of new applications. Fueled by growing broadband connectivity, the Internet is becoming richer in terms of multimedia applications and services. For example, in the past two years, there has been unprecedented growth in social networking applications, such as YouTube,* where users view over 100M video clips per day,[8] and MySpace* which has over 100M users.[9]

Beyond complementing WiFi by extending affordable broadband connectivity outside of workplace, home, and public hotspots, WiMAX promises to deliver new usage models for subscribers. Connectivity from WiMAX and WiFi networks delivers exciting possibilities from real-time location awareness for social networks to real-time information sharing for mobile business productivity to extended education beyond the classroom. These new mobile Internet possibilities combined with existing user comfort levels with broadband and wireless networks are expected to reduce the barriers to user adoption for mobile broadband Internet.

MySpace on the Go

On the way home from school, John goes on MySpace on his WiMAX-enabled mobile Internet device and chats with his buddies. They decide to go out to a see a movie. John looks up the theaters and selects one that is closest to the mall. He and his buddies watch streaming video trailers of the movies that are playing and pick one. He then checks times for that theater and a specific movie. John finds the movie times and posts them on MySpace. He then checks the route to see what time he needs to leave. After he figures out the time that he is going to arrive at the theater, he decides it is best to order tickets off Fandango.*

11 www.techcrunch.com
12 www.digital-lifestyles.info

Arriving home from school, John automatically connects to the home WiFi network via his laptop and prints out his tickets. He sees that several of his friends are playing online gaming, so he joins them before he gets ready to go out. He leaves by car, reconnecting to the WiMAX network on his mobile Internet device, and clicks "go to buddy" to get directions to pick up his friends on the way to the theater. His friends can see that he is en route and go outside to meet him.

On the way there, they run into road work and must take a detour. The online directions are not clear, so they access Google Earth* images to figure out where they are located. They arrive at the theater and several more friends who used MySpace "what are my buddies doing" are there to join them. At the theater, they access WiFi and hear the movie previews on their personal headsets, order popcorn with their mobile devices, download the movie theme tune, and enter the online movie contest.

Mobile Business Productivity

Because traffic is heavy, Tom stops at a coffee shop to review his e-mail and make conference calls. Today, he has to be at a client site by 10 a.m., so he checks the traffic report and estimated drive time. Tom has to leave before he has handled all of his e-mails, so he switches over to the WiMAX network and voice mode on his mobile Internet device. He reads his e-mail, and for the urgent issues, he calls the sender via VoIP.

Tom initiates a scan of news feeds and requests the latest articles on the client he is visiting. He listens to these articles as he drives to the client site. While listening to these articles, a call comes in from his family. His daughter scored the first goal of the season and his family is sending him the video clip. Arriving at the client site five minutes early, Tom watches the clip of his daughter and orders her a "congratulations teddy bear" online to be delivered that afternoon. He arrives at his meeting and shares the video clip with his client. They enjoy her accomplishment and the meeting is off to a good start.

Extended Education

Mary is a student at the local college. Before leaving her dorm in the morning, she checks the WiFi network via her laptop to see if there are any schedule changes. Walking to the lecture halls, she automatically connects to the WiMAX network on her music player and listens to music via the community iTunes* server. Arriving in the lecture hall, she switches to WiFi on her laptop. The grade from her previous assignment is downloaded, along with today's lecture notes. Between lectures, Mary sits outside and reconnects via WiMAX, and alerts her buddies as to where she is just in case they are close by. She also takes the opportunity to call home via VoIP.
Mary's next lecture is by a remote overseas professor via video feed. It's a beautiful day, so she decides to stay outdoors and participate in the lecture via the WiMAX network. The professor is covering complex topics, so Mary records the session in order to watch it again later. At the end of the lecture, the professor takes student questions. Mary closes her video feed and walks to the I-café while listening to the end of the lecturer's comments.

Once at the I–café, she automatically connects to the WiFi network, so she can print her homework assignment. She initiates a scan of the university resources that she needs to do her homework and determines that she has to get a book from the library. She checks out the book online and plans to pick it up on her way back to the dorm. Before she leaves the I–café, Mary downloads a movie and invites her friends over to watch it later. She then heads back to the dorm. She automatically switches to the WiMAX network, and the movie download continues.

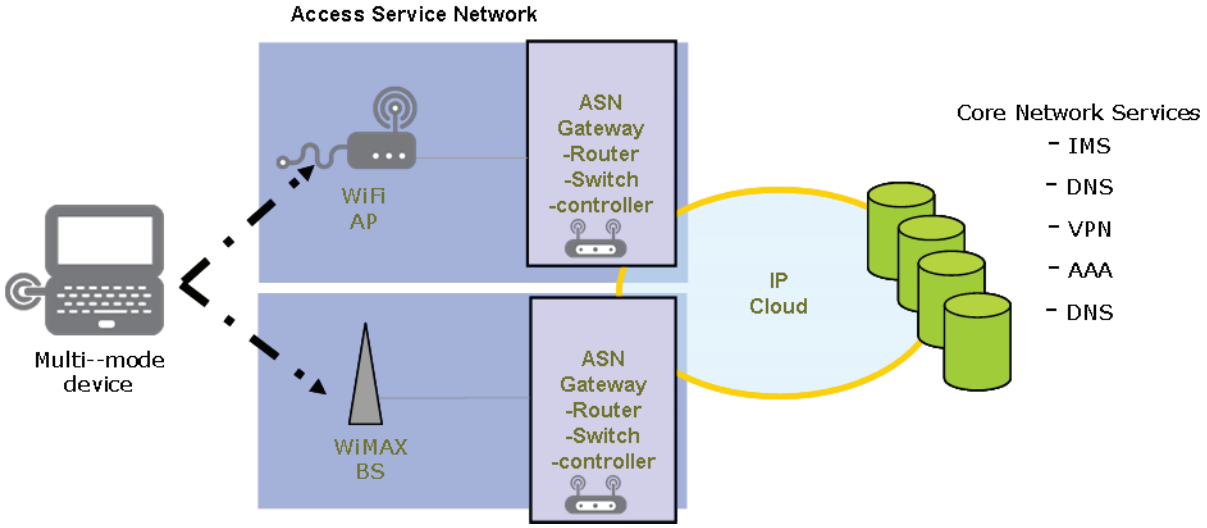
WiMAX/WiFi Inter-working

The inter-working capabilities between WiMAX and WiFi enable service providers to deliver consistent, transparent, and user-friendly broadband services to their subscribers. (See Figure 5) Achieving this transparency requires two key elements:

- Multi-mode subscriber devices that can communicate on both WiMAX and WiFi networks.

- The ability to provide service across WiMAX and WiFi networks when users move between them. This is generally implemented through a controlling Access Service Network Gateway (ASN GW) and common Authentication, Authorization, and Accounting (AAA) service functionality located in the service provider network.

Figure 5: WiMAX/WiFi Inter-working



Multi-Mode Devices

The most widespread WiFi technology being shipped today is IEEE 802.11g, which is based on OFDM. Over the next 18 months, it is anticipated that users and hotspot administrators will start to transition to the higher throughput of IEEE 802.11n, based on MIMO antenna advancements. IEEE 802.16e-2005 is based on OFDMA and supports MIMO and beamforming antenna techniques as well for higher throughput and better reception.

Commonalities between 802.11n WiFi and 802.16e-2005 Mobile WiMAX facilitate a high level of silicon and platform integration not possible between dissimilar radio technologies. For example, notebooks with integrated Intel WiMAX and WiFi technology will benefit from these synergies:

- WiMAX and WiFi technologies are both based on an OFDM air interface, enabling the sharing of silicon blocks at the baseband level to reduce die size and cost.
- Both IEEE 802.11n and WiMAX (Release 1, Wave 2) employ MIMO antenna mechanisms and can share the same antennas.[10] Sharing antennas saves component cost and device real estate, a critical aspect for smaller form factors.
- Integration of WiMAX and WiFi onto the same Peripheral Component Interconnect (PCI) mini-card module frees up valuable notebook real estate leaving a PC card slot open for other uses.
- A common platform level approach for interfacing the operating system's power management utilities optimizes power consumption and maximizes battery life.
- At the user interface level, a common connection manager coordinates and displays available WiMAX and WiFi networks, and compatibility-tested software drivers work harmoniously together.[11]

For more information on Intel WiMAX platform solutions, go to www.intel.com/go/wimax.
The availability of appealing consumer devices will have a major influence on subscriber service adoption. Today, WiMAX PC data cards and CPE are available for operation in the 2.3, 2.5, and 3.5 GHz bands. Soon a range of integrated WiMAX and WiFi devices, including CE and mobile Internet devices, will become available.

For more information on Motorola CPE and subscriber device solutions, go to www.motorola.com/wimax.

Session Continuity

The Network Working Group (NWG) within the WiMAX Forum has developed specifications for users transitioning between WiMAX & different access technologies, such as WiFi. Inter-working between WiMAX and WiFi is significantly simplified as both networks are deployed using Internet Engineering Task Force (IETF) protocols and comply with IETF IP policy definition and policy enforcement rules. Common IETF protocols include:

- Transport protocols: iPv4, IPv6, Transmission Control Protocol (TCP), User Datagram Protocol (UDP)
- Mobility protocols: Mobile IP (MIP) v4, MIPv6
- Security protocols: IP Security (IPsec), AAA RADIUS, and DIAMETER
- QoS protocols: Resource Reservation Protocol (RSVP), Differentiated Services (DiffServ)
- Connectivity protocols: Domain Host Configuration Protocol (DHCP), Domain Name Server (DNS), Virtual Private Network (VPN)
- Manageability protocol: Simple Network Management Protocol (SNMP)

13 WiMAX Forum conducts conformance and interoperability testing in stages of increasing functionality as part of its certification process. MIMO support is mandatory for Release 1, Wave 2 client certification.
14 A connection manager is a software utility that resides in the subscriber's device and provides a common user interface for displaying and connecting to WiMAX and WiFi networks.

The NWG has defined an Access Service Network Gateway (ASN-GW) to manage access to services, such as AAA and DHCP, in addition to session and mobility management. Leveraging the IETF MIP protocols, the NWG Release 1 specification supports intra-ASN session continuity.[12] Subsequent releases will support inter-ASN session continuity to enable more seamless movement between WiMAX and WiFi networks.

Figure 6: Access Service Network Gateway (ASN-GW)

ASN-GWs are being deployed today in WiMAX networks. Go to www.motorola.com/wimax for additional product and availability information.

Conclusion

WiMAX extends the benefits of WiFi networks to deliver the next-generation mobile Internet. Integrating WiMAX and WiFi promises convenient and affordable broadband connectivity that brings new deployment models for service providers, as well as new usage models for subscribers. The ability to be connected to the Internet and to have access to real-time information in more places is of high value to business professionals and consumers alike, whereas the advantages of coupling WiMAX and WiFi together enable service providers to:

- Provide bundled fixed, portable, and mobile broadband Internet services based on WiMAX and WiFi.
- Provide a common user experience in either access network.
- Leverage both licensed and license-exempt frequency bands.
- Optimize the network by routing traffic based on the subscriber's need for mobility, QoS, and bandwidth.
- Offer appealing and compelling devices with both WiMAX and WiFi capabilities and take advantage of device cost savings enabled by the synergies between the two technologies.

Motorola and Intel are delivering best in class WiMAX silicon, end user devices and network infrastructure equipment to drive the mobile broadband Internet revolution forward. The two companies will continue to collaborate in the WiMAX Forum and IEEE, and to work with service providers to realize new models for mobile broadband Internet.

15 Session continuity is the ability to continue a packet data session during handoff while minimizing packet loss.

Resources

[1] "WiMAX Opens the Door to New Communications Markets, Fresh Opportunities for New Industry Entrants", Motorola, 2007.
[2] WiMAX Forum: www.wimaxforum.org.
[3] Intel WiMAX information: www.intel.com/go/wimax.
[4] Motorola WiMAX information: www.motorola.com/wimax.

Acronyms

AAA	Authentication, Authorization, and Accounting
ARPU	Average Revenue Per User
ASN	Access Service Network
ASN GW	ASN Gateway
BS	Base Station
BSS	Base Station Subsystem
CE	Consumer Electronics
CPE	Customer Premise Equipment
CPGA	Cost Per Gross Add
DHCP	Domain Host Configuration Protocol
DiffServ	Differentiated Services
DNS	Domain Name Server
DSL	Digital Subscriber Line
GW	Gateway
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPsec	IP Security
IPv4	Internet Protocol Version 4
MDU	Multiple Dwelling Unit
MIMO	Multiple Input/Multiple Output
MIP	Mobile IP
MIPv4	Mobile IPv4
MIPv6	Mobile IPv6
Muni	Municipal
NWG	Network Working Group
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PCI	Peripheral Component Interconnect
QoS	Quality of Service
RSVP	Resource Reservation Protocol
SNMP	Simple Network Management Protocol
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
WAN	Wide Area Network
WLAN	Wireless Local Area Network
WWAN	Wireless Wide Area Network

Notice and Disclaimer

(Footnotes)

1 Cost per gross add (CPGA) is the cost associated with adding a new subscriber.

2 MIMO and beamforming support are mandatory for Release 1 Wave 2 client certification. Operators may optionally choose to deploy network infrastructure which supports these capabilities.

3 IEEE 802.11e, k and r are the QoS, measurements, and fast Base Station Subsystem (BSS) transition standard enhancements required to support VoIP.

MOTOROLA

Motorola, Inc. www.motorola.com/wimax

www.intel.com/go/wimax