

WiMAX in Emerging Markets

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Introduction

Network operators worldwide are evaluating how WiMAX will enable them to roll out profitable services—that is if they are not already trialing or deploying the technology. While each market presents its own peculiar opportunities and challenges, the most attractive opportunities are to be found in emerging markets.

Likewise, the impact of WiMAX in extending broadband availability for residential and business users will be substantially higher in developing markets than in developed ones, where broadband access is already available to most households and businesses. The true disruptive power of WiMAX will manifest itself in emerging markets, which will be able to leapfrog more advanced markets dominated by legacy technologies like DSL by skipping them in favor of more advanced, flexible and cost-effective wireless technologies like WiMAX.

In emerging markets, WiMAX represents a win-win proposition, benefiting both network operators and subscribers at the same time. In the following pages we will discuss how WiMAX makes this possible, what the market drivers are and then provide market forecast data for Latin America, one of the most active WiMAX markets.

Fixed and mobile access with a single technology

WiMAX is a powerful yet flexible technology that marks the beginning of a new phase in the BWA market, where the same technology can support both fixed and mobile services and help operators reach profitability in a shorter time frame than allowed by the previous generation of proprietary BWA technologies.

There are four key advantages that WiMAX brings to the table:

- **Interoperability.** WiMAX is a standards-based technology that is actively supported by most vendors. Interoperability is ensured by the certification program managed by the WiMAX Forum which tests whether products from different vendors are capable of operating successfully in the same network. Interoperability brings greater flexibility to operators in the selection of vendors, subscriber equipment form factors and base station configurations.
- **Lower cost.** Wide support for WiMAX from vendors and operators will lead to lower prices overall, as economies of scale kick in and components become

mass-produced. This greatly improves the business case for service providers, especially in countries like India where the expected ARPU is low and subscriber equipment needs to be affordable—that is, below \$100—to achieve profitability in the residential market.

- **Improved performance.** WiMAX is a leading-edge technology that takes advantage of OFDM and OFDMA modulation, wide RF channels, advanced antenna technologies like MIMO and beamforming, and sophisticated QoS functionality. As a result, WiMAX enables operators to use their spectrum holdings efficiently and promises high throughput and capacity, coupled with low latency and great flexibility in traffic management.
- **Reduced complexity.** WiMAX is an all-IP technology based on a core network that is not tied to the complexity and higher cost of legacy technologies, and that can be easily integrated with other IP networks.

While none of these advantages on its own would determine the success of WiMAX, their combination gives it an unprecedented flexibility that positions WiMAX to become a mass-market technology. For an operator, this flexibility means a wider range of service options:

- Offer **fixed services** (DSL replacement, uncontended links, redundancy connections) **or mobile services** (personal broadband¹, application- or device-based services, e.g. online gaming or music downloads).
- Target **residential subscribers** with desktop or laptop subscriber equipment or **business subscribers** with more powerful outdoor antennas when needed. By 2008–2009, **mobile or personal broadband subscribers** will also be able to use PDAs, phones and consumer electronic devices.
- Select equipment for **multiple spectrum bands** (Figure 1). Commercially available WiMAX equipment operates in the 3.5 GHz band, but support for the

2.3 GHz and the 2.5 GHz bands is expected by early 2007. In the future, WiMAX equipment may also be certified in the 5.8 GHz band, which in most countries is unlicensed and thus open to operators that lack access to licensed spectrum. Within each band, WiMAX can operate using various channel widths and TDD or FDD duplexing.

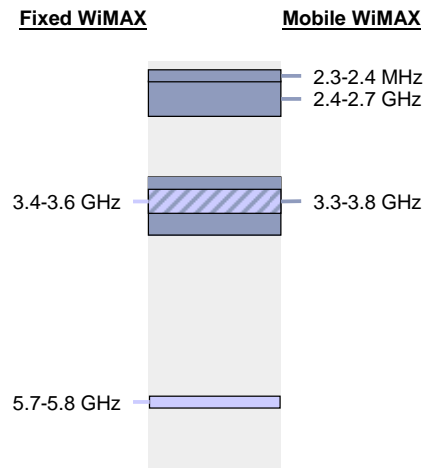


Figure 1. Spectrum bands for Fixed and Mobile WiMAX. Source: Senza Fili Consulting

- Complement **data** services with **voice** services.

There are two versions of WiMAX (Figure 2). Fixed WiMAX is deployed by operators that focus on fixed access for residential or business subscribers. Mobile WiMAX supports both fixed and mobile access, depending on the frequency, location, and operator preference. The first products introduced into the market use Fixed WiMAX. Mobile WiMAX will become available during 2007.

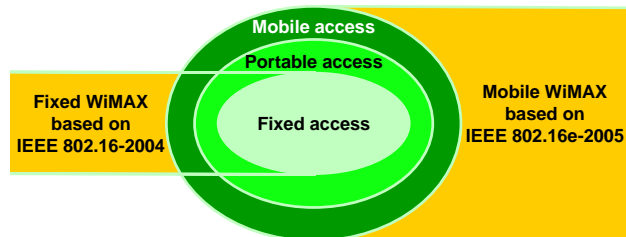


Figure 2. Fixed and Mobile WiMAX. Source: Senza Fili Consulting

¹ "Personal broadband" refers to a service that offers comparable performance to a wired DSL-like connection regardless of location. Personal broadband subscribers can access their customary applications, from home, work or wherever they are, using a single account.

TDD or FDD?

WiMAX supports two duplexing mechanisms:

- **FDD.** It requires two spatially segregated channels, one for the uplink and one for the downlink. Many regulators assign spectrum in paired channels and require the utilization of FDD.
- **TDD.** It uses a single channel for both uplink and downlink transmissions. Widely used in license-exempt bands, it is increasingly allowed in licensed bands as well.

Table 1. Comparing FDD and TDD

FDD	TDD
Best suited for voice.	Best suited for data traffic.
Separate uplink and downlink channels are less efficient for transporting inherently asymmetric data traffic.	Single channel for uplink and downlink allows for more flexibility in managing uplink or downlink traffic.
More complex.	Less expensive.
Regulator may mandate use of FDD for paired spectrum.	Can be used with both paired and unpaired spectrum.
Subscriber equipment needs two radios to be able to receive and transmit at the same time, thus increasing its cost.	Expected to dominate where regulation does not mandate FDD.

BWA vendors and network operators that focus on data services generally prefer TDD, while FDD dominates in cellular communications. The choice between the two is often dictated by regulatory constraints.

Fixed WiMAX supports both TDD and FDD to ensure a wide market appeal, although we expect TDD to dominate where there is a choice, as it is best suited to data applications (although it can support voice applications as well) (Table 1).

Mobile WiMAX currently supports only TDD operations, as TDD facilitates support for MIMO and beamforming,

which give WiMAX a performance advantage over 3G FDD-based technologies like EV-DO and WCDMA that do not yet support them.

From standards development to commercial deployments

After standards ratification, WiMAX products are now commercially available and being deployed.

Certification² is the first step towards commercialization and ensures that certified equipment from different vendors interoperates. The first certified products in the 3.5 GHz band using TDD were announced in January 2006. Redline Communications was the first vendor to receive certification for both a base station and a subscriber equipment station. As of August 2006, five equipment vendors have received certification under the 3.5 GHz profile using TDD and seven under the 3.5 GHz profile using FDD.

Commercial deployments can support a variety of services:

- Residential broadband connections, with optional add-on VoIP subscriptions.
- Enterprise data links, ranging from contended services (comparable to DSL) for small businesses, to uncontended links with burstable capacity (as a T1 alternative), to redundancy links. In all cases, VoIP services are supported.
- Portable or mobile subscriptions, either as a stand-alone service plans, or bundled with residential or enterprise ones.
- Personal broadband services, allowing users to use the same connection while at home, in the office or on the go, using a mobile or portable device.

² Only equipment certified by the WiMAX Forum can be referred to as WiMAX. Often however the term is used incorrectly to include a wide range of BWA products that are not WiMAX Forum Certified or even based on the IEEE 802.16 standard.

- Application-specific services, like online gaming or music downloads, may be offered in the future when consumer electronic devices have an embedded WiMAX module.

WiMAX subscribers have access to all applications currently available over wired connections, with the added advantage of mobility and portability, if supported by their device. In particular, robust QoS and low latency make WiMAX especially well suited for real-time applications like VoIP, content streaming, online gaming, and vertical applications for safety and surveillance. Broadcast applications will be also supported through the Multicast Broadcast Service (MBS) currently being developed by the WiMAX Forum.

As mobile devices supporting WiMAX will appear in the market in the 2008–2009 timeframe, we expect to see the emergence of new applications especially suited for mobile access. Mobile search and location-based applications are likely to be among the most popular initially.

Market drivers in emerging markets

Market dynamics in emerging and developed countries are divergent (Table 2) as service requirements, demand patterns, existing infrastructure and competitive environments differ markedly. This leads to different types of deployments, business models and prevailing service offerings.

WiMAX is being deployed in both developed and emerging markets, but the most attractive opportunities are typically presented by emerging markets where wired infrastructure is less widely available or requires expensive upgrades to support broadband services. Businesses are often forced to subscribe to expensive leased lines or satellite links and residential users typically pay high fees for slow DSL or cable modem service. In such environments, WiMAX provides a cost-effective alternative to wired technologies that is faster to deploy and to maintain. Mexico is a good example of a country where limitations in the wired infrastructure have driven an aggressive deployment of wireless broadband technologies even before WiMAX was available. We

expect that WiMAX will accelerate this trend as the lower price of subscriber units will enlarge the addressable market to include wider segments of the residential market that cannot be profitably served with more expensive proprietary technologies.

Incumbent operators may adopt WiMAX to extend their coverage, while avoiding expensive upgrades to the existing infrastructure. This fill-in strategy will also help them ward off emerging competition from new entrants and strengthen their market position.

WiMAX offers new entrants a unique opportunity to control the infrastructure and quality of the service offered to its customer. This is impossible to achieve if the service providers relies on the incumbent DSL infrastructure through wholesale arrangements.

In many markets, new entrants also benefit from limited competition or a regulator that is committed to promoting broadband penetration and market competition. More importantly, broadband penetration is often so low that no player has yet achieved a dominant position. A service provider with competitive pricing and innovative service plans can quickly gain market share.

The revenue opportunity is also likely be substantially higher than in most developed markets. In countries with limited competition, broadband access commands a high price, in some cases two or three times as high as in developed markets for a comparable type of service.

Table 2. WiMAX in emerging and developed markets

Emerging markets	Developed markets
Low broadband penetration	High broadband penetration
Early phases of strong growth	Market reaching saturation
Limited broadband availability	Broadband coverage extends to 80–95% of household
New entrants can get a large market share	Dominant players control the market
Low price elasticity among residential subscribers	Aggressive competition in the residential market
Initial focus on fixed access	Portability and mobility are key service differentiators

Table 3. The WiMAX opportunity in the short term

Urban areas. Demand is mostly concentrated here. Rural areas typically have too low a density of demand to make a profitable business case, without the active involvement of local government or public agencies.

Business users. While more demanding, they are the most attractive market segment at the beginning because of high demand, lower churn and higher profitability. The residential market is largely untapped and growing quickly and, in the medium- to long-term, represents a huge opportunity. In most countries, however, subscriber equipment prices have to come down further for the residential market to become profitable.

VoIP. It is a key component of the operator service offerings, as in emerging markets voice charges are typically still high and many households may have mobile phones which carry even higher per-minute fees but no fixed phone line. Voice acts both as a revenue generator and as a tool to attract new subscribers.

Fixed services. The most pressing demand is for basic fixed data and voice connectivity. Demand for mobile services will grow with time, but in the majority of emerging markets it is not yet sufficiently high to justify a network deployment. In addition, network operators are also well placed to extend their services to include mobile access or personal broadband.

Licensed bands. While unlicensed bands can be used effectively in rural areas or in limited deployments, metropolitan deployments require licensed bands. The 3.5 GHz band is well suited to fixed services. Bands below 3 GHz are suitable for mobile services as well, but spectrum is often more expensive and difficult to obtain.

Once competition is introduced, the incumbent will typically lower the prices, but it will take time or some unusually aggressive competitors to drive prices down to the level of developed markets. At the same time, deployment costs (notably staff and site acquisition) are often a fraction of those in developed countries, leading to a lower capex overall.

Despite the opportunities offered in these rapidly growing emerging markets, WiMAX operators face tough challenges:

- Markets like India have limited broadband availability, but aggressive competition among service providers and low price elasticity have

resulted in very low ARPU, which for residential subscribers can be as low as \$8 per month. In such environments, the availability of low-cost equipment is clearly needed to reach profitability. We expect that economies of scale will bring costs down to acceptable levels, but it will take time to reach this point.

- In some markets regulators may protect incumbents, especially if publicly owned, or may not make spectrum available for WiMAX or, more generally, for wireless broadband services. While WiMAX can operate in unlicensed bands, no certified product is currently available for these bands and, understandably, most network operators are not willing to use unlicensed bands for large-scale deployments.
- While broadband penetration is growing rapidly, the density of demand (i.e. the number of businesses or residential subscribers per square mile) may not be sufficiently high to justify a WiMAX network deployment in some areas. Network operators need to gain a good understanding of the markets they operate in and they need to choose carefully which areas to cover and make realistic assumptions about service uptake.

These challenges may prove overwhelming in selected markets. Generally, however, the fast-paced growth and specific requirements of emerging markets encourage network operators to adopt innovative approaches and offer substantial rewards to those operators that devise a successful strategy.

The Latin American market opportunity

Latin America is one of the most attractive of all emerging markets. Its share of the total number of subscribers worldwide will only be 11% by 2010 (Figure 3, top) because the population and the overall number of broadband subscribers are smaller than North America (with 20%) or Asia Pacific (with 41%). However, WiMAX will have a much stronger impact in Latin America than in

neighboring North America. In Latin America WiMAX will account for almost 8% of broadband subscribers by 2010, more than twice as in North America (Figure 3, bottom).

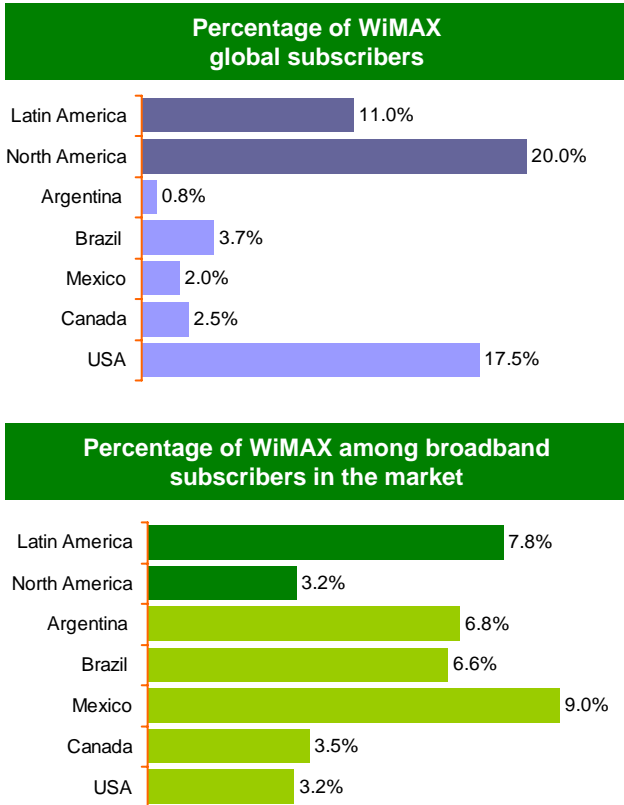


Figure 3. The impact of WiMAX in Latin America and in North America

Spectrum is available in many countries both in the 2.3–2.5 GHz and the 3.5 GHz licensed bands and it has often already been allocated or is being allocated at present. For some time Latin America has been a keen and early adopter of BWA technologies. Several network operators already offer BWA services, often alongside other products, like MMDS wireless cable TV. They look forward to cheaper subscriber equipment that will enable them to enter the residential market more aggressively, and to interoperable products that will give them more flexibility and more bargaining power with vendors.

Limited competition in both data and voice services keeps ARPUs higher than the average, although it is not so high as to discourage adoption of these services. In fact, in most Latin American countries it is easy for BWA providers to offer lower prices than the incumbents while still turning a profit. This has led several MMDS operators to move to broadband: the margin opportunity there is

substantially higher than in cable TV services, where tough competition from terrestrial cable and satellite TV has reduced profitability.

By 2010, there will be 1.7 million WiMAX subscribers, most of them (97%) using the service primarily as a fixed connection and contributing US\$2.7 million in service revenues, with 13% accounted for by VoIP (Figure 4). WiMAX will account for 73% of BWA subscribers by 2010, with the number of subscribers using non-WiMAX BWA technologies starting to decline in 2008, as network operators increase the pace of their transition to WiMAX.

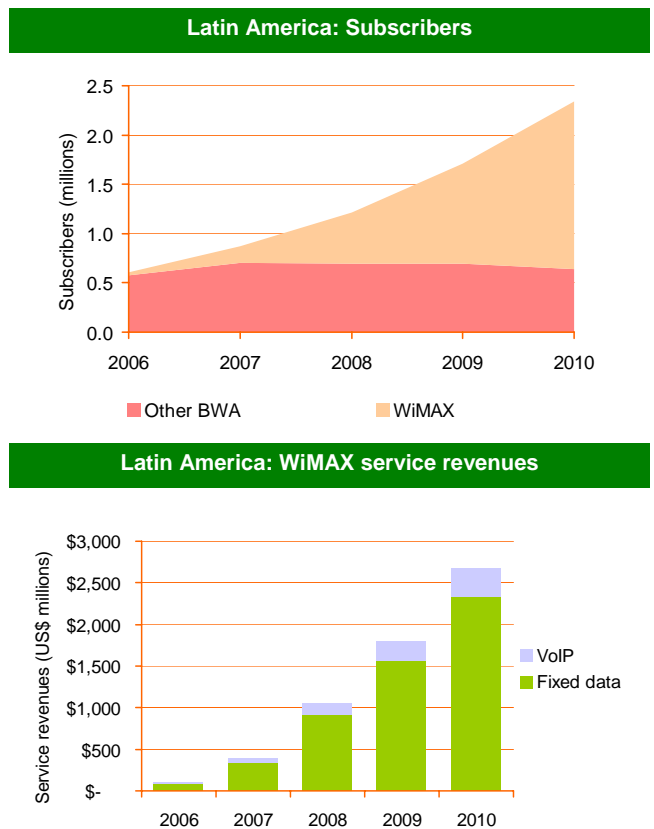


Figure 4. Wireless broadband subscribers and WiMAX service revenues in Latin America

Figure 5 shows the corresponding data for the market worldwide.

The next five years mark only the initial phase in the adoption of WiMAX. Leading operators will start deploying networks, but network expansion and subscriber acquisition will require time. In addition, operators will continue to operate their non-WiMAX BWA networks. The next five years will see operators laying down the foundations for their success and we expect to

see more aggressive growth in the number of subscribers in the following years.

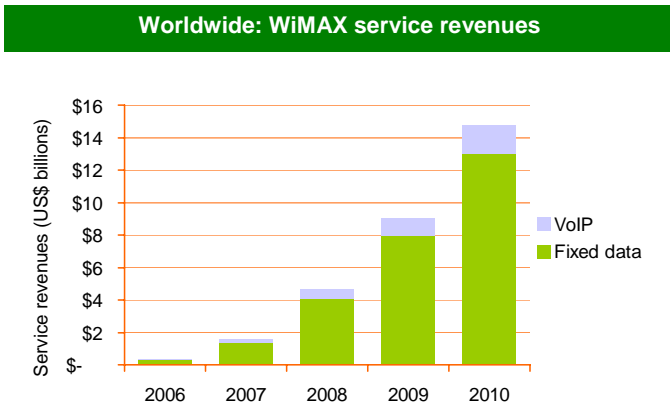
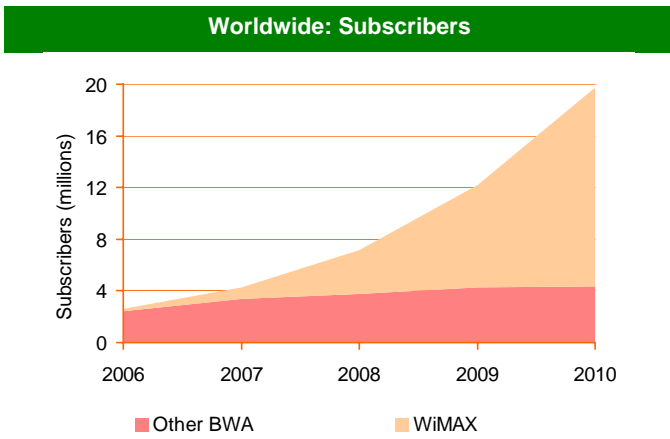


Figure 5. Wireless broadband subscribers and WiMAX service revenues worldwide

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Acronyms

3G	Third Generation
ARPU	Average Revenue Per User
BWA	Broadband Wireless Access
DSL	Digital Subscriber Line
EV-DO	CDMA Evolution Data Optimized
FDD	Frequency Division Duplex
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
MBS	Multicast Broadcast Service
MIMO	Multiple Input Multiple Output
MMDS	Multichannel Multipoint Distribution Services
OFDM	Orthogonal Frequency Division Multiplex
OFDMA	Orthogonal Frequency Division Multiple Access
QoS	Quality of Service
RF	Radio Frequency
TDD	Time Division Duplex
VoIP	Voice over Internet Protocol
WCDMA	Wideband CDMA
WiMAX	Worldwide Interoperability for Microwave Access

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At Senza Fili we have in-depth expertise in financial modeling, market forecasts and research, white paper preparation, business plan support, due diligence, training, and evaluation of end-user requirements. Our clients are international and span the entire value chain: they include fixed and mobile operators, ISPs, wireless ISPs, other service providers, vendors, solution providers, system integrators, investors, and industry associations.

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