## Connecting Rural and Developing Communities through Wireless Mesh Networks

Dr. Bilel Jamoussi  
Director of Strategic Standards, Chief Research Office  
*Tunis, Tunisia, 21-24 November 2005*

## Why Connect Anyone Anywhere through High Speed Broadband Access?

<table>
<thead>
<tr>
<th><strong>ECONOMIC GROWTH</strong></th>
<th>Access to a Global Knowledge Economy</th>
<th>Eradicate disadvantages in distance &amp; opportunity</th>
<th>Reduce exodus and relocation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESEARCH &amp; EDUCATION</strong></td>
<td>Access a wealth of Information</td>
<td>Access Open Source Software</td>
<td>Access Web Services on the Internet</td>
</tr>
<tr>
<td><strong>ENERGY Efficiency &amp; ENVIRONMENT Protection</strong></td>
<td>Teleworking – Home-based workers</td>
<td>Information &amp; Services without driving or traveling</td>
<td>Critical with rising fuel cost &amp; increasing pollution</td>
</tr>
</tbody>
</table>
Nortel at a Glance…

OUR HISTORY
Over 100 years at the forefront of major technological innovation in telecom

OUR OPERATIONS
Serving more than 150 countries

OUR PEOPLE
Approximately 30,000 employees worldwide

WWW.NORTEL.COM

Nortel’s Customers

SERVICE PROVIDERS
> Public network carriers
> Wireless operators
> Cable operators

ENTERPRISES
> Small, medium and large businesses
> Governments and Public Institutions
> Educational institutions
> Financial institutions
> Hospitality industry
> Healthcare facilities
> Other industries
Telecom Market Trends

Options of High Speed (>512 kbps) Broadband Connections in Developing Nations

Wireline Broadband Access
- Upgrade the Telephone Network
  - ISDN – Low speed and Costly by the minute charges
  - DSL – Digital Subscriber Line – Density required for economics
- Television Cable Modem Networks rarely an option

Wireless Broadband Access
- 3G Networks
  - New Installation – limited data bandwidth
  - Upgrade to cellular network
- Wireless Mesh Networks
  - Cost Effective
- WiMAX - Emerging

Presentation Focus
Wireless Broadband – The New Category

Segmenting the Telecom Market

Voice and Data are different challenges
Mesh Networking Overview

- Reduces backhaul facilities and opex significantly
  - Small fraction of access points are directly connected to the network
  - Access points act as intermediate data transmission nodes, connecting wirelessly to each other

- Reduces deployment and operations costs
  - Just needs power – installed by an electrician
  - Self organizing – minimal setup required
  - Auto recovery – does not require technician intervention to re-establish transmission paths

- Secure transmission links
- Seamless mobility in the mesh coverage area

Wireless Mesh Network

Innovative WLAN Access Solution

- Wireless AP7215 & AP 7220
  - Access Points for indoor and outdoor deployment
  - 802.11b/g access link
  - 802.11a transit link with smart antennas
  - Self-configuring, self-healing mesh formation
  - Mobility client proxy for seamless subscriber mobility

- Wireless Gateway 7250
  - Enterprise class router
  - Advertises reachability (within Enterprise/ISP Network) for WLAN Community Area Network subscribers
  - Provides WLAN CAN-specific mobility anchor point
  - Provides data security for the mesh transit link

- Wireless Bridge 7230
  - Wireless point-to-point multiplexer transferring Ethernet traffic over wireless links
  - Full duplex, full rate for links as far as 2 km

- Wireless Range Extension
  - Provides indoor access to the outdoor Mesh network
  - Ethernet Adaptor with directional high gain antenna

- Network Management
  - APs and Gateway support SNMP network management interfaces
  - Integrated with Nortel’s Optivity NMS:
    - Centralized facility for monitoring and managing network operations, leveraging a field proven network mgmt solution
    - Discovery & visualization of WG 7250 & APs
    - Fault management – traps, faults, system log
    - Real-time performance metrics – utilization, errors, interface metrics
**Wireless Access Point 7220**

**Description**
- Small size (10" tall x 7.5" diameter) for flexible placement
- Optimized for outdoor deployment
  - Temperature range: -40 °C to +50 °C
  - Ingress protection: IP56 rated
- AC powered with low power consumption – 8W to 14W typical
- Advanced antenna designs for extended reach, simplified deployment, and reliability
- 802.11a with extensions (802.11s) for inter-AP transmissions (Transit Link)
- 802.11b/g for user access (Access Link)

**Functionality**
- Traffic collection & distribution functions for traffic within the Community Area Network (CAN)
- Routing and wireless transit
- Security functions for validating connections to other Wireless APs
- Security functions for controlling access by user devices

---

**AP 7220 Radio Networking Technology**

**Transit Link @ 5 GHz**
- Elevated dual-polar antennas with switched beams
- Uses 802.11a technology

**Access Link @ 2.4 GHz**
- Elevated, dual-polar, diversity switched antennas
- Uses 802.11b/g technology

Coverage of the Access Link (AL) from the Wireless AP

Access and Transit links separated in space and frequency
Wireless AP 7215

**Description**
- Low profile: 240 mm x 155 mm x 50 mm
- Wall, ceiling or desk mount for flexible placement
- Optimized for indoor deployment
- Temperature range: 5 °C to +50 °C
- AC powered with low power consumption – 8W to 14W typical
- 802.11a with extensions (802.11s) for inter-AP transmissions (Transit Link)
- 802.11b/g for user access (Access Link)

**Functionality**
- Traffic collection & distribution functions for traffic within the Community Area Network (CAN)
- Routing and wireless transit
- Security functions for validating connections to other Wireless APs
- Security functions for controlling access by user devices

Available Now

Wireless Gateway 7250

**Description**
- Developed on Nortel’s Contivity platform
- 19” rack mount Enterprise-class router
- 2U (3.5”) tall
- Temperature range: 0 °C to +40 °C
- Relative Humidity: 10% - 90% non-condensing
- AC powered; 200W typical power consumption
- I/O: 2x 100BT Ethernet ports

**Functionality**
- Advertises reachability (within Enterprise/ISP Distribution Network) for WLAN Community Area Network subscribers
- Mobility anchor point – manages mobility within the mesh and between peer Wireless Gateways
- Provides data security for the mesh transit link
- Typically supports up to 90 AP 7220s or 7215s

Available Now
Wireless Bridge 7230

Description
- Low profile: 304 mm x 304 mm x 58 mm
- Wall or pole mount for flexible placement
- Outdoor unit with integrated antenna
  - Temperature range: -35 °C to +60 °C
- Power over Ethernet – 20W maximum

Functionality
- Supports up to 17 Mbps full duplex for links as far as 2 km.
  - Up to 25 miles at lower data rates (with integrated antenna)
- Operates in unlicensed 5GHz bands (5.725-5.850GHz)
- Channel Bandwidth: 20MHz (5 configurable channels)
- Latency < 8 msec (3 msec typical)

Available Now

Nortel’s Wireless Mesh Network for Rural Communities

Nortel’s Community First Approach:
Nortel offers a comprehensive community solution with the Wireless Mesh Network and flexible backhaul possibilities
Delivering cost-effective broadband access to rural and remote communities

Leverage Nortel’s Wireless Bridge 7230 or value-add WiMAX partners for an end to end community solution with the Wireless Mesh Network

Network Backhaul Link e.g. Fiber, microwave etc.

Local Library

Local Community Centre

Local High School

Solutions for a Rural Community
Nortel’s Wireless Mesh Network for Rural Communities - Deployment Scenarios

General deployment scenario with Nortel’s Wireless Mesh Network for range extension

**HOW IT WORKS**

- Step 2: Ethernet traffic bridged from a client device (e.g., laptop, desktop PC) connected in the home or business to the “range extender” via Ethernet.
- Option: Support for multiple clients in the dwelling by connecting a low-cost standard home internet router or wireless router.

Nortel’s Wireless Mesh Network solution offers range extension for flexible deployment scenarios for residents and business owners in rural communities

---

Scenario 1 – Support for a single user device

**HOW IT WORKS**

- Step 1: Place the range extender with unobstructed line of sight to the Wireless AP7220.
- Step 2: CAT-5 Ethernet cabling runs directly from the range extender to the client’s Network Interface Card (NIC).
- Note: For this scenario, the user’s client device (laptop, PC) authenticates directly to the Wireless Mesh Network via the range extending device.

Nortel’s Wireless Mesh Network solution offers range extension for flexible deployment scenarios for residents and business owners in rural communities
Nortel’s Wireless Mesh Network for Rural Communities - Deployment Scenarios

Scenario 2 – Support for multiple user devices

Outdoor

Indoor

- 802.11b/g
- 802.11b/g
- 802.11b/g
- 802.11b/g

Nortel’s Wireless Mesh Network solution offers range extension for flexible deployment scenarios for residents and business owners in rural communities

HOW IT WORKS

- Step 1: If multiple devices in the dwelling (house or small business) must be connected, then a router will allow multiple computer devices to connect.
- Step 2: In this mode of operation, the router’s WAN port is connected to the range extender, and will be assigned its WAN IP address via DHCP by the outdoor Wireless AP7220.
- Step 3: The router will then hand out private addresses (i.e. 192.168.X.Y) to all client devices attached to the router, wired or wireless.

Nortel’s Wireless Mesh Network for Creating Value for Rural Communities

Without a range extender
Up to 12 typical homes in a residential area in rural community cluster

With a range extender
Up to 18 typical homes in a residential area in rural community cluster

Notes:

(1) Diagram not to scale
(2) Assumes homes are approximately 10m by 10m, 5m from street. Actual # of homes covered will vary.
(3) Street is approximately 10m
(4) Coverage in each home will vary based on the physical interior & layout

Potential to INCREASE coverage to up to 50% more residential dwellings; ~33% fewer Wireless AP7220s required for indoor coverage
Nortel’s Wireless Mesh Network
Potential Applications for Rural Communities

<table>
<thead>
<tr>
<th>eHealth</th>
<th>Education</th>
<th>eDemocracy</th>
<th>Economic Development</th>
<th>Public Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; Digitized Patient records</td>
<td>&gt; Learning management/ Course registration</td>
<td>&gt; Televoting</td>
<td>&gt; Online stores/virtual marketplace</td>
<td>&gt; Emergency Services</td>
</tr>
<tr>
<td>&gt; Long-term health care</td>
<td>&gt; eLearning; webcasting, multicasting</td>
<td>&gt; Online voting</td>
<td>&gt; Internet Access</td>
<td>&gt; Video Surveillance</td>
</tr>
<tr>
<td>&gt; Telementoring</td>
<td>&gt; Community Portal</td>
<td>&gt; Jobs</td>
<td>&gt; Call Centres</td>
<td>&gt; Security</td>
</tr>
</tbody>
</table>

Nortel’s Wireless Mesh Network can enable a host of value-add services and applications for community-wide initiatives

Wireless Mesh Networks - 802.11s Summary

> WLAN Mesh Standard developing in IEEE 802.11s
> WMN Characteristics
  • Cost Effective
  • Simple to deploy and operate – Self Configuring and Healing
  • Integrated Security, QoS, and Power Savings support
  • Used for Uni-cast, Multi-Cast, and Broadcast Multimedia Traffic
> WMN Applications:
  • Access in Rural and Developing Communities
  • Metro Networks
  • Campus Networks
  • Military and Security Applications
Wireless Mesh Network & WiMAX (802.16.d)
Complementary Solutions Today

Wireless Mesh Network delivers:
• Consumer broadband access in rural and developing communities
• Hot zones – expanded public WiFi access coverage areas
• Extended enterprise WiFi network to both indoor and outdoor areas
• Nomadic, portable VoIP service
• Pedestrian speed mobility

WiMAX (802.16d Fixed) delivers:
• Backhaul of WiFi hot zone and hotspot traffic
• Broadband access for small to medium enterprises (SME)
• Consumer broadband services in rural and other underserved - microcellular
• Simultaneous delivery of these services over a single WiMAX system

WiMAX Market – 802.16d & 802.16e

> 802.16d – fixed – minor delays but rolling out late 2005
  • Strong player with DSL extension & backhaul applications
  • Good applications but not a massive market

> 802.16e – portable / mobile – strong momentum ➔
  the main event
  • Momentum
    • WiBro / WiMAX 802.16e reconciliation
    • Sprint / Nextel - 2.5 GHz spectrum consolidation in US
  • Timeline
    • 2006 – year of trials
    • 2007 – small scale deployments
    • 2008 – break out year
>THIS IS THE WAY

THANK YOU

>THIS IS NORTEL