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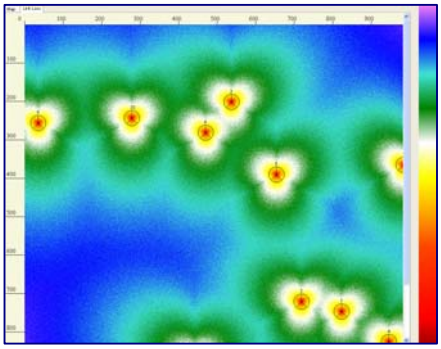
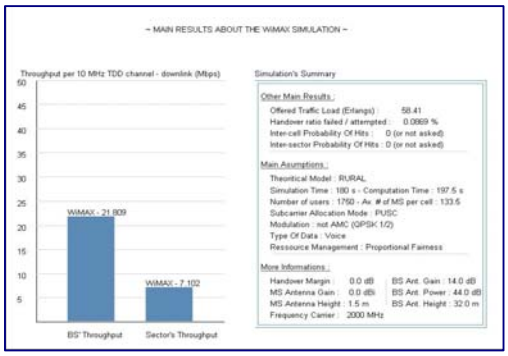
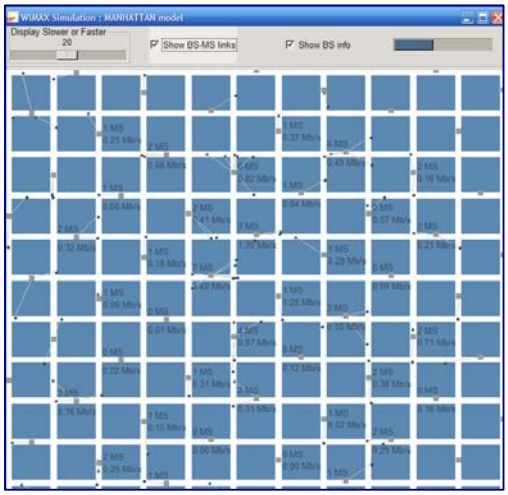
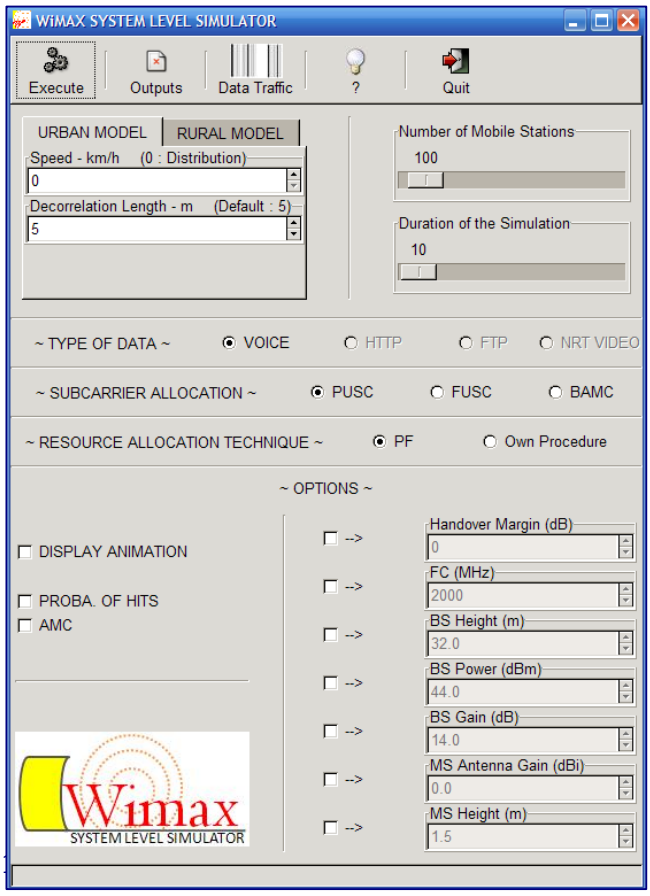


White Paper
Mobile WiMAX Potential and Challenges







Mobile WiMax Potential and Challenges

The number of voice users is approaching saturation in most of developed countries, and incumbent operators are therefore not expected to be able to increase their revenues only by offering voice and SMS. The only option left for them is to offer their customers a range of broadband services and applications, particularly similar to those already offered by fixed Internet service providers. Incumbents are nevertheless still looking for killer broadband applications to increase their revenues, akin to conventional business models. However, the era of the "killer application" has already passed, and the era of the "long tail" in successful applications has begun. There will be no new "killer applications" for mobile users; instead, it is expected that there will be a large number of smaller-scale services and applications, which together will continue the blossoming of revenues for operators and service providers. Such services and applications include:

- *High Speed Access to the Internet,*
- *Mobile TV,*
- *Peer-to-peer applications,*
- *Mobile advertising,*
- *Location-based social networking,*
- *Location-based dating,*
- *Collaborative social/corporate services and applications.*

Incumbent 3G operators cannot currently offer such services efficiently and cost effectively to their customers. This is because these services generate a large amount of traffic in the core and access networks. There are, however, two competing wireless broadband technologies which could, in the future, offer operators a network infrastructure to launch such services and applications cost-effectively: Long Term Evolution (LTE), and Mobile WiMAX. In the following, we compare the technical and commercial aspects of LTE and Mobile WiMAX for both 3G incumbent operators, and for new entrants into the sector.

Technically, both LTE and WiMAX have the following common features:

- *OFDM-based air interface,*
- *Adaptive modulation and coding,*
- *Hybrid ARQ,*
- *Fast scheduling,*
- *MIMO and beam forming antennas,*
- *IP-based access networks.*

They use different access techniques on the uplink: LTE uses Single-Carrier FDMA (SC-FDMA), while Mobile WiMAX uses OFDMA. This gives LTE a very slight advantage over Mobile WiMAX, since SC-FDMA, having a lesser envelope of signal envelope variation at the input of the terminal power amplifier, is more power-efficient than OFDMA. Another difference is that the core and access networks of

Mobile WiMAX is expected to be fully IP-based, while those of LTE will be IP over the existing 3G infrastructures with some enhanced IP functionalities and mechanisms. Hence Mobile WiMAX is expected to handle IP traffic more efficiently.

The 3G incumbent operators have invested billions of Dollars on spectrum and network infrastructures, hence it is common sense for them to adopt an evolutionary approach to deployment of LTE (from 3G, to HSXPA, through to LTE). However, for new entrants, it is a different story. Let us first examine the factors affecting the business case of new entrants who intend to deploy full cellular networks. These are:

- *Spectrum cost,*
- *Infrastructure cost (CAPEX),*
- *Maintenance cost (OPEX),*
- *Terminal cost (operators' subsidized cost),*
- *Revenue (ARPU).*

It is expected that the costs of infrastructure and maintenance for new entrants will be lower for Mobile WiMAX than for LTE (Green field scenario). This is mainly due to the fact that new operators will be able to deploy their IP-based core and access networks using low cost off-the-shelf equipment such as IP routers and servers. Assuming that the number of base stations required for both technologies is the same, the total cost of deployment (infrastructure and site acquisition costs) of a cellular network for Mobile WiMAX is lower than that for LTE. Also the maintenance costs of full IP-based networks are much lower than for circuit-switched or conventional packet-switched networks.

If new entrants decide to choose Mobile WiMAX, they should acquire lower frequency bands (of less than 1GHz carrier frequency), if possible. At higher operating frequencies their networks require a higher number of sites which considerably increases the cost of deployment. It is estimated that a network which operates at 2.5 GHz requires at least 2 times more sites than 3G (operating at 2GHz) in order to achieve an acceptable indoor and outdoor coverage. This is because higher frequencies have greater path and shadowing losses and in addition, due to higher data rates of anticipated broadband services and applications which reduce the coverage range.

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The selection of procedures and tools for cell planning and optimisation in Mobile WiMAX deployment are critical issues. They have direct impact on coverage, performance and cost of the network. The deployment of Mobile WiMAX is more challenging than that of its counterparts, and requires comprehensive planning by skilled and experienced RF and network engineers. There are not many propagation models and measurement results for the ~2.5 and ~3.5 GHz frequencies that Mobile WiMAX might operate in, particularly for an indoor environment. Also, there are at least three options for frequency planning; frequency reuse one, frequency reuse three, and fractional frequency reuse. Cell planners should have a comprehensive knowledge of the mechanisms, functionalities and algorithms implemented in Mobile WiMAX network equipment to be able to achieve successful cell planning and optimisation.