

Arthur D Little

**HSPA and Mobile WiMax for
Mobile Broadband Wireless Access**

Executive Summary

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Smart Innovation



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Executive Summary

The advent of mobile broadband access is accompanied by significant uncertainties over the likely future successes of the new technology choices that are becoming available. In particular, the relative commercial and technical advantages and disadvantages of operating HSPA vs. mobile WiMax remain unresolved. Operators, regulators and vendors are developing their plans for the future in a cloud of hype, biased comparisons, and easily misinterpreted statistics.

In this report, Arthur D. Little attempts to take an unbiased view of both technologies, assessing their limitations and achievements on a like-for-like basis, in a framework that is relevant to investors and operators making strategic decisions about technology investments.

For this purpose, we have interviewed 31 HSPA and WiMax equipment vendors, operators running the networks, government regulators and financial investors around the globe. We have not only gathered and analysed the qualitative assessments made by our interviewees but together with our colleagues from Altran Telecoms & Media and Praxis HIS have also collected some 300 parameters required for a quantitative assessment of the differences and have modelled these in realistic deployment scenarios.

Main Findings

Our findings can be summarized as follows:

- **HSPA will account for the majority of mobile broadband networks worldwide over the next five years;**
- **Mobile WiMax is a competitive technology for selection by operators over this period in only a limited number of circumstances where conditions are favourable;**
- **There are 93 commercial HSDPA networks in operation today, while the first commercial mobile WiMax networks are expected to enter service during 2007¹;**
- **In the long term mobile broadband wireless systems will be characterized by technologies such as OFDMA and MIMO whose development is being actively pursued throughout the industry and are part of the evolution path for both;**

¹ Sources: GSA and WiMAX forum - the first mobile WiMAX Forum Certified™ products are expected in early 2007.

- **While future mobile WiMax systems are expected to achieve significantly greater data transfer rates than today's HSPA networks (theoretical speeds of e.g. 16.8 Mbps in urban areas vs 2-3 Mbps for HSPA), mobile WiMax cells will tend to be significantly smaller, at only half to a quarter the cell radius of the equivalent HSPA cell;**
- **Initial indications are that capex for current WiMax technology can be up to 5-10 times HSDPA capex on a like-for-like basis.**

First indications arising from our quantitative commercial model illustrate the relative benefits and limitations of HSPA and WiMax. WiMax is capable of achieving higher peak bandwidths to the user than HSPA through higher modulation of 64QAM in up- and downlink, compared to 16QAM with HSDPA and QPSK with HSUPA. High modulation means a higher data rate is available, but is less robust and so does not travel as far as lower modulation. Such high bandwidth is, however, only available very close to a base station, and falls away rapidly as the user moves away from the cell centre.

In contrast, the bandwidth available in an HSPA system falls off much more slowly with distance from the base station, allowing for larger cells. For example, the bandwidth expected to be available to the user through WiMax can be up to 16.8 Mbps in urban areas vs the commercially available 2-3 Mbps for HSPA under identical conditions, but this higher bandwidth is only available within a significantly smaller cell area. Typically, the radius of HSPA cells is 2-4 times larger than that of mobile WiMax cells, leading to cells that are 4-16 times larger in area.

The limited size of mobile WiMax cells under such conditions necessitates a larger number of base stations and sites to cover the same geography, with major consequences for both an operator's capex and opex. **The initial indications are that capex for current WiMax technology can be up to 5-10 times HSDPA capex on a like-for-like basis. This is particularly pronounced in rural areas.**

In practice, mobile WiMax operators will use means that will extend the range of each base station but to the detriment of data rates. To increase the cell range and hence reduce capex and opex, WiMax technology enables operators to deploy networks using PUSC modes (Partially Used Sub Channels) that can achieve cell ranges closer to or beyond those of HSPA. This, however, results in a trade-off of bandwidth available to the user, particularly in the uplink where it can drop by up to ~95%. Hence WiMax has a range problem for high data rates. This impacts not only more rural areas of developed countries but also developing countries overall.

The momentum behind HSPA

Over the next five years HSDPA networks and upgrades, including HSUPA and HSPA+, will be deployed much more widely than mobile WiMax thanks to the combination of:

- The substantial **momentum in HSDPA deployments** and plans that have been built up since late 2005, and its time-to-market advantage over mobile WiMax;
- The large number of GSM and UMTS operators **already operating commercial networks in 3G spectrum** for whom HSDPA (and upgrades) constitute a natural migration path;
- This large HSDPA base gives rise to significant **economies of scale**, particularly on handsets and user devices;
- This is supported by a very **large ecosystem** of global suppliers of components, subsystems, equipment and network design and implementation services;
- Demands for higher speed data services in nomadic and mobile environments which earlier (pre-HSDPA) 3G systems cannot satisfy, and are being generated by competitive pressures and **demands from significant customer segments**.

Clearly, the momentum in HSDPA deployments has been stimulated among other factors by competition from other broadband wireless technologies and the prospect of competition from mobile WiMax.

In contrast to preceding versions of 3G technologies, HSDPA achieves a quantum leap over dial-up speeds, reaching levels comparable to that of the first generations of DSL access in fixed networks, which was sufficient to help trigger the takeoff of broadband internet services. HSPA offers for most operators the least risky and best understood route to offering broadband mobile services with speeds comparable to early DSL access services. Furthermore, in contrast to the environment at the beginning of this century, today powerful internet-based interests (e.g. Google, Yahoo!, and MSN) are devoting considerable resources and ingenuity to deliver innovative and valuable services and capabilities aimed at mobile users. This will stimulate demand for mobile broadband wireless access. Hence, there are strong incentives from both consumer demand and competitive pressure for operators to deploy available wireless infrastructure and handsets capable of achieving user speeds comparable to first generation DSL access.

The limitations of WiMax

Over the past year WiMax has made significant progress in building a comprehensive “ecosystem” of supply, albeit one which has not yet established the depth and breadth of the HSDPA equivalent. This progress is making mobile WiMax a credible alternative to consider for deployment by operators where appropriate circumstances exist. The number of operators which fall into these circumstances is much smaller than the number for whom HSDPA represents a natural upgrade.

Unlike HSDPA which can address large numbers of established networks as a natural upgrade, the deployments of mobile WiMax will be paced by the:

- Timing of proof of performance of mobile WiMax in large scale deployments with significant numbers of users before 2008;
- Timing of availability of suitable WiMax-embedded user devices at attractive prices and with acceptable power consumption and other characteristics; the first such devices in notebook PC and PDA-like formats are expected to be available in quantity in 2008 and handsets only in 2009 or later;
- Resulting from the above, WiMax user devices will not have the same benefits of economies of scale that HSPA will.

There are situations where an operator may choose mobile WiMax in preference to other mobile technologies. These are where the operator:

- Does not have access to 3G spectrum but does have spectrum at frequencies such as 3.5, 2.3 GHz²;
- Is a fixed operator wishing to deploy broadband to areas where wired alternatives, notably DSL, are neither available nor economic to deploy;
- Is looking to develop or enlarge and enhance “hot spot” or “hot zone” broadband, primarily nomadic services.

In this last case it is unlikely that the operator will offer national or wide area coverage or mobility capabilities comparable to those which existing mobile networks and their HSPA upgrades will provide.

An operator in this last situation that possesses both 3G and WiMax spectrum assets (Sprint Nextel is one example in the U.S.) may deploy two broadband wireless

² Spectrum in the 2.5 GHz band is allocated as an IMT-2000 extension band by the ITU, so operators with such spectrum in paired frequencies could also choose non-WiMax systems such as HSPA; if only unpaired spectrum is available (as is the case with Sprint Nextel in the U.S.) then the choice currently lies between WiMax and the UMTS TD-CDMA standard available only from IP Wireless.

networks, with the idea of concentrating the delivery of new data services over WiMax and voice over 3G. Operators who consider this path will need to factor into their business plans the added operational cost of running two networks, to show that this cost will be more than compensated for by the generation of new revenues from mobile WiMax. The mobile WiMax network will involve a variety of WiMax-enabled user terminals in different formats from the typical handset, most likely acquired by the customer at full retail cost.

Given the limitations above, these terminals may be dual mode in some instances so they can rely on the 3G or 3G+ network for connectivity where there is no WiMax coverage, to provide wide area coverage and to enable mobile WiMax operators to gain scale.

A major factor which operators considering mobile WiMax will have to take into account is the cost of WiMax user terminals in markets, notably price-sensitive emerging or developing economies, where business cases without significant voice revenues are not viable. Because of low WiMax volumes, the prices of WiMax handsets will remain significantly higher than those of other, much higher volume, mobile terminals, which are being developed and offered in increasingly lower cost versions.

The upper hand on performance

There are conflicting claims about the presumed superiority (or inferiority) of mobile WiMax compared to HSDPA technologies in terms of technical performance and costs. To date, there is no convincing real-world evidence of the actual relative performances of these technologies across the wide variety of network environments and designs that operational networks will encounter in diverse conditions of terrain, climate, density of users, and traffic patterns. However, in the context of the systems that are expected to be available in the near future, it is likely that these technologies will achieve comparable levels of performance in specific situations. This means that mobile WiMax should not be regarded as a “killer” technology. It is unlikely that operators will abandon the upgrade paths of WCDMA networks. Operators with a need to deploy networks offering high speed services to their customers can do so with HSPA without the risk of a possible loss in competitiveness by delaying deployment until another technology becomes available.

In the fullness of time

In the longer term, during the second decade of this century, new OFDMA technologies will form the foundation of the next step change in access speeds in broadband wireless networks. Development of these technologies is being pursued by the 3G/HSPA “ecosystem”, within the framework of 3G LTE³ as well as by WiMax. When demand for faster speeds exceeds the capabilities of HSPA and the first versions of mobile WiMax competitive and demand forces will lead many operators to plan the deployment of networks based on this new generation of technologies. At this point numerous existing HSPA networks will face “upgrades” or “makeovers” that are likely to be more extensive and expensive than earlier upgrades from UMTS to HSDPA.

Hence a longer term competitive question for equipment vendors and markets is whether in this longer term either the mobile WiMax or the 3G LTE streams will achieve a significant time-to-market advantage over the other. It is possible that mobile WiMax might enjoy a time-to-market advantage over 3G LTE, if the latter were delayed substantially beyond its current roadmap for standards completion and commercial implementation. This opportunity for mobile WiMax would only arise if it succeeded itself in building a solid niche installed base with proven performance and a credible upgrade path in coming years. The prospects for this outcome would be enhanced if during the intervening period one or more of the following developments were to unfold:

- very evident demands which HSPA could not satisfy grew rapidly for the capabilities associated with higher speed demands;
- the implementation of new business and use models for wireless networks driven by the mobile internet rather than by traditional voice-centric mobile models; and
- establishment of roaming capability between mobile WiMax and other mobile networks as well as between WiMax networks themselves.

However, it is also possible that the mobile WiMax stream may be delayed or frustrated in its drive to develop a credible alternative to 3G LTE for the long term if its own progress is slowed by the time it takes to overcome inevitable teething problems in achieving creditable network performance. At this stage, the availability of WiMax-enabled user devices remains low and while their prices are higher than alternative broadband wireless-enabled terminals, although this is likely to change.

The risk faced by today’s mobile WiMax community is that its products may be both too late and too early to capture a significant proportion of billion dollar contracts.

³ Long Term Evolution – the next major revision of the 3G WCDMA air interface

Mobile WiMax may be too late to address a gap in speeds between a few hundred kbps to an Mbps or so which HSPA is rapidly filling now. Yet it may also be too early in terms of the readiness of components technology and network capabilities (e.g. rapid cell handover) needed for the full flowering of OFDMA/MIMO-based networks, the large scale deployment of which may not take place until 2015 or thereabouts.

The long term outcome for the roles of WiMax and 3G LTE broadband wireless systems will be influenced by the initiatives of both equipment vendors themselves and operators. Closer collaboration between these groups, although rejected in the past, may arise if the perceived interests of their members change as result of developments in the market and pressure from major operators. The outcome may range from convergence of the separate technology streams, with possible changes in vendors' relative competitive positions depending on whether one stream is more dominant in this convergence than the others, to a continued separation into distinct technology "camps."

Current debates over HSPA vs mobile WiMax tend to be dominated by vendors. However, the influence of vendors will be affected by possible changes in their priorities and alignments comparable to the impact of well publicized recent consolidations within the telecommunications equipment industry. These realignments may result from business initiatives such as divestment and acquisition, corporate M&A, or the formation (and abandonment) of partnerships, driven by the realities of the broadband wireless market, which, in our judgment, cannot profitably support all the currently vendors. Vendors' decisions will be determined by their respective competitive positions and perceptions of their prospects in various market segments, as well as by their overall corporate goals. These decisions may lead to reallocations of their finite resources across various R&D initiatives which are competing for financial, staff and other investments. The WiMax movement itself has been spearheaded by vendors who did not achieve leadership in the 3G network equipment market, and are striving to grow their market share in the overall broadband wireless equipment market thanks to the hoped for success of mobile WiMax.

Operators will also influence the long term shape of wireless equipment markets, as they pursue their interests as buyers rather than sellers of equipment, for example by coordinating and maximizing their influence on standards and specification procedures. This motivation lies behind the multi-operator NGMN (Next Generation Mobile Network) consortium formed during 2006 (which includes the mobile WiMax operator Sprint Nextel as well as several of the largest GSM operators) to foster interoperable multi-vendor equipment markets in which no one vendor can exploit a privileged position with respect to IPR, or unreasonably limit operators' individual choices of supplier(s) by proprietary approaches.

Towards a common agenda

Growing attention is now being paid to the complementary rather than the competitive aspects of mobile WiMax with respect to mobile networks and their upgrades, as evidenced by interest in the value of multi-mode user devices and roaming capabilities across these different technologies. This development, which reflects the widespread anticipation of the central role of OFDMA and other technologies involved in WiMax and 3G LTE in all eventual future broadband wireless networks, is a welcome change from the provocative and misleading headlines that have appeared over the past two years which imply - misleadingly in our judgment - that mobile WiMax threatens the viability of today's HSPA and related technologies.

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