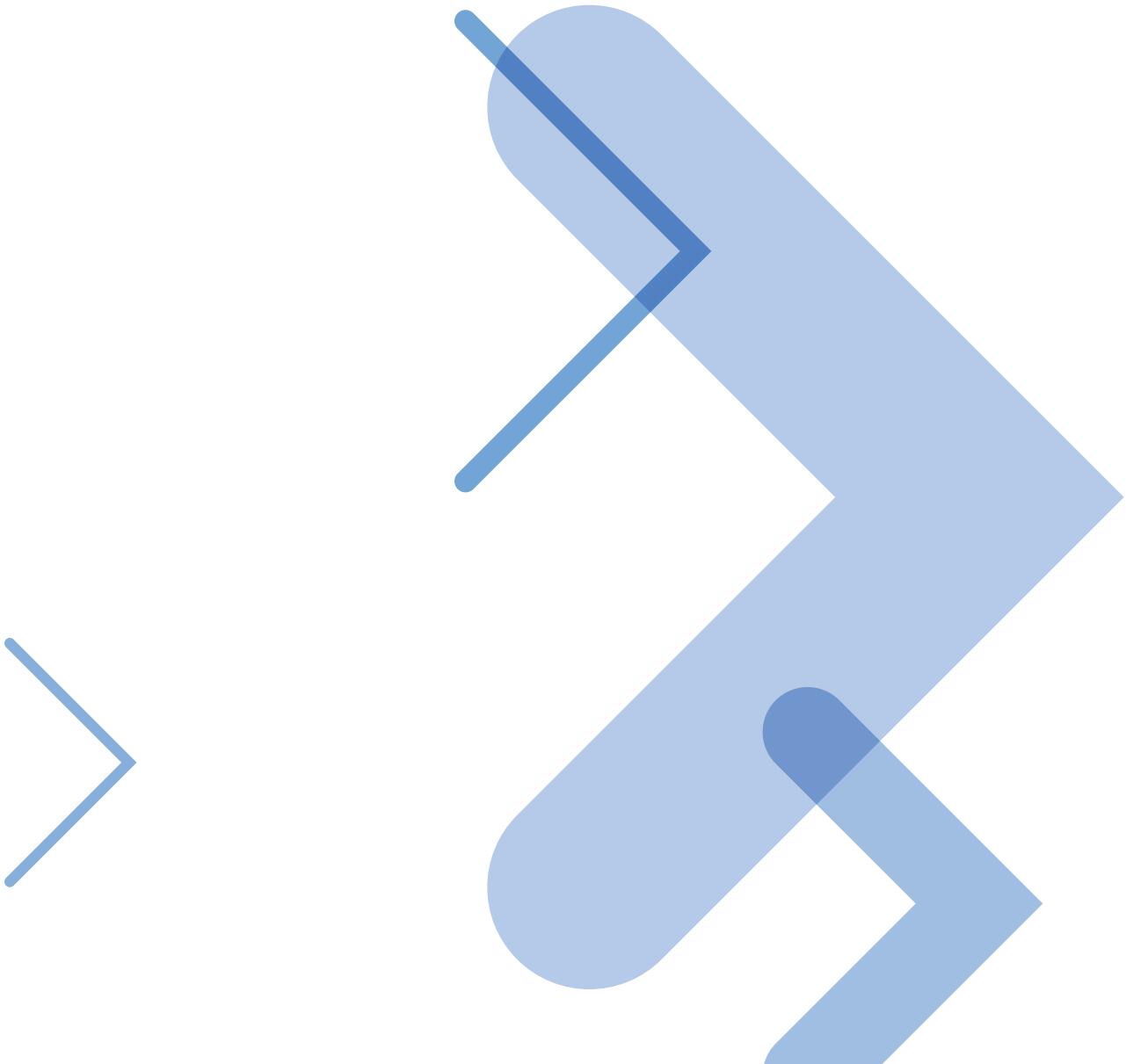
WHITE PAPER

Maximizing the Wireless Network Evolution with WiMAX

How 2G, 2.5G and 3G wireless operators can leverage IP-based WiMAX technology to speed their networks' evolution to meet the fast-growing demand for "Broadband-on-the-Go."



Today's end users want richer, more personalized media experiences like music, video, live television and interactivity.

Speed of Change

Fueled by a technologically savvy new generation of mobile end users, the wireless telephony marketplace is on the cusp of both rapid change and virtually limitless opportunity. At the same time, wireless service providers face tough new competitors vying to give the new generation of end users exactly what they want.

What is it that they want? They want it all. Today's more sophisticated end users are no longer satisfied with voice service and simple data downloads. These days they're demanding a great deal more from their wireless communications. For sure, they're demanding higher speeds. But they're also looking for richer, more personalized—and more bandwidth-intensive—media experiences like music, video, live television and interactivity.

They're also not content to access these new high-speed services only sometimes and in some places. They want them all the time. They demand high-speed access whenever they want it, wherever they are—at home, at work, on the road—and everywhere in between. In short, they want "Broadband-on-the-Go." For proof, operators need only look at the burgeoning global popularity and penetration of mobile broadband. Also, the widespread acceptance of WLAN such as WiFi (802.11b/g) is driving demand. As residential users experience wireless technology at home and at hotspots and as enterprise users enjoy mobility from EVDO/UMTS, they now want access to their fast, wireless applications universally.

So right now, the question every mobile operation is facing is this: how will we give these more demanding, yet more profitable, end users the higher speeds and advanced services they demand? The good news is, there are now a number of answers to that question, with multiple alternative network evolution strategies to choose from, led by IP-based WiMAX.

Challenge for Wireless Operators

Although operators of 2G, 2.5G and 3G wireless networks have different strategic and technological challenges, they share the same basic realization that their existing networks—which have worked so well for so long—must evolve to succeed in the new wireless environment.

Strategic Challenges for 2G Networks

For 2G networks the biggest challenge involves adapting voice-centric networks to deliver competitive high-speed Internet access and data rates. Operators must also address the need to provide the advanced mobility that can deliver new high-speed access and services anywhere and everywhere customers want them.

Strategic questions for 2G operators are many:

- How can a 2G network evolve beyond 3G and provide sustained future growth in a performance-centric marketplace?
- What levels of performance do 2G networks need to provide the rich, mobile media experiences today's new high-spend end users value so highly?
- With ARPU levels static or falling, how can 2G providers best leverage new mobile broadband technologies to increase revenues?
- How can a 2G provider adapt the networks to take advantage of the wide range of new applications being developed in virtually every corner of the globe?
- How can a 2G operator adapt an existing network to the new demands of the marketplace without losing the value of current technology investments?

Strategic Challenges for 2.5G and 3G Networks

Even though 2.5G and 3G networks have been built to provide both voice and data services, the reality is that current 2.5G and 3G speeds are significantly slower than they need to be in the new broadband wireless marketplace. The major challenge is to

improve performance, substantially increasing current speeds to offer what's most important to the new end users: high-speed Internet access and full broadband mobility.

Subscribers experienced with 2.5G and 3G wireless networks like access to mobile data, but they want the speed provided by their cable or DSL connections in their home or office. High throughput fiber and metro Ethernet have increased backend transport network capacity. Also the use of IP/MPLS routing and switching protocols such as those implemented in public networks/Internet and private networks has increased network efficiency. With this core network and transport in place 2.5G and 3G wireless operators are now positioned to offer higher throughput wireless access networks such as WiMAX.

Specific questions facing 2.5G and 3G operators include:

- How can 2.5G and 3G network operators best evolve both their networks and their business models to facilitate sustained future growth?
- How much must 2.5G and 3G network performance increase to deliver the rich, mobile media experiences today's sophisticated new end users demand?
- What are the best new revenue-generating options available for 2.5G and 3G providers as they evolve their networks?
- How will 2.5G and 3G providers best be able to leverage the wide range of new applications being developed worldwide?
- Can 2.5G and 3G operators adapt existing networks to the new marketplace without losing the value of their present investments in technology?

IP-Based Networks

In answer to these challenges, many traditional cellular service providers are exploring the use of an all-IP infrastructure as either a substitute for, or supplement to, their cellular systems. It's an option that's becoming increasingly popular, and for good reason.

IP-based networks provide an open, shared environment and outstanding interoperability. They provide unparalleled synergies between different networks and a broad range of wireless devices. End-users will enjoy not only breakthrough new high-speed mobile applications, but also a consistent experience from network to network and device to device.

With IP as a common foundation, mobile operators will gain access to a growing global community of content providers, advertisers and high-spend end users. IP interoperability is already facilitating establishment of an active, worldwide environment for the development of new high-speed content, applications and services, as well as for fostering new business models, new partnerships and new revenue opportunities.

Evolution to all-IP networks is predicted to play a fundamental role in helping wireless operators position their businesses for sustainable future

Choosing the Optimal Network Evolution Path

As they examine various scenarios for evolving their wireless networks, mobile providers are evaluating their alternatives on a number of strategic and technical issues, including:

- **Marketplace Dynamics.** Operators are analyzing their market share, strength of competitors, types of target audiences and physical and geographic considerations.
- **Applications.** Mobile operators should closely examine the types of current and forthcoming applications that will be the best fit for their market, their current and potential customers and their network infrastructure.
- **End User Use Cases.** Operators must also determine which core target audience or audiences they plan to serve both now and in the future. Then they need to examine specific use cases, analyzing customer needs and wants in terms of applications and mobility.
- **Access to Spectrum.** Operators that wish to explore WiMAX technologies must first make certain they either have or can procure access to licensed spectrum.

success, enabling them to provide truly personal broadband with seamless high-speed mobility. Today, the IP-based mobile broadband technology generating the most industry buzz is WiMAX 802.16e.

A WiMAX Primer

A growing number of wireless service providers are looking at WiMAX 802.16e as the optimal technology for evolving their cellular networks. WiMAX will enable them to create a seamless broadband wireless fabric that empowers end users in all their environments: home, office and mobile.

WiMAX 802.16e is an IP-based broadband wireless access technology developed from the ground up to provide high-speed data and voice capabilities combined with advanced interactivity, ubiquitous mobility and exceptional cost-effectiveness.

WiMAX delivers standards-based high-speed voice, data and Internet connectivity in licensed spectrum. It is the first technology that delivers true broadband mobility at speeds that enable powerful applications—such as VoIP, online gaming, mobile TV and other personalized, interactive media experiences—that differentiate networks, enhance revenues and reduce churn.

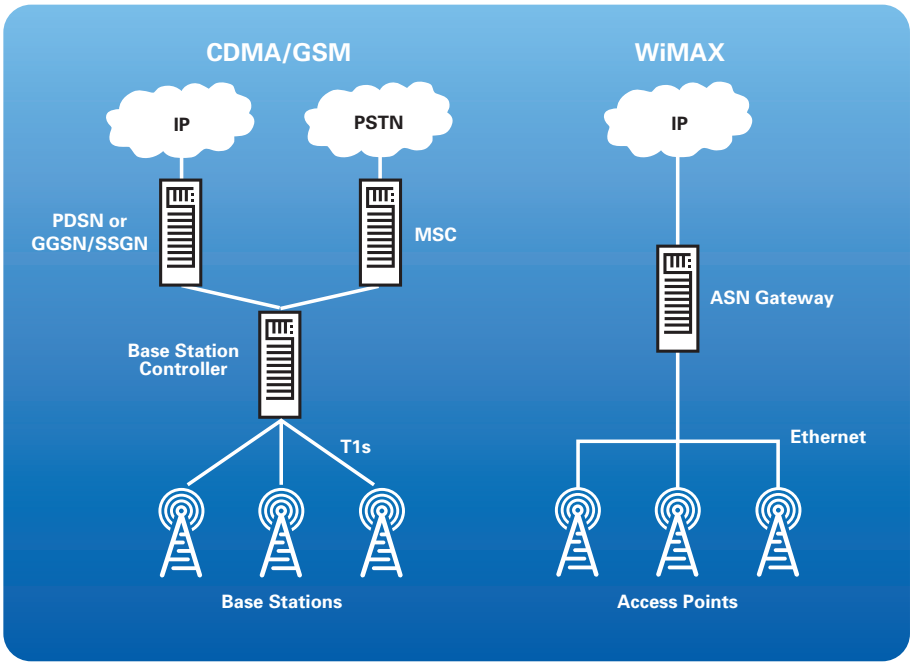


Figure 1. A Comparison of Networks

Mobile WiMAX offers the industry a very capable platform by which to deliver the demanding service requirements for wireless access today and tomorrow. With the added support for a variety of advanced multi-antenna implementations such as MIMO (multiple input multiple output) and beamforming, mobile WiMAX offers the wireless operator considerable relief in meeting their growing network demands with higher performance, fewer sites, less spectrum and reduced cost.

The WiMAX 802.16e standard enjoys remarkable industry wide acceptance. That means WiMAX is well positioned to be embedded in a wide range of low-cost, off-the shelf CPEs—including handsets, laptops, digital cameras, gaming consoles, mp3 players, television sets and more—that can virtually eliminate costly end user CPE subsidies.

WiMAX Architecture

The WiMAX distributed architecture is a simpler, more powerful alternative to traditional hierarchical cellular networks based on complex layers of control. WiMAX networks and supplemental solutions take maximum advantage of the power of IP technology, utilizing the latest advancements in mobility management and providing a robust and versatile services platform.

How does IP-based WiMAX technology compare with 2G and 3G mobile networks? WiMAX is simpler and more efficient, providing both "Broadband-on-the-Go" capabilities and significantly reduced CAPEX and OPEX. As shown in Figure 1, traditional 2G and 2.5G network traffic must go through the equivalent of an MSC (Mobile Switching Center). The backhaul from the base stations to the MSC is either through low throughput frame relay or E1/T1 connection. Traffic is rerouted to a data network or a circuit network for voice. Furthermore, data traffic is directed to the SGSN/GGSN in a GPRS/EDGE network or through a PDSN in a CDMA network.

In contrast, the WiMAX network has a flat IP architecture with high throughput backhaul using Ethernet (10/100/1000 Base T Ethernet) that is remarkably easy, efficient and cost-effective, significantly reducing CAPEX and OPEX.

Mobile users are demanding high-speed access wherever they are: at home, at work, on the road, on the street… and everywhere in between.

Advantages of WiMAX

Mobile operators considering deployment of a new stand-alone WiMAX network, or using WiMAX as an extension or overlay to their existing networks, can look forward to a number of critical advantages, including:

- **True Mobile Broadband.** WiMAX IP-based technology is an efficient and cost-effective solution for delivering the dramatically higher speeds necessary to give end users the bandwidth-intensive applications they demand and the mobility to provide them anywhere and everywhere.
- **Substantial Reductions in Interference.** Because WiMAX operates in licensed spectrum, it effectively does away with most of what can be substantial interference challenges posed by solutions that work in unlicensed spectrum.
- **Lower Cost of Ownership.** The WiMAX IP-based architecture enables highly cost-effective implementation for both small- and large-scale deployments. The WiMAX distributed architecture eliminates costly centralized boxes, enables efficient remote management and allows for software-driven upgrades.
- **Shorter Time-To-Market.** In a market moving as quickly as mobile broadband, WiMAX networks offer distinct advantages in both ease of deployment and reduced time-to-market.
- **Outstanding Revenue Opportunities.** The WiMAX open IP-based architecture encourages developers to supply applications that provide the rich media experiences today's consumers want. Current applications such as VoIP, streaming video and gaming can help you maximize revenues and profitability today, and next-generation applications such as mobile TV, real-time trading and video telephony can keep profitability growing tomorrow.

Widespread Acceptance. WiMAX technology enjoys exceptional industry acceptance with over 400 member companies currently in the WiMAX Forum. The WiMAX Forum includes not only WiMAX vendors and providers but also application developers, content developers and component suppliers. As shown in Figure 2, significant spectrum has been allocated worldwide in the 3.5, 2.5, and 2.3 GHz bands for wireless broadband solutions such as WiMAX.

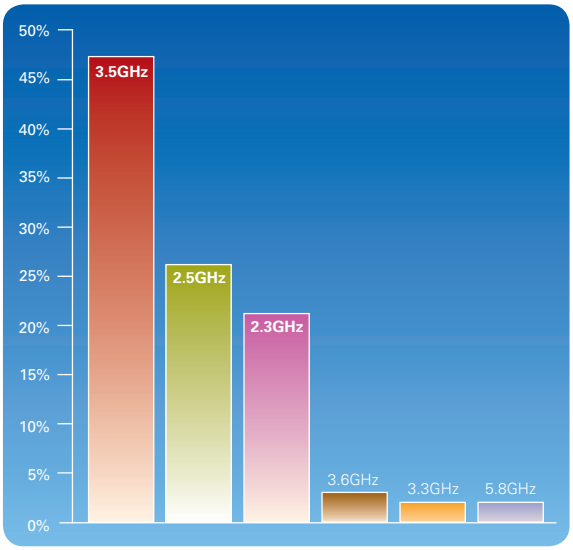


Figure 2. WiMAX Frequency Allocations

Source: Motorola Research

In a wireless communications marketplace that is moving inexorably toward seamless, high-speed mobility, wireless operators must recognize that sustainable success may depend on their ability to evolve their networks to be able to provide "Broadband on the Go." Operators should carefully consider their evolutionary strategies, and explore all available options, including the exceptional potential of IP-based WiMAX solutions.

Wireless operators are quickly realizing that no single evolutionary path is right for every network.

Getting Up to Speed for New Data-Heavy Applications

How do the speeds needed to facilitate "Broadband on the Go" differ from current network capabilities? Today's 2G, 2.5G and 3G wireless networks typically offer downlink speeds in the range of 34 Kbps to 900 Kbps under favorable conditions. But to offer data-heavy, rich media experiences like interactivity and streaming live TV, wireless operators must be prepared to enable their networks to offer true, multi-megabit connections similar to what DSL and Cable currently offer in many mature markets. With over 20 Mbps data rates supported by a single WiMAX base station sector, such multi-megabit connections can become a reality.

WiMAX in Wireless Network

Many wireless operators are already considering WiMAX as a preferred option for their next generation wireless network because WiMAX complements their existing wireless solution. A WiMAX network can be built on existing cellular sites or on tower tops. Today, zero footprint, light infrastructure solutions can be deployed completely outdoors with an antenna mounted on a building, water tower or existing pole.

For wireless operators with cellular infrastructure, existing towers, antennas, power, operation and maintenance infrastructure can be reused. Existing transport, routing and switching network elements can be reused in many initial deployments. Wireless operators with IMS in their existing networks find that IP based WiMAX improves the IMS application experience for their subscribers and creates new revenue generation with higher ARPU.

WiMAX is a versatile solution with application across various operator profiles. However, among the diverse operator profiles, wireless operators have demonstrated particular interest in employing WiMAX technology. This is underscored by the fact that, as depicted in Figure 3, wireless operators own the largest portion of WiMAX spectrum globally.

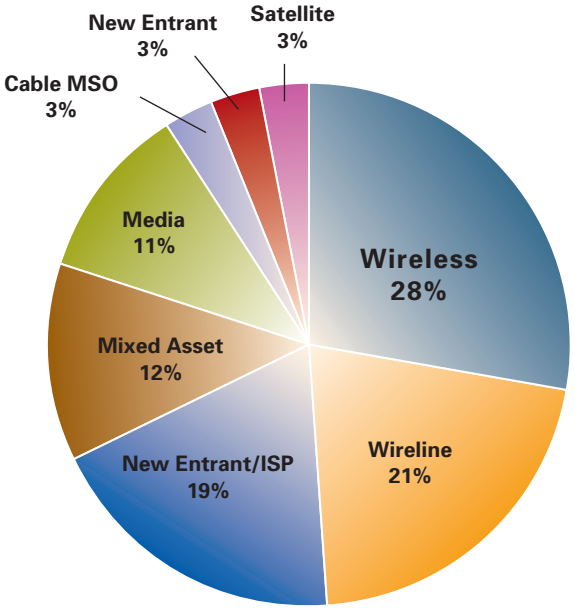


Figure 3. WiMAX Spectrum Holders

Source: Motorola Research

Conclusion: Delivering Seamless Mobility WiMAX

Personal Broadband is the promise of always on, always available connectivity, allowing users to take their information and services with them when they leave the confines of their home or office.

Just as cellular technology freed the world to roam and talk, personal broadband services over mobile WiMAX frees the world to connect anywhere, any time. Compelling multi-modal devices will allow operators to seamlessly transition across multiple networks: cellular, WiFi, WiMAX, wireline. End-Users will have ubiquitous broadband connections that follow them wherever they may be for ready access to bandwidth-intensive, personalized, rich-media content.

The IP-based, flat WiMAX architecture is inherently more interoperable with legacy cellular networks, in large part, because the design is not encumbered by the requirement to support a number of proprietary components. This makes interconnectivity to existing operator systems more agnostic when integrating common subscriber management, messaging and other services.

With WiMAX we have the opportunity to free the tethers of wired broadband and transform the way we share, connect, and communicate with seamless mobility.

GLOSSARY

1xRTT	1x Radio Transmission Technology
2G	Second Generation Wireless
2.5G	Second and Half Generation Wireless
3G	Third Generation Wireless
ASN	Access Service Network
ARPU	Average Revenue Per User
Capex	Capital Expenditure
CDMA	Code Division Multiple Access
CPE	Customer Premises Equipment
EDGE	Enhanced Data for GSM Evolution
EVDO	Evolution Data Only
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
IP	Internet Protocol
ISP	Internet Service Provider
MIMO	Multiple Input Multiple Output
MPLS	Multiprotocol Label Switching
MSC	Mobile Switching Center
MSO	Multiple System Operator
OFDMA	Orthogonal Frequency Division Multiple Access
OPEX	Operational Expenditure
QoS	Quality of Service
PDSN	Packet Data Serving Node
PSTN	Public Switch Telephony Network
SGSN	Serving GPRS Support Node
STC	Space Time Coding
UMTS	Universal Mobile Telecommunications System
VoIP	Voice over IP
WAN	Wide Area Network
WLAN	Wireless Local Area
WiMAX	Worldwide Interoperability for Microwave Access

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