REALITIES OF 802.11ac SPEEDS IN THE ENTERPRISE

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AIROPATH, INC. – SEATTLE, WA
IT'S WIRELESS. HOW HARD COULD IT BE TO NOT INSTALL WIRES?
THE CLAIMS

• Deliver increased scale and coverage
• Offers a significant boost in performance
• Offers up to 7Gbps of throughput
• Can handle up to XXXX users per radio
• MU-MIMO can talk to multiple clients simultaneously
• To deploy you need multigigabit links to the Access Points
WHAT WE ARE COVERING

• Definitions and Inner Workings

• Key Factors that affect performance

• The Real Deal

• Refuting or Validation of the Claims
WIRELESS BASICS

• Half Duplex
  • Only one device can speak
  • Cannot TX and RX at the same time
  • Time slicing
  • CSMA/CA

• Environment is key
  • Attenuation
  • Interference
  • Other factors
Channels defined for 5 GHz bands (U.S. regulations), showing 20, 40, 80 and 160 MHz channels
(channel 1 is now allowed in the U.S. for one additional 20 MHz, one 40 MHz and one 80 MHz channel)

**US U-NII 1 and U-NII 2 bands**
- U-NII 1: 5150-5250 MHz (indoors only)
- U-NII 2: 5250-5350 MHz
- 8x 20 MHz channels
- 4x 40 MHz channels
- 2x 80 MHz channels
- 1x 160 MHz channel
- U-NII II requires DFS (& TPC if over 500 mW/27 dBm EIRP)

**US intermediate band (U-NII 2 extended)**
- 5450-5725 MHz
- 12x 20 MHz channels
- 6x 40 MHz channels
- 3x 80 MHz channels
- 1x 160 MHz channel
- Requires DFS (& TPC if over 500 mW/27 dBm EIRP)
- 5500-5650 MHz is used by weather radars and is temporarily not available in the U.S.

**US U-NII 3/ISM band**
- 5725-5825 MHz
- 5x 20 MHz channels
- 2x 40 MHz channels
- 1x 80 MHz channel
- Slightly different rules apply for channel 165 in ISM spectrum
Modulation

- Method of modify the carrier signal to represent 1’s and 0’s - Symbols
- Amplitude, Phase, and Frequency or a combination (Ex. QAM)
Modulation Continued

Voltagex

Time

1 0 1 0

Input Modulating Digital Signal

Carrier Frequency

PSK Signal

BPSK
MODULATION CONTINUED

Quadrature PSK

- 45° = 11
- 135° = 10
- 225° = 01
- 315° = 00

00, 01, 10, 11
MODULATION CONTINUED
MODULATION CONTINUED
CODING

• Form of Forward Error Correction
• Expressed in x/y format
  • X = Number of Real Data Bits
  • Y = Total Number of Bits Sent
  • Difference equals number of repeated bits
• Current Rates – 1/2, 2/3, 3/4, 5/6
MODULATION CODING SCHEME (MCS)

- Uses Index numbers - .11ac is 0-9
  - Each index number represents
    - Modulation – BPSK, QPSK or XX-QAM
    - Coding rate

<table>
<thead>
<tr>
<th>Spatial Streams</th>
<th>Modulation &amp; Coding</th>
<th>Data Rate (20MHz)</th>
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SERVICE SET IDENTIFIER - SSID

• 2 Levels Used
  • Extended Service Set Identifier – ESSID
    • Common Name used to identify the network as a unit – “Corp” or “Guest”
    • Transmitted by every Access Point in the network
  • Basic Service Set Identifier – BSSID
    • Used to identify the individual Access Point (radio) and SSID within its programming
    • Format is MAC address – Ex. aa:12:cc:34:ee:56
    • Each and every BSSID has its own set of Management and Control Frames
    • All Management and Control Frames are:
      • Sent using the lowest Basic (a.k.a. Mandatory) Data Rate
      • Sent using 20MHz wide channels for backwards compatibility
CONTENTION FREE PERIODS

- Used to allow channel bonding in the medium
- Initiated by the Access Point
- Sent using 20MHz wide channel
  - Part of the Management and Control Frame set
  - Attempt to avoid collisions with older clients that can’t Channel Bond
KEY FACTORS THAT AFFECT PERFORMANCE

• Signal to Noise Ratio (SNR)
• Overlapping Basic Service Sets (OBSS)
• Client Device Capabilities
• Greenfield versus Mixed
• Other Forces
SIGNAL TO NOISE RATIO

• Higher the number – better the signal quality

• Affected by
  • Attenuation
  • Distance
  • Interference
  • Noise floor

• Manufacturers are using derivatives / calculations – “Air Quality”, “Link Quality”
# MCS Value Achieved by Clients at Various Signal to Noise Ratio Levels (SNR)

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<th>Protocol</th>
<th>Channel</th>
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<th>SNR in dB</th>
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<tr>
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**Modulation Key**
- None = Grey
- 8PSK = Red
- QPSK = Orange
- 16-QAM = Yellow
- 64-QAM = Blue
- 256-QAM = Green

**802.11 Type Key**
- 802.11b
- 802.11a/g
- 802.11n
- 802.11ac
OVERLAPPING BASIC SERVICE SETS (OBSS)

• What is it?
  • When AP density is high
  • When number of access points exceed available channels within “earshot”
  • By-product is CCI & ACI
  • Further exacerbated with channel bonding
  • Can occur due to client device location as well
High Density Design = Many Users / High Throughput
Using 20MHz or 40MHz (with DFS) Channels
Using 80MHz Wide (with DFS) Channels
Duty Cycle / Airtime / Utilization

- How long any one TX is taking up the RF
- TX from attenuated devices “take longer” than one closer to the RX
- When channel bonding, increase utilization as you decrease channel diversity
- Remember this is for both Access Points and Client devices
- More “cars on the road” means “less overall speed”
GREENFIELD VERSUS MIXED

• Definition – All or Some
• Mixed environments are most common, even in Enterprise
• Can’t control Guest / Visiting Client
• Sometimes little control over Corporate Owned
  • Healthcare
  • Where cost is king
OUTSIDE FORCES

• Client Devices
  • Hardware support for Channels and Capabilities (Ex. MU-MIMO)
  • Driver Challenges

• Neighboring Networks

• Manufacturer options
THE REAL DEAL

• Depending on Environment use of Channel Bonding will be limited
  • 20MHz – always
  • 40MHz – sometimes depending on AP density
  • 80MHz+ - not likely

• Designs are moving to more users in condensed areas
  • Increases OBSS likelihood

• Can’t control all devices in the environment
  • Capabilities Need to be equal
  • Hardware and Driver support
THE CLAIMS

• Deliver increased scale and coverage.
  - Coverage isn’t increased
  - Depends on what they mean by “scale”

• Offers a significant boost in performance.
  - Compared to .11a/b/g
  - Compared .11n, not so much

• Offers up to 7Gbps of throughput.
  - Only in very few cases
THE CLAIMS

• Can handle up to XXXX users per radio.
  - ✔ Newer capabilities and hardware have increased capacity
  - ✗ Efficiency is hampered with large numbers of devices

• MU-MIMO can talk to multiple clients simultaneously.
  - ✗ Only in Downlink Direction
  - ✗ Not all Manufacturers support

• To deploy you need multigigabit links to the Access Points.
  - ✗ Half-duplex medium and limited wireless speeds even with .11ac
I WANT YOU TO FIRE DILBERT FOR INSULTING MY WIFE IN HIS SLIDE DECK.

THE PRESENTATION WAS ABOUT WI-FI, NOT YOUR WIFE.
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