Demystifying MIMO and 802.11n

From Today’s Wireless LAN to Tomorrow’s Fixed Mobile Convergence

Peter Reinders
Regional Technology Manager EMEA
Agenda

• Introduction
  – Wireless LAN Waves over time
  – Evolution of Enterprise Wireless LAN

• Enterprise grade MIMO basics
  – RF fundamentals about multipath reflections
  – SISO and diversity antennas
  – How does MIMO works?
  – Real world test data
  – Benefits of Enterprise grade MIMO
  – Difference between pre-N and Enterprise grade

• Update workgroup IEEE 802.11n

• Recap & Q&A
Wireless LAN ‘Waves’ Over Time

- Security
- RF Management
- Voice & Mobile Convergence

Market Opportunity:
- 1999
- 2003
- 2006
- 2007-08

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Evolution of Enterprise Wireless LAN

1st Gen.
- Traditional AP
- Secure wireless gateways

2nd Gen.
- Centralized WLAN

3rd Gen.
- Secure Centralized WLAN
- 3rd Gen.
- 4th Gen.

4th Gen.
- Secure Centralized WLAN
- 4th Gen.
- 5th Gen.

5th Gen.
- Mobile Convergence & Applications
  - First enterprise MIMO
  - Controllers built for MIMO
  - Fixed Mobile Convergence (FMC)
  - Excellent voice support
  - 802.11 RFID & LBS
  - Enhanced Guest Access

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Let’s talk about MIMO

• **Introduction**
  – Wireless LAN Waves over time
  – Evolution of Enterprise Wireless LAN

• **Enterprise grade MIMO basics**
  – RF fundamentals about multipath reflections
  – SISO and diversity antennas
  – How does MIMO works?
  – Real World Test Data
  – Benefits of Enterprise grade MIMO
  – Difference between pre-N and Enterprise grade

• **Update workgroup IEEE 802.11n**

• **Recap & Q&A**
1. The original transmitted signal bounces off walls and objects, reflections arriving at AP slightly delayed in time or phase shifted.

2. Original signal + reflections arrive at the receiver and are “added”, resulting in a distorted reconstructed signal.

3. Null Waves: Original signal and reflected signals are 180 degrees out of phase, cancelling each other out. Causing drop outs.
Today’s common architecture: Single Input and Single Output
Antenna Diversity

• Diversity
  – Two independent antennas and radio systems are used for transmitting and receiving RF signals

• Diversity Voting
  – Voting processor choose which radio has the best signal path to the client

• Today’s common technology
  – To reduce to effects of multipath, dropouts, etc. on signal quality & throughput
What do you perceive as MIMO’s biggest advantage?

• **Select your answer?**
  – Overcoming RF Multipath
  – Higher Performance
  – More Coverage
  – Price
MIMO Architecture

- **Who does it works?**
  - MIMO divide a data stream into multiple unique streams
  - MIMO transmits data streams in same radio channel at same time
  - MIMO use the advantage of multipath (reflections of the signals)
  - MIMO receiver combines all streams
  - It’s improve also performance of non MIMO-NIC’s
MIMO clients: Multiple Spatial Streams

Spatial stream 1
Spatial stream 2
The MIMO difference

Before MIMO: Legacy 802.11a/g AP

MIMO Technology: 802.11a/g AP
Real World Test with 802.11a/g Client

- Standard 802.11a/g Client (Cisco / Intel Centrino)
- Throughput close to AP equal
- MIMO effects seen at greater distance
- TP4
  - 8 Office Walls, Approx 100 ft
- TP5
  - 9 Office Walls, Approx 120 ft

<table>
<thead>
<tr>
<th>Test</th>
<th>Cisco G</th>
<th>MIMO G</th>
</tr>
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<tbody>
<tr>
<td>TP1</td>
<td>22.429</td>
<td>22.5</td>
</tr>
<tr>
<td>TP2</td>
<td>22.777</td>
<td>22.1</td>
</tr>
<tr>
<td>TP3</td>
<td>19.378</td>
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<tr>
<td>TP4</td>
<td>5.783</td>
<td>12.012</td>
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<tr>
<td>TP5</td>
<td>0.319</td>
<td>7.52</td>
</tr>
</tbody>
</table>

*Throughput in Mbps*
Benefits: Enterprise grade MIMO

• **MIMO Excellent Voice support**
  – Enhanced seamless roaming due to MIMO’s higher RF signal quality and range at the edge of cell
  – Voice applications benefit from MIMO’s larger cells with fewer handovers

• **MIMO Overcomes RF multi path effects**
  – Echoes, Reflections, Refractions, Coverage Issues
  – Improves Performance & Coverage

• **Works with any IEEE 802.11 standard**
  – Will become pre-requisite for 802.11a/b/g and mandatory for 802.11n
  – First Wi-Fi “radio” breakthrough since 2004 (802.11g)
  – Unique design ensures IEEE 802.11n compliance
    ▪ no forklift upgrades
    ▪ no proprietary pre-802.11n access point
## Consumer pre-N v.s. Enterprise grade

<table>
<thead>
<tr>
<th>Feature</th>
<th>Consumer Pre-N</th>
<th>Enterprise Grade MIMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Management &amp; Dynamic RF</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Multiple VLANs / SSIDs (guest access, voice, etc.)</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>VLAN SSID mapping</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td># Users</td>
<td>Limited</td>
<td>Branche office to Campus</td>
</tr>
<tr>
<td>RF-IDS/IPS</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Enterprise VoWLAN &amp; FMC</td>
<td>Limited features, No advanced Roaming &amp; QoS, no secure voice policies</td>
<td>✓ Enterprise class voice</td>
</tr>
</tbody>
</table>
When will IEEE ratify 802.11n?

Select your answer:
1. End of 2006
2. 1st Half 2007
3. 2nd Half 2007
4. Sometime 2008
5. Never
What is 802.11n?

• New IEEE Standard under development
• Uses MIMO radio technology as a basis
• End result will be more “wire-like” performance
• Anywhere from 100Mbps to 600Mbps depending on implementation
• First standard to support both 2.4 GHz and 5 GHz
• Includes advances in QoS & Power Saving as well as lessons learned from 802.11i
• High definition video mode at 5 GHz
• Uses multiple streams
• “Push” towards 5 GHz operation for less interference and more channels
“Best Case” IEEE TGn Schedule

Hawaii 2006

Denver

JP draft spec’s confirmed with unanimous support

Initial Letter Ballot Documents

Jacksonville

San Diego

Recirculation Letter Ballot

Initial Sponsor Ballot Documents

Melbourne

Dallas

Recirculation Sponsor Ballot

Updated Sponsor Ballot Documents

London 2007

Orlando

IEEE Publish the Final Specification

Final Working Group Approval

RevCom Approval

Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   Dec   Jan   Feb   Mar   Apr   May   Jun
“Best Case” IEEE TGn Schedule

- Draft 1.0 failed IEEE Meeting Ballot
- IEEE record - 12,000 comments received
- Draft 2.0 is now required – Orlando March 2007 IEEE Meeting
- Pre-N certification program starts March 2007
- Reality – 802.11g took 6 drafts before ratification
- Early silicon is 1st generation MIMO for the Atheros, Broadcom, Marvell, Intersil vs. 3rd Gen from Airgo
- Software upgrade unlikely despite promises
- Result – Expect ratification in early 2008
- Until then, only pre-n home use with proprietary interoperability
Recap / Q&A

• BSAP1700 first enterprise grade MIMO

• BSAP1700-MIMO Availability in EMEA
  – GA : Mid 2007

• Unique design ensures IEEE 802.11n compliance
  – no forklift upgrades
  – no proprietary pre-802.11n access point
Delivering seamless, converged and secure wireless network solutions
Excellent Voice Support

• **Single click voice configuration**
  - Simple and automatic policy configuration
  - Advanced Quality of service and call admission control

• **Multi-vendor voice support**
  - Avaya, Nortel, Alcatel, 3Com, Spectralink (SVP)
  - Cisco ‘Skinny’ (SCCP)
  - Vocera, SIP and H.323

• **Enterprise grade & Secure Voice over WLAN**
  - Enterprise QoS (WMM/802.11e, Diffserv, Controller prioritization/CAC)
  - Advanced layer 2 roaming by (proactive) key caching & pre-authentication
  - Secure Mobility™ ensures fast layer 3 roaming (since 2002)
  - First WLAN Controller with integrated SIP Proxy for NAT’d voice calls
  - Stateful Firewall guarantees secure voice applications and monitoring of
dynamic VoIP protocols
Bluesocket and FMC

• Fixed Mobile Convergence (*Wi-Fi to Cellular*)
• One Phone, One Number (*Easy to Use, Everywhere*)
• Seamless roaming between Wi-Fi & GSM/3G
• Improved coverage (*Excellent WLAN voice coverage*)
• Cut Costs (*minutes in bulk, no additional RAN investments*)

Dual-mode Wi-Fi/SIP connection

Operator GSM/UMTS

Dual-mode GSM/UMTS connection

Enterprise WLAN

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Two Bluesocket FMC solutions

- **Enterprise**
  - SIP based platform
  - Call forwarding GSM to SIP over WLAN
  - Client software selects WLAN or GSM/UMTS
  - Reduction mobile telephony costs

- **Operators**
  - UMA or IMS based platform
  - Real seamless roaming
  - Fixed & Mobile Telephony in one contract
  - No additional RAN investments
Historical perspective WLAN-standards

<table>
<thead>
<tr>
<th>Year</th>
<th>Technology</th>
<th>Speed</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>85</td>
<td>predecessor</td>
<td></td>
<td>WLAN</td>
</tr>
<tr>
<td>95</td>
<td>802.11 FHSS</td>
<td>100 kbps</td>
<td>Logistics, outdoor, Cash register, RF-scanners, etc.</td>
</tr>
<tr>
<td>96</td>
<td>802.11b</td>
<td>2 Mbps</td>
<td>2 Mbps</td>
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<tr>
<td>97</td>
<td>802.11a</td>
<td>11 Mbps</td>
<td></td>
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<tr>
<td>98</td>
<td>802.11g</td>
<td>54 Mbps</td>
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<tr>
<td>99</td>
<td>802.11n</td>
<td>200 Mbps</td>
<td>11n</td>
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Wi-Fi standards:

- **802.11**: 2 Mbps
- **802.11b**: 11 Mbps
- **802.11a**: 54 Mbps
- **802.11g**: 2 Mbps
- **802.11n**: 200 Mbps