



Deployment of Mobile WiMAX™ Networks by Operators with Existing 2G & 3G Networks

The deployment of Fixed WiMAX™ networks to address “last mile” broadband access has been highly successful in the last few years, and that model is reasonably well understood. However, the deployment of Mobile WiMAX by existing mobile operators has highlighted some important questions, the answers to which this paper provides high level direction.

OFDM & MIMO: Technologies of Choice for Mobile Broadband

2.5 and 3G networks have enabled users around the world to access data on their handsets and laptops. However, as mobile data services increase and more PC users start using the same broadband Internet applications “on the go” as they do at home, the expectation is for mobile data traffic to grow by a factor of 10x between 2010 and 2015.* And this requirement could easily exceed expectations with a surge in applications like rich social networking which combine Internet multimedia and mobility. Although 2.5 and 3G networks will continue to serve up voice and mobile data for the foreseeable future, these networks will become capacity constrained as mobile broadband data use increases. Hence, the deployment of new networks to offload data-intensive mobile broadband applications is inevitable. Along with increased and scalable data capacity, these new networks will be capable of supporting new, open Internet models and new device distribution and subsidy models – flexibly accommodating operators’ business model needs.

OFDM & MIMO have emerged as the technologies of choice to satisfy this growth, not

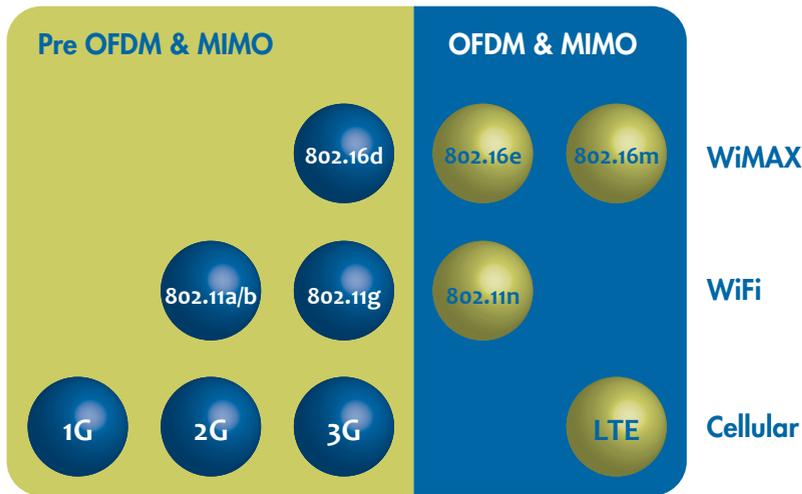
* A Review of Spectrum Requirements for Mobile WiMAX, Sep 2007, p.27. Available on WiMAX Forum website.

only for WiMAX, but also for 3GPP's future LTE** standard as well as Wi-Fi (802.11n). The combination of OFDM and MIMO is highly scalable and systems based upon it are best positioned to satisfy the headroom requirements for mobile broadband data over the next decade.

In 2007, commercial Mobile WiMAX Release 1.0 systems which have not yet incorporated MIMO capability, showed a consistent 3x capacity improvement over other mobile wireless solutions in the same amount of spectrum. And that's just the start. In 2008, MIMO-enabled WiMAX systems are expected to deliver 50% gains over the current SISO implementations. In 2010, wider channel bandwidth support in Release 1.5 will enable peak data rates well in excess of 100 Mbps using 20 MHz channels. In the future, when equipment can cost effectively support 4x4 MIMO configurations, peak data rates of over 300 Mbps will be achievable.***

WiMAX as a Data Overlay to Existing 2G & 3G Networks

Figure 1



All roads lead to OFDM & MIMO. Mobile WiMAX (802.16e) is already there.

WiMAX, 2G & 3G are complementary. The circuit-switched voice offered by 2G & 3G networks is highly efficient and the coverage level of many of these networks is excellent.

** 3GPP's Long Term Evolution (LTE) as well as 3GPP2's Ultra Mobile Broadband (UMB) technologies are based upon OFDM & MIMO. The LTE standard is under development in 3GPP.

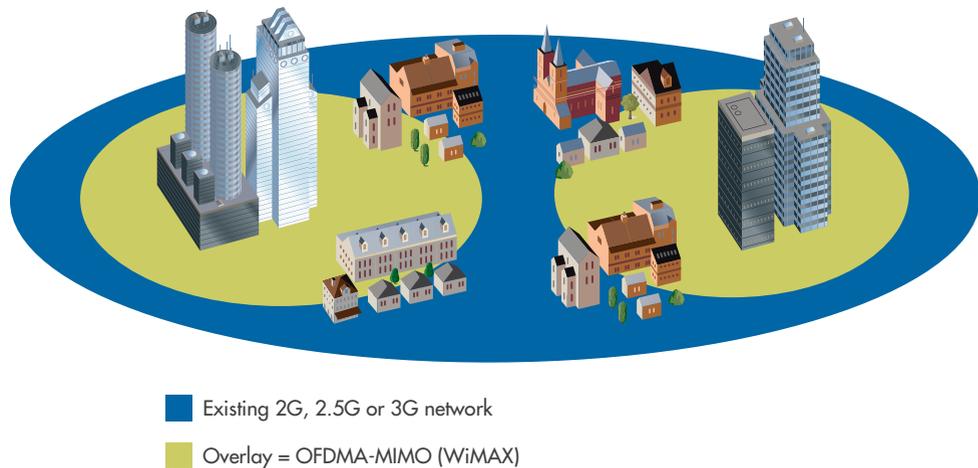
*** Using 20 MHz channels and WiMAX Release 2.0. Based upon IEEE 802.16m Systems Requirement Document.

New, data-optimized networks based upon OFDMA**** & MIMO (e.g., today's WiMAX or 3GPP's future LTE) will be deployed in entirely new spectrum, and will take years to reach the coverage levels of today's 2G & 3G networks. These combined factors point towards operators maintaining their existing 2G & 3G networks for voice & narrower-band data, and deploying WiMAX for more data intensive applications. This is precisely what KT is doing with HSPA + Wibro and EV-DO + Wibro; likewise Sprint is planning EV-DO + WiMAX handsets. Operators will offer multi-mode handsets & modems to provide the best of both worlds – coverage + high speed – to their subscribers while they build out their 4G networks over several years. For portable devices such as laptops, the multi-mode combination of Wi-Fi + WiMAX will be the more common embedded solution for ensuring coverage.

The Migration Path to 4G (OFDMA-MIMO)

Figure 2

WiMAX as a Data Overlay to Existing 2G & 3G Networks



2/2.5G Operator, no 3G investment	When EDGE capacity insufficient, deploy OFDM overlay solution in new spectrum
3G Operator - HSPA, EV-DO	Continue to evolve HSPA, EV-DO in existing spectrum; OFDM overlay in new spectrum
Fixed/Non-Cellular Operator (PTT, Satellite, Cable)	Go straight to OFDM deployment

Operator retains 2G or 3G network - Overlays data network

**** The variant of OFDM used by both WiMAX & LTE.

The 3G evolution from WCDMA to HSPA or equivalently, CDMA2000 to EV-DO – all technologies based upon CDMA – was achieved via upgrades to operators' existing 3G networks utilizing the same spectrum. These upgrades will continue, but fundamentally these networks do not have the scaling capability to address future data traffic patterns associated with mobile broadband use. (Higher order MIMO antenna configurations are the core enabler for scaling throughput of OFDM/MIMO systems over the next decade, but CDMA support for higher order MIMO is not efficient. For this reason, IEEE 802.16, 3GPP and 3GPP2 standards bodies are all adopting OFDM & MIMO for 4G.) Since there is no expectation to decommission operational 2G & 3G networks, new OFDMA-MIMO data overlay networks – be they WiMAX today or, in the future, LTE – must be deployed in new spectrum, preferably spectrum offering wider swaths of spectrum to enable very high data capacity.

The addition of an OFDMA-MIMO mobile broadband data overlay network involves deployment of new base station line cards and clients as well as upgrades to the core network to support high amounts of IP (Internet Protocol) traffic. That said, existing mobile operators can co-locate WiMAX base station equipment in their existing 2G or 3G cell sites. In mobile WiMAX commercial deployments to date, we have seen a cell site re-use rate of 70%****.

Once the data overlay network is in place, operators may offer multi-mode devices as it makes sense to enable seamless roaming across their voice-optimized and data-optimized networks as mentioned earlier. The WiMAX community has and will continue to work closely within 3GPP to optimize interworking between WiMAX & 2G / 3G networks. The open network architecture supported by WiMAX may create healthy competition for certain common network elements – potentially increasing innovation and reducing costs.

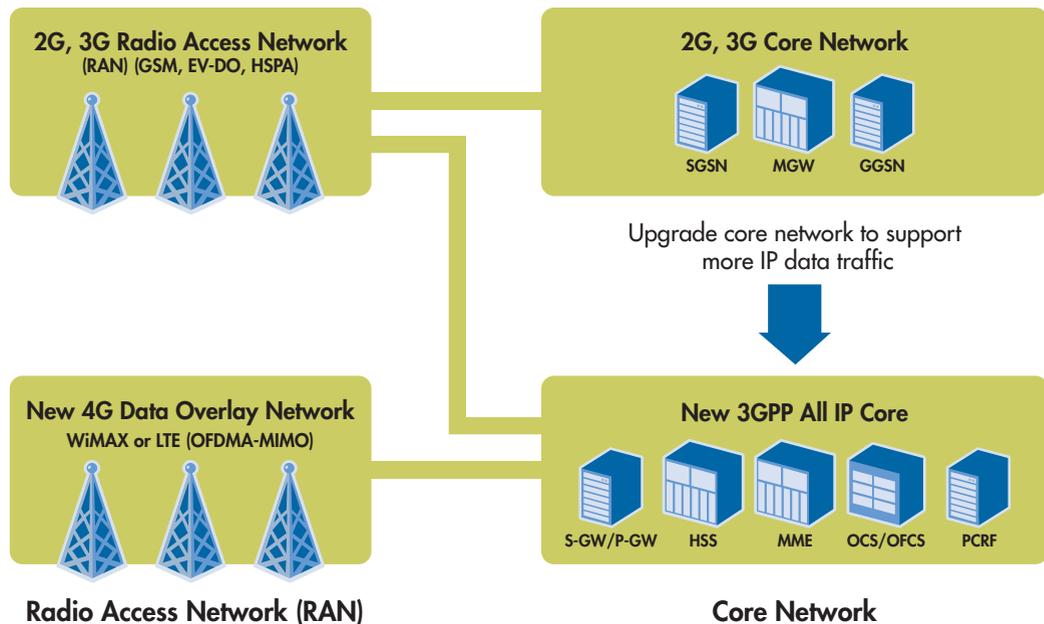
We have found operators very supportive of WiMAX-3GPP interworking as it creates a safe, viable choice in WiMAX for their 4G technology decision.

From Standards Completion to Interoperable Products Available Today

Operators which choose WiMAX will benefit for a plethora of innovative, cost effective devices. The mobile WiMAX standard was ratified by IEEE in December 2005. The WiMAX Forum has held five plugfests since July 2006, with over three dozen equipment vendors participating in the most recent October 2007 plugfest. WiMAX Forum mobile certification

**** Approximate rate of re-use of EV-DO sites in KT Wibro network.

Figure 3



As a data overlay network, WiMAX will interface the new 3GPP Enhanced Packet Core.

began in Jan 2007 and, in anticipation of the submission of hundreds of devices, the Forum has opened five labs: 3 in Asia Pacific, 1 in the U.S. and 1 in Europe.

In the first major commercial mobile WiMAX deployments, we are already seeing an unprecedented level of device innovation: WiMAX USB dongles with integrated MP3 and mobile TV, tri-mode (WiMAX, 3G & T-DMB) smartphones and multi-mode (Wi-Fi, WiMAX, Bluetooth) mobile Internet devices and notebooks.

Expected to further accelerate device & application innovation as well as price/performance metrics, Taiwan launched its M-Taiwan initiative involving dozens of component, equipment, content, application & service providers with over \$1.2 billion USD in planned investment. The recent awarding of WiMAX spectrum licenses in Japan should also produce exciting advancements given that country's historical leadership in driving innovative wireless devices and applications.

Net-net: A global industrial complex is in process of delivering the economies of scale of the Internet & PC industry to the mobile broadband arena via WiMAX. WiMAX Forum membership includes some of the world's largest mobile & wireline operators and virtually every major global telecom equipment manufacturer. Complementing these members are

hundreds of smaller, highly focused application, content & service providers, equipment manufacturers and component makers ensuring supplier support and a variety of applications and devices whether a WiMAX deployment involves 20 or 20,000 base stations.

Summary

For operators with existing 2G or 3G networks, Mobile WiMAX presents a safe and viable complementary data solution backed by a vibrant, globally competitive manufacturing ecosystem.

Examples of Multi-mode Mobile WiMAX Devices from KT Wibro Deployment



KWD-U1100
WiBro + T-DMB
(mobile TV) DBDM



LG-KU1P
WiBro + MP3 player



Samsung: SPH-P9200
WiBro, WiFi



Samsung PDA: SPH-M8200
Triple mode (WiBro, EVDO, T-DMB)
Voice call thru CDMA



EVERUN 60H/S6S
WiBro, 802.11b/g, Bluetooth 2.0



LGE PDA: LG-KC1
Triple mode (WiBro, EVDO, T-DMB)
Voice call thru CDMA



Samsung: NT-Q35
WiBro, T-DMB
Option (WiFi + Bluetooth 2.0 EDR)



PMP: KWS-P1000
WiBro, T-DMB, video player, MP3
Full internet