Maximizing 802.11n Performance
Steps from 54Mbps to 300Mbps

- **Modified OFDM (54 to 58.5 Mbps)**
  - The number of OFDM data sub-carriers is increased from 48 to 52 which improves the maximum throughput.

- **Forward Error Correction (58.5 to 65 Mbps)**
  - FEC is a system of error control whereby the sender adds redundant data to allow the receiver to detect and correct errors. 3/4 coding rate is improved with 5/6.

- **2-Stream Spatial Diversity (65 to 130 Mbps)**
  - 11n standard allows for up to 4 streams, increasing throughput to 600 Mbps – 3 stream and 4 stream will require new AP hardware.

- **Channel Bonding (130 to 270 Mbps)**
  - Increasing channel bandwidth from 20 to 40 MHz slightly more than doubles rate.

- **Short Guard Interval (270 to 300 Mbps)**
  - The GI between OFDM symbols is reduced from 800ns to 400ns.
<table>
<thead>
<tr>
<th></th>
<th>20 MHz Channel</th>
<th>40 MHz Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 stream</td>
<td>2 streams</td>
</tr>
<tr>
<td><strong>Data Rate, in Mbps</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>802.11b</td>
<td>1, 2, 5.5, 11</td>
<td></td>
</tr>
<tr>
<td>2.4 GHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>802.11a</td>
<td>6, 9, 12, 18, 24, 36, 48, 54</td>
<td></td>
</tr>
<tr>
<td>5 GHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>802.11g</td>
<td>1, 2, 6, 9, 12, 18, 24, 36, 48, 54</td>
<td></td>
</tr>
<tr>
<td>2.4 GHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>802.11n</td>
<td>6.5, 13, 19.5, 26, 39, 52, 58.5, 65</td>
<td>13, 26, 39, 52, 78, 104, 117, 130</td>
</tr>
<tr>
<td>GI=800ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 GHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI'=800ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 GHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>802.11n</td>
<td>7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65, 72.2</td>
<td>14.4, 28.9, 43.3, 57.8, 86.7, 115.6, 130, 144.4</td>
</tr>
<tr>
<td>GI=400ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 and 5 GHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1: 802.11 a/b/b/n data rates, Mbps.** *Shaded regions indicate optional capabilities. 600 Mbps data rate is achievable in a 40 MHz channel using GI of 400 ns and 4 streams.*

Image Courtesy – Wi-Fi Alliance
802.11n Client NICs – What’s out there?

- **1x1 MIMO:1**
  - Usually Atheros inside dual mode handhelds
  - Samsung GT-S8500, LG Veri
- **1x2 MIMO:1/2**
  - Usually Broadcom and Intel inside netbooks
- **2x2 MIMO:2**
  - Usually Broadcom inside laptops, netbooks, Macs
- **2x3 MIMO:2**
  - Usually Intel 4965agn inside laptops
- **3x3 MIMO:2**
  - Atheros, inside laptops
- **3x3 MIMO:3 (450Mbps)**
  - Intel 5300agn, inside laptops
Ease of Deployment and Maintenance

- 802.11 channel management
  - Plug and play AP deployment with dynamic channels
  - Enabled with ARM assignment + scanning
- Powering up the access points
  - Max capacity and 1Gbps backhaul with 802.3af PoE
  - 13.5W for AP-125, >12.5W for AP-105
- Watching out for what’s out there
  - Adaptive to noise and 802.11 interference
  - Enabled with ARM assignment + scanning
- Seeing what’s out there
  - Live RF visualization for coverage, capacity, interference
  - Available on Aruba controllers and AirWave VisualRF
Ease of Deployment and Maintenance

• Mixing things up
  • Mix of 11abg and 11n access point deployment
  • Enabled with ARM assignment + scanning

• High performance traffic control
  • Scalable controllers, flexible deployment options
  • Tunneled or bridge mode SSIDs

• Power management on access points
  • Support for specific power use on all APs when required
  • Min/max tx-power with 3dB increment under ARM
Maximizing Network Performance

- Full use of the 802.11 spectrum
  - Increase capacity while increasing coverage
  - Adaptive multi-channel ARM assignment
- Re-using the spectrum in as short distance as possible
  - Dynamic receive sensitivity on the access points
  - Disabled by default, enabled per radio profile
- Neighbor channel AP performance impact
  - Dynamic receive sensitivity on the access points
  - Disabled by default, enabled per radio profile
- Same channel (co-channel) AP performance impact
  - Mitigate with neighbor awareness and rate adaptation
  - Enabled by default, no configuration required
Maximizing Network Performance

- RF scanning performance impact
  - Application (voice, video, etc.) and load aware
  - Enabled by default, ARM configuration
- Bidirectional (wire-like) traffic flows
  - Fair upload and download traffic distribution
  - Enabled by default, no configuration required
- Multicast applications (eg. HD video)
  - Dynamic multicast optimization and IGMP proxy
  - Disabled by default, enabled per virtual AP / IP interface
Bandwidth Assurance

- Mixed mode and speed of clients
  - Fair channel time for all clients (TCP and QoS aware)
  - Disabled by default, enabled per AP group
- High density of clients on the same AP
  - Fair channel time for all clients (TCP and QoS aware)
  - Disabled by default, enabled per AP group
- High density of clients across multiple APs
  - Spectrum load balancing of clients across channels
  - Disabled by default, enabled per radio profile
Bandwidth Assurance

- High density of voice devices within WLAN
  - Voice aware load balancing with Call Admission Control
  - Disabled by default, enabled per radio profile with PEF
- Voice, Video and Data
  - Per application QoS on the wire and wireless
  - Stateful for voice, also configured within PEF
- Efficient use of dual radio
  - Band balance clients across radios on the same AP
  - Disabled by default, enabled per VAP profile
    (coming soon – as an extension to band-steering)
Live RF Plan
Automatic
Fast Roaming
Air-time Fairness
Stateful; Voice CAC
Dynamic

802.3af Support
RF Plan / View
Channel / Power
Coverage Holes
Interference
Roaming
High Client Density
Mixed Rate Clients
High AP Density
Voice
Video
Move/Add/Change

Full Capacity
Multi Channel
Adaptive
Load Balance; Band Balance
CCIM, Dynamic Rx Sensitivity
DMO, IGMP proxy

802.3af Support
RF Plan / View
Channel / Power
Coverage Holes
Interference
Roaming
High Client Density
Mixed Rate Clients
High AP Density
Voice
Video
Move/Add/Change