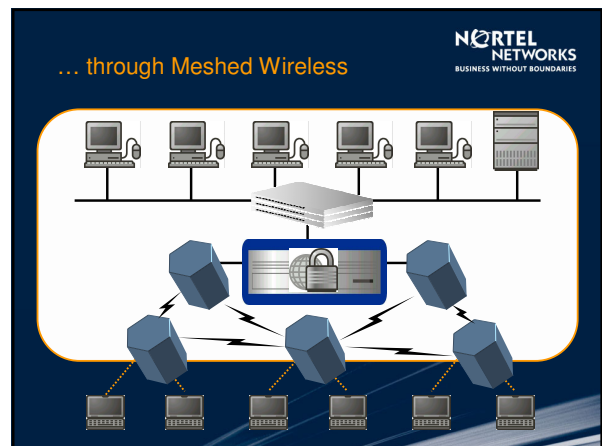
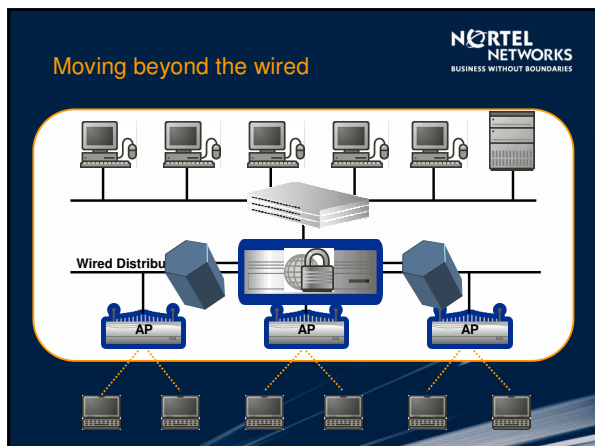
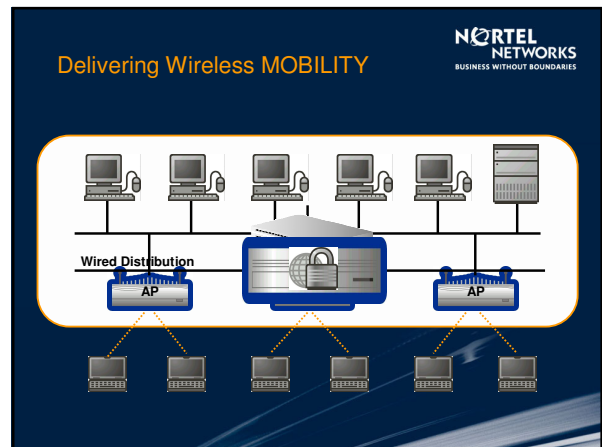
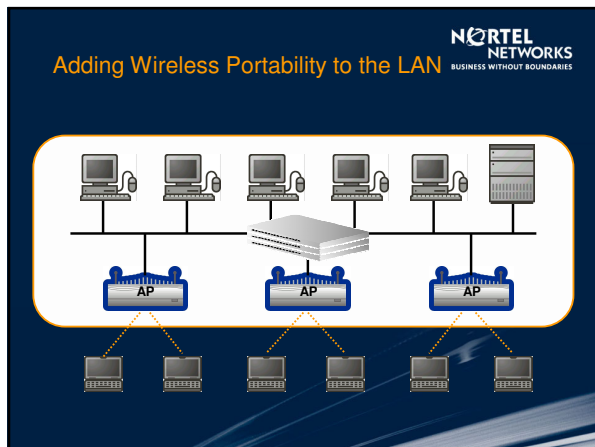
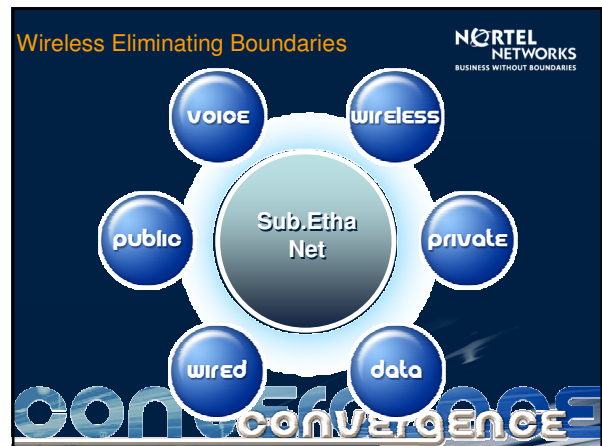


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Wireless Mesh Networks

Richard O'Halloran
Systems Engineer

10th May 2004 NORTEL NETWORKS CONFIDENTIAL



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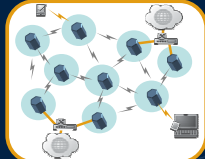
Wireless Mesh Networks (WMN) Concept

Key Attributes

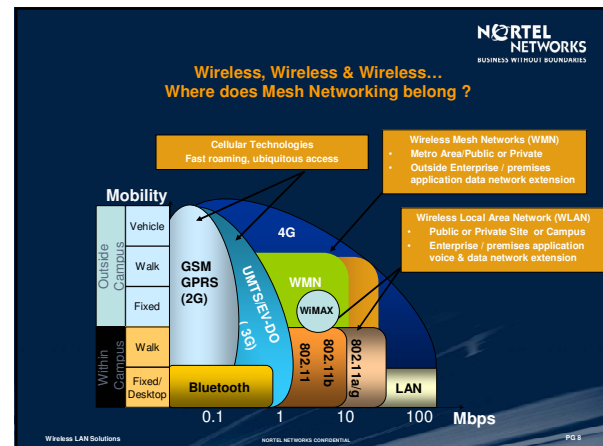
- Wireless Interconnection
- Mesh Topology
- Auto configuration and discovery
- Self-healing
- Centralized management
- End-to-end security
- IEEE 802.11 based

Customer Value

- Revolutionary technology, brings wireless LAN out of the office
- First step in ubiquitous networking technology.
- Potential to do for data what mobile has done for voice




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Wireless Cellular Network Principles



- Conventional cellular systems concentrate on big RF deployment.
- Radios "blast" over and through the environment.
- Signals from central station must penetrate the cluttered environment to reach the end user.
- Coverage is determined mainly by the random shadowing and penetration loss, not the distance.
- Requires high elevation and high RF power to overcome losses

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Wireless Mesh Network Principles



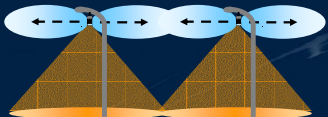
- Wireless mesh network routes around the blockages
- Uses smart software
- Line-of-sight path loss no shadowing
- Low power as the losses are lower
- Higher transmission rates
- Higher throughput
- Coverage is concentrated where the users are and not wasted penetrating obstacles.

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Wireless Mesh Network gains

- Coverage improved due to reduced probability of blocking
- Coverage improves with additional nodes
 - Extra nodes added where coverage is needed
- Shorter link ranges improves RF performance
 - Higher data rates
 - Increased capacity
 - Better frequency re-use, hence more efficient use of the spectrum
 - Lower power



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Metro Wi-Fi Challenges

- Unlicensed
- Line of Sight
- Low power
- QoS – Voice support (802.11e, etc)
- Roaming Speeds – vs 3G
- Expectations
 - Last mile replacement - Primary phone line requirements
 - Cellular network level reliability
 - Inter-carrier roaming

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Wireless Mesh Networks - Components

Wireless AP 7220

- Provides a wireless access function for connection to mobile nodes.
- Provides routing and wireless transit functions
- Small size (10" tall x 7.5" diameter) for flexible placement
- Internal or external antenna for both access and transit

Wireless LAN Solutions

PG 13

Wireless Mesh Networks - Components

Wireless NAP 7220

- Is a 7220 AP that is physically connected into wireless backbone network
- AP@NAP advertises the 7250 networks for the APs to connect with

Wireless Gateway 7250

- Centralised Intelligence, routing, AP authentication and accounting
- Terminates IPsec from each AP

Wireless Mobile Node (MN)

- Consumer device 802.11b/g

Wireless LAN Solutions

PG 14

Switched Beam Antenna for Transit Links

- Switch Beam Antenna
 - Inherent directivity improves reach and reduces interference.
 - One beam is selected for communicating with each of the neighbouring APs.
 - AP may have multiple neighbours
- Multiple degrees of freedom for each transit link
 - Beam
 - Frequency
 - Polarisation
 - Burst time
- Taken together, these mitigate interference and maximise system capacity

Wireless LAN Solutions

PG 15

Mesh Network NOSS

- DHCP Server
- RADIUS Server
 - Mobile User Authentication
 - AP Authentication
 - Accounting
- File Server
 - Configuration File (for Dynamic AP Configuration)
 - AP Software Download
- Network Management System
 - AP Discovery
 - AP Mesh Display
 - Fault/Performance Management

Wireless LAN Solutions

PG 16

Community Area Network

Layer 3

Wireless LAN Solutions

PG 17

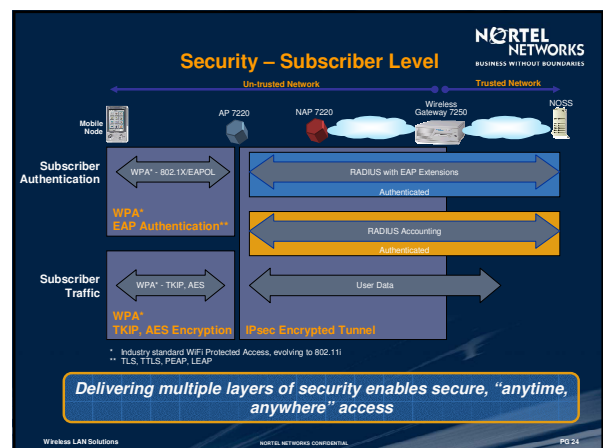
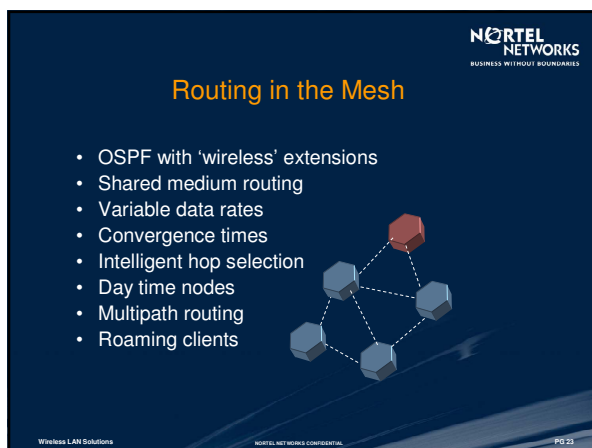
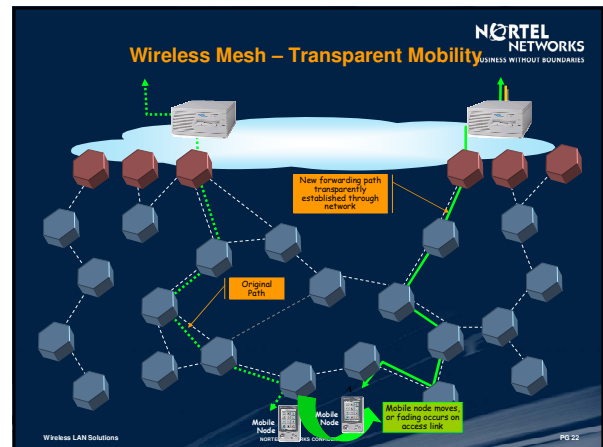
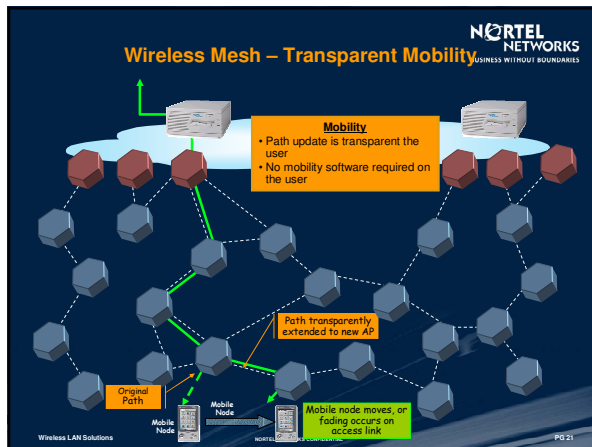
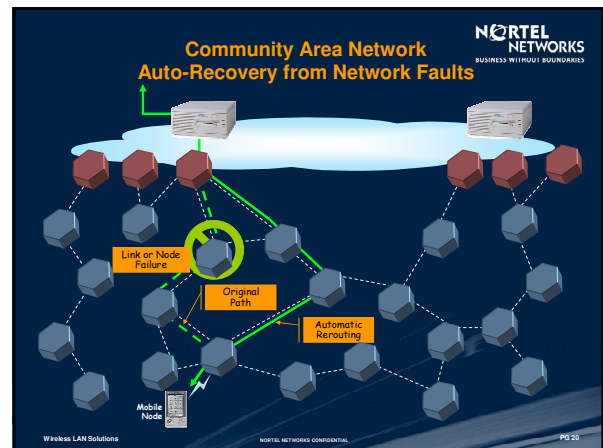
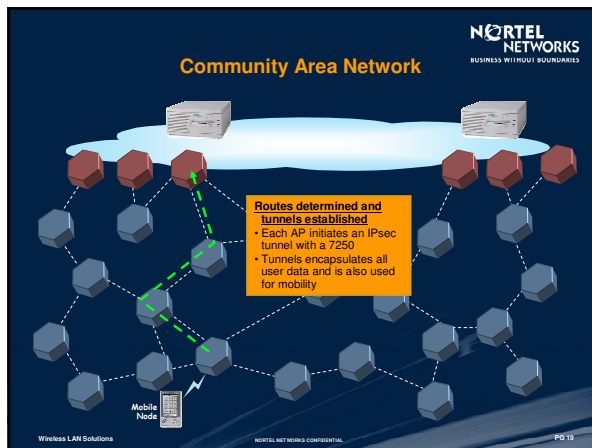
Community Area Network

OSPF adjacencies are made and Mesh is formed

- LSAs and HELLOs are exchanged
- Each AP determines the shortest path to a Wireless Gateway 7250.

Wireless LAN Solutions

PG 18



AP7220 Spacing

- Spacing affects both AL (Client access link) and TL (Transmit link or backhaul)
- The ideal outdoor spacing for both TL and AL is currently around 250 meters. Anything less than that is better.
- TL links must be LOS (Line of Sight)
- Typical height of (4-7m) is expected but higher deployment may be advantageous. As the TL is a focussed transmission, adjacent access points must be on the same level, or tuned manually.

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Pg 25

Number of AP7220 estimate

- The number of APs needed to cover an area will depend upon the environment, the required data rate and availability.
 - A more cluttered environment will require more APs due to obstructions.
 - Different urban layouts will require different density
 - Lower required data rates will translate to a longer range between APs.

Access Link Design Considerations (2.4 Ghz)

Only 3 non-overlapping channels
Everybody uses the same channels

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Pg 26

Flexible Deployment Models: Wireless Mesh Networks

Extending the reach of WLAN in areas which cannot or do not cost-effectively support a wired LAN

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Pg 27

Site Plan

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Pg 29

Mesh Description

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Pg 30

5

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Mesh Description (continued)



NAP 3

NAP3 and AP5 is line-of-sight cross the street



AP 5



Between NAP 3 and AP 4



AP 4

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Where to from here ?

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Wireless LAN Evolution

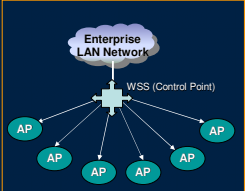
First Generation	Second Generation	Third Generation
Cable replacement Restricted Roaming Weak Security Isolated Management	Enterprise Roaming Layered security Centralised Management Established Standards	Seamless Roaming between public and private networks Wireless LAN Backhaul Advanced Standards Location services
2000	NOW	Future

Security, Management & Roaming challenges driving Next-Gen WLAN

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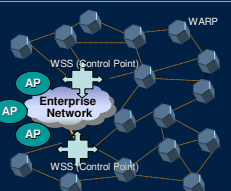
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Evolving the WLAN to Wireless Mesh Network



Today

- APs connected in star topology
- Each AP is connected directly to the Corporate LAN Network



Corporate Wireless Networking:

- AP's for localised coverage
- Wireless Access Points connected in mesh topology for open spaces
- Backhaul using wireless & wired links

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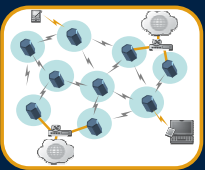
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Wireless LAN is...

- Part of ongoing trend to portable computing
- Consumer driven – Centrino effect
- Consistent user experience to LAN
- Unlicensed, simple, competitive
- Inexpensive

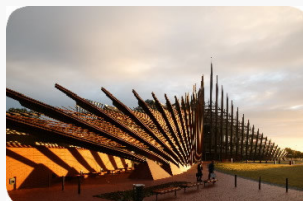




Wireless Mesh is...

- Standards based (802.11, Wi-fi, etc)
- Self configuring and healing
- Centralised Intelligence
- Metropolitan scalability
- Carrier class management
- Ubiquitous future internet with 802.11s

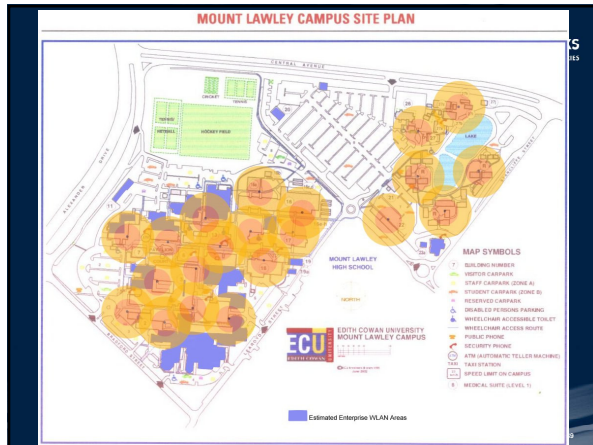
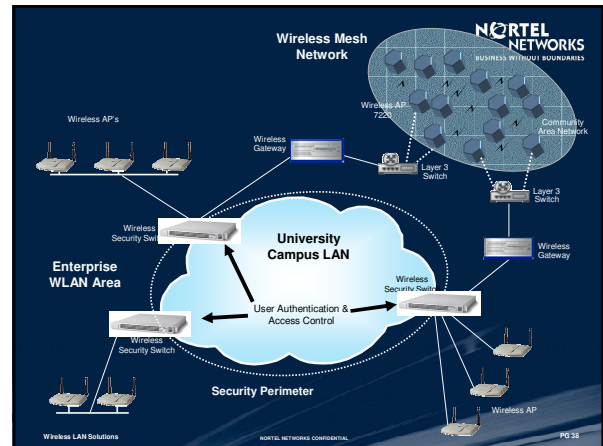
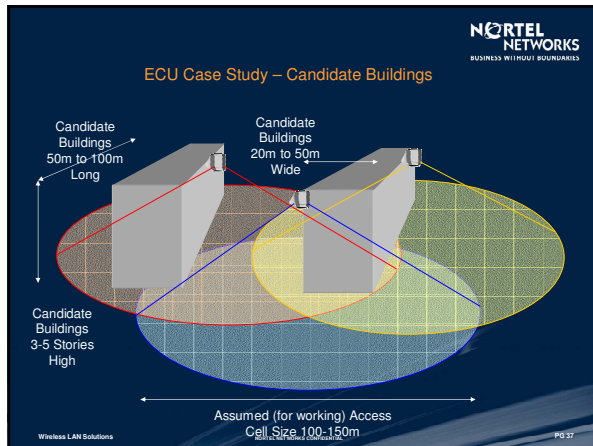
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Case study:
Edith Cowan University
Steve Johnston
Manager, IT Infrastructure



Wireline / Wireless Convergence

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- 3rd Generation Partnership Project (3GPP)
 - a standards oriented consortium
 - 3GPP's goal is to enable multimedia and collaborative services over wireless broadband access using 3G mobile handsets.
 - 3GPP R4 introduces a IP Transport Core with traditional Voice and Data access
 - 3GPP R5 introduces an IP Multimedia Subsystem (IMS) for SIP based multimedia services
 - 3GPP R5 provides the initial context that will enable the high-level evolution of the wireline and wireless core and access networks to a unified, access-agnostic, multimedia-enabled network.
- 3GPP IMS – is the main area of convergence