NORTEL

Solution Brief

Nortel WiMAX 802.16e Portfolio

WiMAX (Worldwide Interoperability for Microwave Access) enables Wireless Broadband Access anywhere, anytime, on virtually any device. WiMAX (802.16e) bridges broadband access at home and in the office, allowing end users to take the Internet with them everywhere they go, making the device of tomorrow as connected as the cellular phone of today.

WiMAX, based on the IEEE 802.16-2005 standard, is a superset of the Fixed WiMAX standard (IEEE 802.16-2004). It adds mobility, Multiple Input Multiple Output (MIMO) into WiMAX devices and base stations for superior performance, and a number of other key feature enhancements like security and QoS. WiMAX 802.16e delivers significant improvements in speed, throughput and capacity that will enable Real-Time Services and bandwidth-intensive applications and services such as streaming music and video, video surveillance, Voice over IP (VoIP) and video conferencing.

Cellular operators, wireline carriers, cable operators, greenfield operators, government agencies and other new entrants will deploy WiMAX-based networks to offer Wireless Broadband Access. Beyond the consumer service value, WiMAX provides unprecedented spectral efficiency, conservation and extension of scarce radio resources — all important benefits for service providers.

WiMAX utilizes Orthogonal Frequency Division Multiple Access (OFDMA), the most efficient technology available for wireless access and the key enabler of all next-generation wireless technologies. With the addition of Nortel's leading edge MIMO antenna technology (which was selected by the WiMAX industry for the IEEE 802.16-2005 standard), WiMAX will deliver up to five times the efficiency of today's 3G cellular networks for wireless data. This means broadband providers can deliver five times the speed, or service five times as many customers, or buy one fifth of the spectrum, leading to lower costs and higher revenue.

Nortel's differentiators

Nortel is the only WiMAX vendor with extensive experience across all other wireless technologies including CDMA, GSM, GSM-R, Wireless Mesh and WLAN, with more than 300 wireless networks deployed in over 70 countries by the carrier service providers. Nortel owns significant IPR in the technologies underlying the WiMAX standard (OFDM and MIMO) and its leadership in this space led to Nortel's

Differentiating wireless technologies			
	3G Cellular	**WLAN / 802.11n**	**WiMAX / 802.16e**
Coverage	Ubiquitous	Hotspot / campus	Zone / regional
QoS	Controlled	Shared spectrum	Controlled
Mobility	Full, vehicular	Very limited	Fixed, portable, full mobility
Range	Miles	100 to 500 ft	Miles
User speed	50 to 700 kbps	1 to 10 Mbps	1 to 10 Mbps
Architecture	Hierarchical	Flat, IP	Flat, IP

Figure 1. How does WiMAX compare to other wireless technologies?

patented OFDM/MIMO technology being accepted by its peers as the basis for the 802.16-2005 WiMAX industry standard. Nortel is an industry leader in scale and scope and is prepared to deliver end-to-end WiMAX solutions globally.

Nortel's WiMAX 802.16e solution delivers:

- *Three times the bandwidth at one third of the cost of Advanced Antenna Systems (AAS) solutions* — This is enabled by MIMO, an antenna technology that leverages interference of signals to its benefit to drive greater throughputs than any other antenna technology.
- *Flexibility and lower operating costs* — Nortel's WiMAX solution is built on Next Generation Architecture designed to provide maximum flexibility in deployment with the smallest footprint for a variety of frequency bands defined currently by WiMAX Forum – 2.3 GHz, 2.5 GHz, 3.5 GHz and many more to come. With Advanced Power Amplifier technology, the BTS uses the power most efficiently and provides up to 50 percent savings in power consumption vs. the competition. Nortel's BTS portfolio offers options for remoting the radio head to compensate for the RF cable losses as well as tower top low noise amplifiers (TLNA).
- *Lower installation costs* — Nortel's WiMAX 802.16e solution is a high-powered macro-cellular solution that leverages the existing cellular infrastructure and cell sites. Rather than building new cell sites, Nortel's solution takes advantage of existing infrastructure to lower the cost of implementing a WiMAX network using MIMO technology. In addition, Nortel's WiMAX BTS is lightweight and small in volume (under 1.6 Cu Ft), providing flexibility in deployment and maximizing the real estate cost savings. With standard antennas for MIMO, a service provider can realize further savings in avoiding bulk antennas that are required for AAS besides reducing the number of cables between BTS and antennas.
- *End-to-end WiMAX solution* — Nortel's solution delivers the base station, IP Multimedia Subsystem (IMS) core, Access Service Network (ASN) gateway, Network Management System, services and an ecosystem of devices that interoperate with its WiMAX network.

The Nortel WiMAX 802.16e solution

Nortel offers an end-to-end solution for WiMAX 802.16e that includes the complete ecosystem including base stations, core network, network management system, devices and services.

Base Stations: The WiMAX BTS 5000 Family

The WiMAX BTS 5000 portfolio is the world's first MIMO-powered solution.

Highlights

- Flexible portfolio:
  - > MIMO base station: 2X2 MIMO (2 Tx 2 Rx per sector) delivers up to 70 Mbps peak rate and 50 Mbps capacity with an upgrade path to 4X4 MIMO (4 Tx 4 Rx per sector) as the capacity grows in the network.
- One to six-sector BTS
- 28 W of transmit power per sector (2.3/2.5 GHz) / 16 W per sector (3.5 GHz)
- Macro-cellular architecture

Figure 2. Nortel WiMAX BTS 5000

Key ingredient to high capacity: MIMO

The key value proposition of WiMAX is the ability to access the Internet everywhere. WiMAX is more spectrally efficient than other wireless technologies and delivers greater bandwidth at the lowest cost per megabit. A key ingredient to delivering this value to operators is the antenna technology in WiMAX called MIMO.

The primary WiMAX antenna technologies are Adaptive Antenna Systems (AAS) and MIMO. Nortel has a long history in both technologies and understands them equally well. With over 10 years of experience in prototyping, building and selling Adaptive Antenna Systems (AAS) and a number of partnerships in this space, Nortel has discovered the drawbacks of AAS. As a result, Nortel has shifted its investment to MIMO over the past six years.

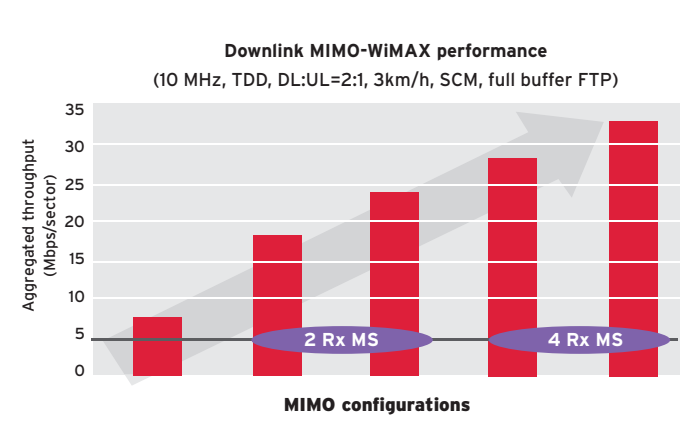

Figure 3. MIMO delivers 2x-5x increase in throughput/capacity

What is MIMO?

MIMO stands for Multiple Input Multiple Output and is an antenna technology that:

- Improves reach
- Thrives on multipath
- Drives greater bandwidth and spectral efficiency
- Uses off-the-shelf antennas

MIMO works by creating multiple parallel data streams from the transmitter to the receiver, utilizing propagation multi-path and interference to its advantage. In dense urban areas, signals bounce off the walls of buildings and MIMO combines all these signals into a single stream, enabling greater throughput.

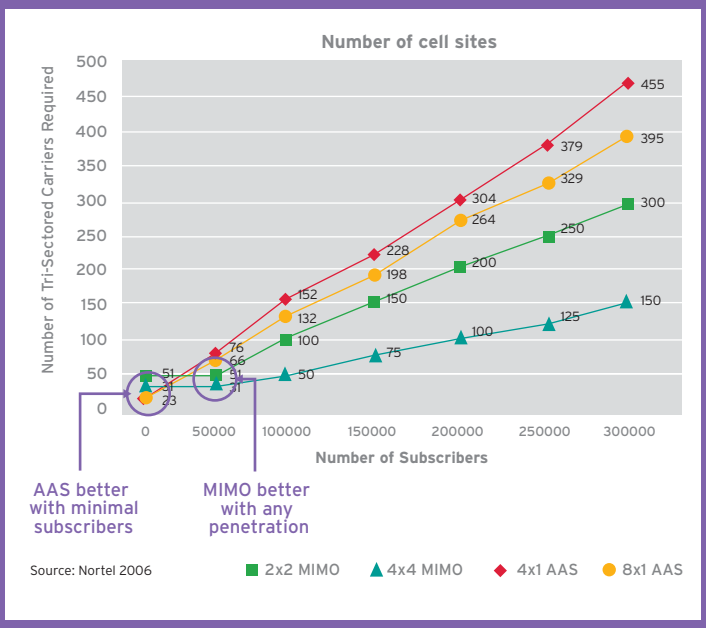

Figure 4. Business Case: City of Atlanta

What is AAS?

AAS stands for Adaptive Antenna Systems, an antenna technology that directs the signal to the end-user device. Using beam steering technology to track devices, this technology focuses the signal on active devices, delivering greater coverage. AAS technology has been available for over 10 years.

How do MIMO and AAS compare?

When put to the test, MIMO prevails. MIMO delivers three times the bandwidth at one third of the cost. In a recent business case using the City of Atlanta in Georgia, USA, as an example, Nortel simulated a 2.5 GHz WiMAX network using real-life data and compared the two technologies. AAS performed well only with minimal subscribers. Once 50,000 subscribers signed on, MIMO thrived by delivering much greater bandwidth and utilizing one third fewer cell sites. Networks designed for success will need MIMO-powered WiMAX.

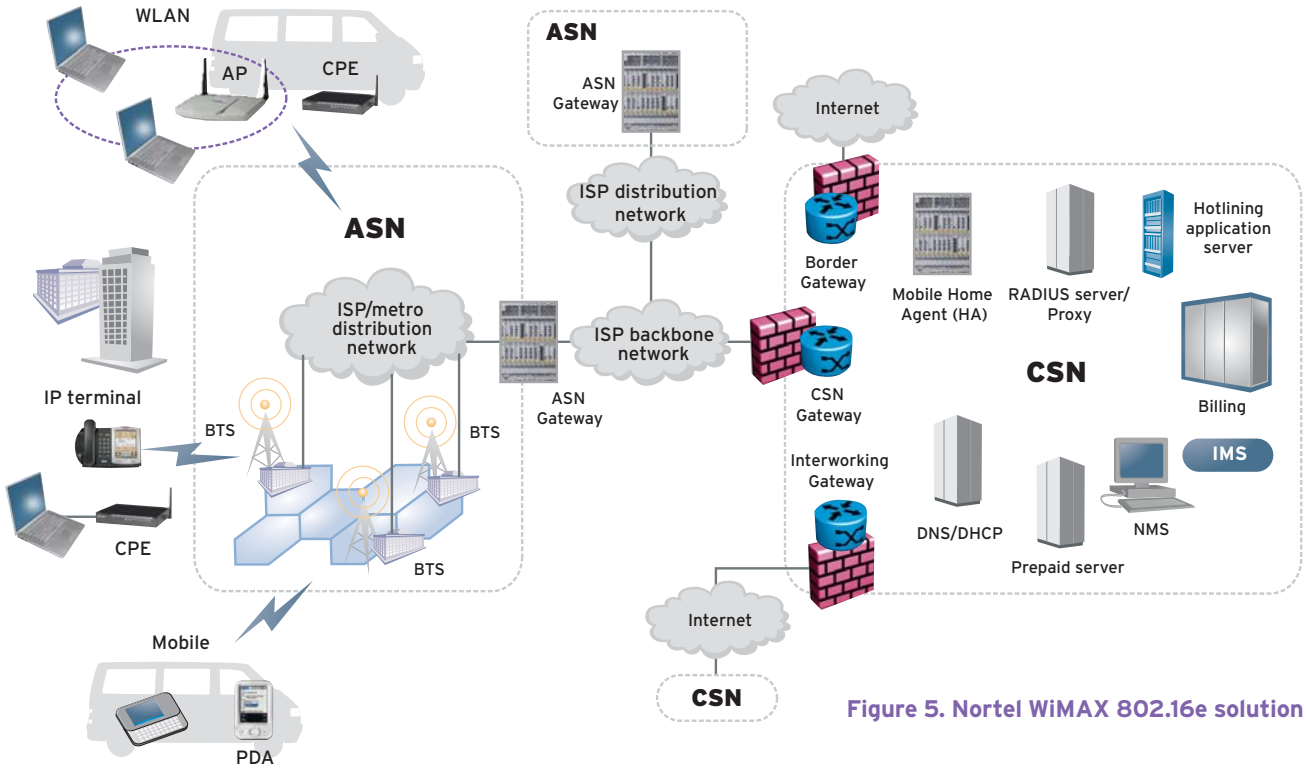

Figure 5. Nortel WiMAX 802.16e solution

- DSP-based software-defined modem for future evolution and upgrades
- Configurations: Indoor, outdoor and wall-mountable
- Supports over-the-air encryption using AES-128 bit algorithm that is designed to meet FIPS-140-2 security requirements.

The BTS consists of two primary building blocks: a Digital Module (DM) and a Radio Module (RM) or Remote Radio Head (RRH). Both modules can be mounted in the standard 19" indoor rack or supplied outdoor enclosure. The Digital Module provides the following functions for the WiMAX BTS:

- OFDMA baseband processing
- WiMAX MAC processing
- Radio interface
- Network timing and synchronization
- OAM processing and management
- Scheduling traffic and enablers for applications

The Digital Module supports 2X2 MIMO configurations for up to three sectors, and can be connected to a second digital module to create 4X4 MIMO configurations, or up to six-sector configurations.

The Radio Module is an indoor rack-mounted radio that contains six transmitters, six receivers, RF filters and the digital baseband processing.

The Remote Radio Head (RRH) is mounted closer to the Antenna for improving the Link Budget. The RRH is a tower, pole or wall-mounted radio that consists of two transmitters and two receivers housed in an environmentally hardened enclosure. It has a fiber optic interface to the Digital module along with a DC power feed.

Outdoor deployments will utilize an outdoor enclosure to house the Digital and Radio Modules. The outdoor enclosures are common across all the frequency bands. A streamlined Digital Enclosure (DE) optimizes the outdoor deployments for the 3.5 GHz product line.

Capacity growth

As the network capacity grows, Nortel's BTS can scale accordingly. The Nortel 2X2 MIMO solution can be upgraded to a 4X4 MIMO configuration with ease and maximum investment protection. The 4X4 configuration uses the same RF channel as the 2X2 configuration; therefore no additional bandwidth is required.

Core network

Access Service Network (ASN) Gateway

The key function of Nortel's ASN gateway is to aggregate the base stations and manage handoff of devices from one BTS to another. Nortel's ASN Gateway is built on a carrier-grade, high availability/reliability IP networking platform. This gateway offers a high degree of cost-effectiveness versus performance scalability that is required for WiMAX deployments ranging from township or campus deployments requiring only a few BTSs, all the way up to nationwide deployments involving thousands of BTSs.

Connectivity Service Network (CSN)

The Connectivity Service Network (CSN) is at the core of the WiMAX network architecture providing control and management for the ASN and subscribers with services such as DHCP server, AAA, FTP, inter-operator and inter-technology roaming, services and other applications.

The CSN also includes the Internet Protocol Multimedia Subsystem (IMS) services support capable of offering VoIP, Video, Gaming, Converged Mobility offering seamless handoffs between WiMAX, Wi-Fi and other cellular technologies and several other consumer and enterprise applications.

Network management

Nortel's WiMAX OAM (Operations, Administration and Maintenance) solution simplifies the complexity of managing the diverse WiMAX network elements and services, while providing the level of OAM functionality for the WiMAX network being deployed. The WiMAX OAM solution leverages the platform used across all Nortel solutions.

WiMAX Device Ecosystem

In order to have a truly successful WiMAX solution, it is critical to have timely availability of end-user devices that have achieved quality and interoperability standards. Nortel Device Ecosystem includes LG Electronics — a global leader in consumer devices and a number of Original Design Manufacturing (ODM) vendors that are the world's most innovative and skilled wireless broadband device/CPE manufacturers, enabling Nortel to deliver a comprehensive end-to-end solution to its customers. Nortel's Device Ecosystem delivers:

- ***Flexibility and innovation*** — The ability to adapt and deliver on a timely basis given the fast-evolving WiMAX CPE/terminal requirements
- ***Quality*** — Deliver durable and reliable devices while offering efficient, global customer support and service/warranty capability
- ***Cost-effectiveness*** — A competitive price offering to network operators in terms of price-to-performance ratio and volume of purchase

A cornerstone of Nortel's Device strategy is the Nortel Device R&D Center of Excellence in Taiwan, which will support and manage technical relationships with our partners while performing interoperability and acceptance testing of the devices for the Nortel WiMAX Ecosystem. The types of Device solutions vary in range from simple PCMCIA cards, to USB adaptors, all the way to ultra-mobile PCs and smart phones with VoIP capability.

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In the United States:
Nortel
35 Davis Drive
Research Triangle Park, NC 27709 USA

In Canada:
Nortel
195 The West Mall
Toronto, Ontario M9C 5K1 Canada

In Caribbean and Latin America:
Nortel
1500 Concorde Terrace
Sunrise, FL 33323 USA

In Europe:
Nortel
Maidenhead Office Park, Westacott Way
Maidenhead Berkshire SL6 3QH UK

In Asia:
Nortel
United Square
101 Thomson Road
Singapore 307591
Phone: (65) 6287 2877

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