

## Key Criteria for Wireless Carriers to Evaluate Mobile WiMAX

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Enterprises and service providers need to evaluate capacity, cost and timing of new wireless technology before choosing a next-generation product. WiMAX will have its place as one of many broadband standards in the long term, but likely will not be a mainstream mobile technology in the near term.

## WHAT YOU NEED TO KNOW

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Wireless operators consider mobile WiMAX to be one of the main technology choices to support wireless mobile data worldwide. There are claimed technical advantages that, if true, will make mobile WiMAX a compelling option, including expected, inexpensive chipsets due to the lessons learned from Wi-Fi and the Universal Mobile Telecommunications System (UMTS). WiMAX is a flat architecture compared with third-generation (3G) wireless technology, requiring less processing power for handoffs and less coordination among network components, resulting in unproven, but likely lower, operational expenditures compared with a full 3G network today. Quality of service for voice over IP (VoIP) support, as part of the standard WiMAX, is a disruptive threat for cellular voice services due to the very low production cost of a mobile minute. There are three top criteria to use when evaluating which technology to deploy.

## STRATEGIC PLANNING ASSUMPTION(S)

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By 2011, fewer than 10 international mobile operators will deploy today's WiMAX standard as their primary wireless broadband strategy (0.7 probability).

## ANALYSIS

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WiMAX Mobile will attract operators who need to compete with mobile broadband providers, but don't have a license to launch new services, but will remain niche players in countries where standards such as 3G or code division multiple access (CDMA) Evolution Data Optimized (EV-DO) are deployed. In situations with new networks, consider WiMAX as one of many choices for an alternative wireless data technology. To determine whether WiMAX fits into your network rollout plans, evaluate:

*Capacity:* What will WiMAX offer in capacity, as it is defined as performance per base station, that current standards can't satisfy in terms of data throughput, coverage and spectrum efficiency?

*Cost:* What will WiMAX offer in terms of lower cost of access network infrastructure, terminals and operational expenditures for data delivery?

*Timing:* What will be the commercial availability of terminals and infrastructure, and the ability of mobile WiMAX to scale for global demand?

We provide key decision criteria for each area as operators explore the use of WiMAX in their network systems.

## Three Main Criteria

In February 2006, mobile profiles were finally developed to extend what the Institute of Electrical and Electronics Engineers (IEEE) ratified in December 2005 as mobile WiMAX 802.16-2005. Mobile operators who are evaluating WiMAX as a broadband alternative need to consider three main criteria:

### Capacity

The first release of mobile WiMAX is specified for 5MHz and 10MHz channels — that is, no standardized support of 1.25MHz or 20MHz. This means additional WiMAX standards might deliver higher data throughput while using channels up to 20MHz. The absolute maximum data throughput downlink could reach 31.68 Mbps (with 64 QAM, 5/6CTC, 10MHz channel), which is compared with maximum 14.4 Mbps higher performance than High-Speed Packet Access

(HSPA). Normalizing mobile WiMAX to common 16 QAM and 5MHz channels, the theoretical data throughput rates of mobile WiMAX release are less than HSPA. Table 1 has the expected theoretical rates comparison per sector.

**Table 1. Expected Theoretical Maximum Throughput Rates per Sector**

Sector	Downlink	Uplink
WiMAX	9.5 Mbps	6.4 Mbps
HSPA	14.4 Mbps	5.8 Mbps
CDMA 5x EV-DO	12.4 Mbps	7.2 Mbps

Source: WiMAX Forum, 3GPP, 3GPP2

Table 1 shows that WiMAX is not faster than UMTS or CDMA 3G services. Initial WiMAX systems will use a single antenna, while later revisions, known as Wave or Phase 2, will employ multiple-input multiple-output (MIMO) — more than one antenna, also part of HSPA and EV-DO standards — that will increase speeds. However, differences of a few megabits per second do not mean that WiMAX operators will be able to run applications that others won't. The majority of mobile applications run well over second-generation (2G) and early 3G systems, and do not need higher speed.

A clear advantage of mobile WiMAX over HSPA or CDMA technologies is the lower latency times. First trials of WiMAX show a delay time of around 50 milliseconds (ms) suitable for VoIP, whether HSPA needs more than 100 ms. Real-time critical applications, such as online gaming, need very fast response times. Compared with fixed asymmetric digital subscriber line technology, showing latency figures of around 40 ms, WiMAX is gaining a competitive edge here. However, the WiMAX architecture may add some extra overhead to VoIP delivery, which could lead to inefficiencies.

## Cost

The question of cost is the biggest and still remains to be answered. Although some vendors' preliminary estimates range from one-tenth to one-half of the costs of established technologies, WiMAX has yet to be tested in any wide-scale commercial network of mobile certified equipment. Costs generally have a way of rising once in the field. Factors that will impact cost include infrastructure, intellectual property rights and terminals.

## Infrastructure

Two criteria are relevant to determine the cost of radio access infrastructure:

*Coverage capital expenditure (CapEx):* Amount of network equipment needed for geographical coverage. From a radio access network planning perspective, the deployment density of base stations is directly correlated with the available spectrum. The simple equation is: The higher the frequency, the higher the network costs. WiMAX will be deployed at higher frequency 2.5GHz and 3.5GHz than existing 3G and CDMA (850MHz to 2.1GHz) technologies.

*Capacity CapEx:* Equipment needed to meet the capacity per cell site.

WiMAX shows a higher spectrum efficiency (bits/sec/Hz) than today's HSPA technology. Therefore, WiMAX networks need fewer base stations for higher data throughput levels and density, compared with HSPA or 3x-7x EV-DO, which means lower investment costs. However, for the same coverage, WiMAX requires higher power levels, which can lead to higher costs.

Most wireless carriers already have massive amounts of access network assets in place. Network interoperability between WiMAX and other mobile broadband technologies is not proven yet. Therefore, 3G or CDMA network operators are limited in a seamless integration of their access assets and will have to make an additional effort in network management. Furthermore, the scalability of WiMAX systems remains uncertain. 3G technology was developed for large-scale deployments and is now scaling into the lower end (modular base stations and radio network controller to provide low capacity).

Operators are in the midst of completing or upgrading their 3G implementations, and will expect at least a 10-year period of productivity for these systems before they can afford the next generation. The business case for 3G deployments is still not showing a break-even point, and the uptake of mobile data applications is very low. Therefore, it is unlikely that those operators will replace their paid (but not used) assets, or build up another broadband technology as an overlay. Global System for Mobile Communications (GSM)/UMTS operators will not likely adopt WiMAX as a fourth-generation (4G) standard as the current network technology evolution.

Some mobile operators should have experimental installations of mobile WiMAX, but must wait to commit to any new follow-on solution. More than likely, the vendors that will provide viable mobile WiMAX services will be the wired operators that were unable to partner with mobile operators, and that see the addition of mobility as a survival strategy. This is especially true in developing countries that lack a strong wired broadband capability. This affects key infrastructure players entering or looking to enter the WiMAX technology market. Although WiMAX is in the early stages, it is being planned as a wide-area technology, and may be used as such in developing countries with a limited wired broadband infrastructure in place. WiMAX success will likely be in LANs, replacing Wi-Fi in 10 years.

## Intellectual Property Rights

Vendors are looking to WiMAX for lower costs associated with developing the technology, because many companies own intellectual property rights or patents for WiMAX vs. just one company, which would drive costs up. Qualcomm has dominated the intellectual property landscape for 3G. Royalties estimated at 4% to 6% of product value are paid to Qualcomm at each sale. Next-generation systems are based on orthogonal frequency division multiplexing (OFDM), in part to distance themselves from Qualcomm's patents on 3G. With the acquisition of Flarion Technologies, Qualcomm has gained patents in categories that could affect equipment suppliers. If those patents become necessary to optimize network performance, then the market could slow while various patent holders argue about cross-licensing and patent portfolio agreements.

According to some estimates, 1,400 OFDM patents are registered, the largest number owned by Samsung with Qualcomm and Lucent following. However, what is not yet known is what are considered "essential" patents — that is, patents that are needed to develop the technology. This will play out for years to come, and the most-likely case is that costs will increase.

## Terminals

Although some of the same terminal technology — such as displays, memory and keyboards for just a few examples — can be used in developing WiMAX terminals, additional development for different frequencies, digital signal processor requirements, antennas and radios need to be factored in. WiMAX is starting from a base of zero and will need to scale rapidly. Gartner forecasts that there will be approximately 315 million 3G terminals by 2008; and even with potentially lower chipset costs, the lower economies of scale of WiMAX terminals will make prices higher. Carriers that need specialized dual-mode devices, such as WiMAX/CDMA, will find costs higher than estimated and probably fewer terminal models from which to choose.

Technical cost-advantage claims may be suspect. For example, Motorola's choice of active electronics in the antenna is an expensive way to get better performance out of wireless broadband, and could cancel the advantages of less-expensive, simpler electronics in the base station. However, companies such as Samsung, Nokia and Motorola are committed to WiMAX handsets. For interoperability, Gartner remains skeptical about seeing multisystem handsets or even WiMAX single-system handsets before 2008. Furthermore, we don't expect to see WiMAX handsets competing on the same price and quality level as 3G handsets before 2011. First approaches will use PC Cards, but Intel is pushing hard for embedded systems on notebooks by 2008. Commitments by notebook manufacturers aren't public yet, and there are no announced embedded products yet from any of the top notebook manufacturers.

## Timing

We expect that it will take 12 to 24 months for WiMAX to transform from a standard into a reliable commercial system. Once standardization is approved, technology providers will need to conform to current standards and go through third-party certification testing for interoperability. This is being conducted by the WiMAX Forum. It is expected that some first products may be certified by year-end 2006, but most won't be available until the end of 2007 or 2008. There is no large-scale commercial deployment of mobile WiMAX, nor are terminals available, and delays are inevitable. At the same time, current operators will be upgrading their networks to increase capabilities.

Frequency availability is another issue. Although it is expected that WiMAX will operate in most of the world at 2.5GHz and 3.5GHz, these frequency bands and the licenses to use them have not been allocated in many parts of the world. Harmonization is key to interoperability. All this takes time.

Equipment vendors are in a hurry to introduce the "next great thing." Even as global operators are launching and developing 3G networks, which have yet to prove an economic case, the rush to 4G is on. However, 4G standards have yet to be written. Elements of WiMAX, such as orthogonal frequency division multiple access (OFDMA) and MIMO, will likely be adopted for a 4G standard. The final specifications will look very different from where WiMAX is today, especially in the areas of spectrum, throughput, spectrum reuse and duplexing. The 4G standards will not appear in a commercial environment until 2015 at the earliest.

The OFDMA modulation shows better performance than today's wide-band code division multiple access on 3G systems. The third-generation partnership project (3GPP) is aiming for a global standard by 2010 at the earliest. This standard should compromise existing infrastructure, such as 3G, but improve data throughput of up to 100 Mbps while maintaining a very low operational cost.

## Bottom Line

Many groups are working to make WiMAX a success for fixed solutions in the short term, for spotty mobile coverage in the midterm, and for one of the members of the 4G solution set in the long term. Intel, Motorola and Samsung are investing billions of dollars in the technology and promoting it heavily. The venture capital firms are wide open to invest money in this hype as well. More than 30 companies are making chipsets for WiMAX.

WiMAX is an all-IP network permitting voice to be treated as an application, with all the benefits of that transition now obvious in the IP-PBX or VoIP market. A byproduct of the all-IP network is that mobile voice tariffs are becoming significantly less-expensive. There are claimed, but unproven, technical advantages that, if true, will make WiMAX a compelling option, including expected, less-expensive chipsets due to the experiences gained from Wi-Fi and UMTS. WiMAX is a flat

architecture, in comparison with 3G, requiring less processing power for hand-offs and less coordination among network components, resulting in lower capital and operational expenditures.

Decisions on which technology to deploy should be based on the three main areas presented in this research, as well as your role.

*Wireline providers:* WiMAX should be considered for data capabilities as a fixed or mobile access solution, with low-quality voice.

*Mobile providers:* For Tier-1 service providers, WiMAX provides little advantage over existing network evolution plans, unless the cost of systems truly turns out to be 10 orders of magnitude lower, as currently hyped.

*Enterprises:* Evaluate the use of mobile WiMAX for outdoor campus-based services, which would currently complement Wi-Fi technology and anticipate migration in a five-year time frame to 100% WiMAX.

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