Introduction to Wireless

Presented by:
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Hi my name is... Lasantha Perera

5+ Years at LA Networks – Network Engineer

Former companies I’ve worked for:

- Mercedes Benz
- Patterson Dental
- Bank of America

Hobbies:

- WiFi enthusiast, automotive enthusiast, traveling, cycling, snorkeling, and more!
Session Agenda

- Wireless Intro
  - WIFI technology evolution
  - Cisco indoor AP portfolio
  - Meraki indoor AP portfolio
- Standards and Characteristics
  - What is 802.11abgn/ac?
  - Frequency & Channels
  - Wave 1, Wave 2
- Challenges for Wireless Networks
  - Environment
  - Coverage
  - Interference
Session Agenda

- Best practices
  - Channel Best Practices
  - AP placement best practices
  - Wireless Security
  - Site Survey
- Questions & Answers
The evolution
Wireless Everywhere!

• "7.7 billion new Wi-Fi (a/b/g/n) enabled devices will enter the market in the next five years.*

• In 2015 there will be 7.4 billion 802.11n devices in the market.*

• 1.2 billion Smartphones will enter the market over the next five years, about 40% of all handset shipments.*

• Smartphone adoption growing 50%+ annually.**

• Currently 16% of mobile data is diverted to Wi-Fi, by 2015 this number will increase to 48%.*

• As of 2012, more than 50% of network devices will ship without a wired port.***

Source: *ABI Research, **IDC, *** Morgan Stanley Market Trends
Credit to: CiscoLive360 for images and all information above
Let's say a 100 employee company, how many devices on the wireless network?
**Definition of Wireless:**

- Not using wires to send and receive electronic signals: sending and receiving electronic signals by using radio waves.
- Of or relating to the use of radio waves to send and receive electronic signals.

**Definition of Radio Waves:**

- An electromagnetic wave that is used for sending signals through the air without using wires.
2 common types of Cisco Access Points

- Internal (indoor) APs
  - LAP/Standalone AP
  - Cloud-managed (Meraki)
- External (outdoor) APs
# Cisco Access Points

## Cisco Aironet Indoor Access Points Portfolio

**Industry’s Best 802.11ac Series Access Points**

<table>
<thead>
<tr>
<th>Enterprise Class</th>
<th>Mission Critical</th>
<th>Best in Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1810w</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 2x2:2SS 80 MHz; 867 Mbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Tx Beam Forming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 1 GE Port uplink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 3 GE Local Ports, including 1 PoE out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Local ports 802.1x ready</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Integrated BLE Gateway*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OEAP1810</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 2x2:2SS 80 MHz; 867 Mbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 3 GE Local Ports downlink, including 1 PoE out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- One or Two Local Ports can be tunneled back to corporate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **1830**         |                  |               |
| - 3x3:2SS 80MHz; 867Mbps |
| - Spectrum Analysis* |
| - Internal antenna |
| - Tx Beam Forming |
| - 1 GE Port |
| - USB 2.0 |
| - Centralized, FlexConnect and Mobility Express |

| **1850**         |                  |               |
| - 4x4:3SS 80MHz; 1.7 Gbps |
| - Spectrum Analysis* |
| - Internal or External antenna |
| - Tx Beam Forming |
| - 2 GE Ports |
| - USB 2.0 |
| - Centralized, FlexConnect and Mobility Express |

| **2800**         |                  |               |
| - 4x4:3SS 160 MHz; 5 Gbps |
| - 2.4, 5GHz or Dual 5GHz |
| - 2 GE Ports |
| - Internal or External antenna |
| - Smart Antenna Connector |
| - Enhanced Location* (External Antenna) |
| - CleanAir 160MHz |
| - ClientLink 4.0 |
| - USB 2.0 |
| - Centralized, FlexConnect and Mobility Express* |

| **3800**         |                  |               |
| - 4x4:3SS 160 MHz; 5 Gbps |
| - 2.4, 5GHz or Dual 5GHz |
| - 2 GE or 1 GE + 1 mGig (5G) |
| - Internal or External antenna |
| - Smart Antenna Connector |
| - Enhanced Location* (External Antenna) |
| - CleanAir 160MHz |
| - ClientLink 4.0 |
| - Stadium Vision |
| - USB 2.0 |
| - Modularity |
| - Centralized, FlexConnect and Mobility Express* |

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Cisco Wireless Controllers

- Cisco 8500 Series WLC
  - High scalability in a single rack-unit space with a centralized touch point
  - High speed with 10 Gigabit Ethernet connectivity support: 2 x 10 Gigabit Ethernet ports
  - High Availability with sub-second access point and client stateful failover
  - High resiliency with redundant dual power supplies
  - Architectural flexibility to support centralized controller switched architecture for campuses

- Cisco 5500 Series WLC
  - Integrate next-generation wireless networking technology into a highly scalable platform
  - Help ensure a quality mobile experience with efficient roaming on any smartphone device with voice and video
  - Support all mobility services, including ClientLink, VideoStream, CleanAir technology, and the OfficeExtend solution
  - High Availability with sub-second access point and client stateful fail-over

- Cisco 2500 Series WLC
  - Entry-level wireless controller for managing wireless functions in small to midsize enterprises
  - Simplified deployment and operation of Cisco Aironet access points and wireless networks
  - Support for advanced services such as ClientLink, VideoStream, and CleanAir technologies
Cisco Wireless Controllers

* Cisco 3650 Series Switch

Cisco Catalyst 3650 Series Switch
- Converged access switch with integrated controller
- Up to 40 Gb of wireless capacity per switch (48-port models)
- Support for up to 25 access points and 1000 wireless clients on each switching entity (switch or stack)
- Three six-uplink models with 4 × Gigabit Ethernet, 2 × 10 Gigabit Ethernet, or 4 × 10 Gigabit Ethernet ports
- Dual-redundant, modular power supplies and three modular fans providing redundancy

* Cisco 3850 Series Switch

Cisco Catalyst 3850 Series Switches
- Best-in-class and feature-rich stackable platform with 480 Gbps stacking for gigabit desktop and 802.11ac wireless
- Converged wired and wireless access by extending wired features, resiliency, granular QoS, and scalability to wireless
- Distributed intelligent services across wired and wireless for security, policy, application visibility and control, and more
- Foundation for Cisco Open Network Environment enabled by a new ASIC with programmability and investment protection

* Cisco Virtual Wireless Controller
Meraki Cloud Managed APs

100% cloud managed for faster deployment, simplified administration, and richer visibility

High Capacity

Cisco Meraki access points are built from the highest grade components and carefully optimized for a seamless user experience. The outcome: faster connections, greater user capacity, more coverage, and fewer support calls.
Meraki Wireless

Indoor Access Points:
- MR53 – 2.5 Gbps (Wave 2 support) – Multi-gigabit Ethernet port
- MR52 – 2Gbps (Wave 2 support) – 2 Gigabit Ethernet port
- MR42 – 1.9 Gbps (Wave 2 support)
- MR33 – 1.3 Gbps

Outdoor access points:
- MR84 – 2.5 Gbps 802.11ac – Multi-Gigabit Ethernet port
- MR74 – 1.3Gbps 802.11ac
- MR72 – 1.2Gbps 802.11ac
- MR66 – 600 Mbps

Subscription license:
- 1 YR, 3YR, 5YR, 7YR and 10YR license options
* Multi-gigabit Ethernet support
* 802.11ac Wave 2 support
* CMX Location Analytics
* Identity-Based Firewall with content filtering (Sourcefire)
* Application Visibility & Control
* Dedicated Security Radio
* Built-in guest access
Components of a Typical Wireless Network:

❖ Access Point – Standalone Mode – No WLC
   • Router (layer 3)
   • Switch (layer 2)
   • Wireless Access Point standalone
   • End Devices (Wireless phone, ipad, laptop, etc)

❖ Access Point – Lightweight Access Points – (LWAPP/CAPWAP – Controller Mode)
   • Router (layer 3)
   • Switch (layer 2)
   • Wireless Access Point (LAP)
   • Wireless LAN Controller
   • End Devices (Wireless phone, ipad, laptop, etc)

❖ Access Point – Cloud controller
❖ Wireless NIC – On the client side
802.11a, b, g, n, ac is a set of IEEE standards for implementing a wireless LAN.

- **802.11a** operate at:
  * 5.0GHz band
  * Uses OFDM with modulation formats that are available: BPSK, QPSK, 16-QAM, 64-QAM

- **802.11b** operate at:
  * 2.4GHz band
  * Uses DSS (Direct-sequence spread spectrum) with CCK or PBCC modulation formats.

- **802.11g** operate at:
  * 2.4GHz band
  * Uses either OFDM or DSS and the modulation formats are set according to the data rate.

- **802.11n** operate at:
  * Can operate at both 2.4GHz and 5.0GHz band
  * Uses DSSS but prefers OFDM (Orthogonal frequency division multiplexing)
  * MIMO + OFDM

- **802.11a/c** operate at:
  * 5.0GHz band with support for backwards compatibility with other 802.11n technologies operating in the same band. MIMO + OFDM
RSSI and SNR

❖ RSSI – Received signal strength indicator
  • The measure of signal strength that arrives at the receiving device.
  • The higher the value (closer to 0dBm) would indicate a stronger signal
  • Grade value from 0 to 255 with each grade value is an equivalent dBm (decibels to a milliwatt) value.
  • The scale will be different from one card vendor to another.

❖ SNR – Signal to Noise Ratio
  • Comparison of the amount of signal as compared to the surrounding noise.
  • The higher the SNR the better. (Anything between 25dB to 40dB SNR is very good signal)
  • Anything above SNR of -72dBm would mean the client is far away or signal is weaker
## Bandwidth & Data rates

<table>
<thead>
<tr>
<th>802.11</th>
<th>Frequency</th>
<th>Data rate</th>
<th>Channels</th>
<th>Channels ‘usable’</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>5 GHz</td>
<td>54 Mbps</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>b</td>
<td>2.4 GHz</td>
<td>11 Mbps</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>g</td>
<td>2.4 GHz</td>
<td>54 Mbps</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>n</td>
<td>2.4 GHz &amp; 5 GHz</td>
<td>(min) 65, 150, 300, 450, (max) 600 Mbps</td>
<td>2.4 GHz &amp; 5 GHz Rules apply.</td>
<td>2.4 GHz &amp; 5 GHz Rules apply.</td>
</tr>
<tr>
<td>ac</td>
<td>5 GHz</td>
<td>867 Mbps, 1.3 Gbps, 1.7 Gbps, 3.5 Gbps, 6.9 Gbps*</td>
<td>24* 37**</td>
<td>24* 37**</td>
</tr>
</tbody>
</table>

* = 802.11ac Wave 2
** = 802.11ac Wave 2 (US)
Higher speeds are achieved by

- Modulation (OFDM, CCK, BPSK, QPSK, QAM)
  
- Ex: BPSK encoding with OFDM

<table>
<thead>
<tr>
<th>BPSK</th>
<th>QPSK</th>
<th>QAM 16</th>
<th>QAM 64</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Mb/s</td>
<td>12 Mb/s</td>
<td>24 Mb/s</td>
<td>48 Mb/s</td>
</tr>
<tr>
<td>9 Mb/s</td>
<td>18 Mb/s</td>
<td>36 Mb/s</td>
<td>54 Mb/s</td>
</tr>
</tbody>
</table>

Example: 802.11ac uses QAM 256 (33% more speed burst at shorter, yet still usable ranges)

- Channel Aggregation – Example: 802.11n uses 2 carriers (channel bonding – Max of 40 MHz in 802.11n) to more then double the speed. 802.11ac now up to 80 MHz or even 160MHz to gain higher speeds.
Higher speeds are also achieved by – MU-MIMO:

- MU-MIMO (Moo-My-Mo) – Multiple User - Mulitiple Input Multiple Output - Example: Access points can now send data (downlink) to multiple devices at the same time. Think of 802.11n technology as a HUB and 802.11ac as a wireless switch.

Figure 8. MU- MIMO Using a Combination of Beamforming and Null Steering to Multiple Clients in Parallel
2.4Ghz range:

- Each channel is about 22 MHz
- There are 3 Non-overlapping Channels (Channels 1, 6 and 11 for North America)
5.0 GHz range:
- There are 23 Non-overlapping Channels
- To use the 11 new channels for indoor/outdoor, the radios must comply with TPC and DFS (802.11h specifications)
  - TPC – Used for Power Levels
  - DFS – Used for changing/avoiding radar channels when detected
# Frequency and Channels

## Table 3-3: Operating Frequency Range for 802.11a

<table>
<thead>
<tr>
<th>Channel ID</th>
<th>36</th>
<th>40</th>
<th>44</th>
<th>48</th>
<th>52</th>
<th>56</th>
<th>60</th>
<th>64</th>
<th>100</th>
<th>104</th>
<th>108</th>
<th>112</th>
<th>116</th>
<th>120</th>
<th>124</th>
<th>128</th>
<th>132</th>
<th>136</th>
<th>140</th>
<th>149</th>
<th>153</th>
<th>157</th>
<th>161</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Freq. MHz</td>
<td>5180</td>
<td>5200</td>
<td>5220</td>
<td>5240</td>
<td>5260</td>
<td>5280</td>
<td>5300</td>
<td>5320</td>
<td>5500</td>
<td>5520</td>
<td>5540</td>
<td>5560</td>
<td>5580</td>
<td>5600</td>
<td>5620</td>
<td>5640</td>
<td>5660</td>
<td>5680</td>
<td>5700</td>
<td>5745</td>
<td>5765</td>
<td>5785</td>
<td>5805</td>
</tr>
<tr>
<td>Band</td>
<td>UNII-1</td>
<td>UNII-2</td>
<td>UNII-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Frequency and Channels

Example of a channel-set for a BSS:
- primary 20 MHz on ch60 (beacons, virtual carrier sense and 802.11a devices)
- primary 40 MHz on ch60+64 (802.11n devices)
- primary 80 on ch52-64 and 160 MHz on ch36-64 (802.11ac devices)

40 MHz = adjacent 20 MHz channels grouped into pairs;
80 MHz = adjacent 40 MHz channels grouped into pairs;
160 MHz = adjacent 80 MHz channels grouped into pairs

Weather radar issue
Spans UNII-2 and UNII-2-extended
Wave 1, Wave 2

- Transition to 802.11ac as part of your normal upgrade
- Upgrade to the AP that best fits your business need
- Look for value added features
- Don’t get too carried away with 802.11ac speeds!
Wi-Fi Connectivity Speed Timeline
Gigabit Wi-Fi As Primary Access

[Diagram showing the timeline from 1997 to 2016, highlighting the evolution of Wi-Fi standards and their speeds.]

- **Wave 1, Wave 2**

### Standards and Capabilities

- **4SS**: Desktops / Infra
- **3SS**: Desktops / Laptops
- **2SS**: Laptops / Tablets
- **1SS**: Tablets / Smartphones

- **Connect Rates (Mbps)**

  - * Assuming 80 MHz channel is available and suitable
  - ** Assuming 160 MHz channel is available and suitable
Wave 1, Wave 2

### 80 MHz PHY rate

<table>
<thead>
<tr>
<th>Spatial streams</th>
<th>64</th>
<th>256</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>290</td>
<td>430</td>
</tr>
<tr>
<td></td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>650</td>
<td>870</td>
</tr>
<tr>
<td>3</td>
<td>980</td>
<td>1300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1700</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>3500</td>
</tr>
</tbody>
</table>

### 160 MHz PHY rate

<table>
<thead>
<tr>
<th>Spatial streams</th>
<th>64</th>
<th>256</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>650</td>
<td>870</td>
</tr>
<tr>
<td>2</td>
<td>1300</td>
<td>1700</td>
</tr>
<tr>
<td>3</td>
<td>2000</td>
<td>2600</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>3500</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>6900</td>
</tr>
</tbody>
</table>

1. 2700 and 3700 max data rate
2. 1850 max data rate
3. 2800 / 3800 single radio max
Wave 2 clients will be a significant percentage of users on the network end of 2016/2017

Wave 2 will only be present in very high-end laptops.
The World’s Most Versatile Access Points

All The Benefits of 802.11ac Wave 2 + *a lot more!*

<table>
<thead>
<tr>
<th>Wave 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Wi-Fi Performance Ever</td>
<td>Better End Device Efficiency</td>
</tr>
<tr>
<td>Higher Data Rate</td>
<td>Simultaneous Data Delivery</td>
</tr>
<tr>
<td>Wider Channels</td>
<td>Better Battery Life</td>
</tr>
</tbody>
</table>

**Cisco Aironet 2800**

**Cisco Aironet 3800**

**Plus Cisco Innovations for High Density Environments**

**Self-Optimizing Network**

- New Flexible Radio Assignment
- New Multi-Gigabit Uplinks
- Improved Modularity

**Optimized Mobile User Experience**

- Improved ClientLink
- Turbo Performance
- New Smart Antenna
- Improved Enhanced Location
- Optimized Roaming
Challenges for Wireless Networks

* Environment
* Office space
  * Multi-tenant
  * Multi-floor
  * Structures
* Warehouses
  * Structures
  * Location
  * Temperature
Challenges for Wireless Networks

* Coverage
  * Design for # of client devices
  * Not all clients are created equal
  * Smaller coverage cell sizes
  * Enable use of ClientLink (if supported)
  * Special consideration for VoWLAN deployments
Challenges for Wireless Networks

* Interference
  * Who or what is responsible?
Interference
What happens in the air?

- Shadowing
- Reflection
- Refraction
- Scattering
- Diffraction
Interference

Co-Channel: Every client and access point on the same channel competes for time to talk.

Adjacent-Channel: Every client and access point on overlapping channels talk over each other.

Non-Wi-Fi: Non-802.11 devices compete for medium access.

- Microwave
- Analog Camera
- Cordless Phone
Interferences

* Types of signal interference:

  • Physical interference – Easier to see.
    • A cordless phone sitting next to an AP.
    • Plants and Trees
    • Microwave ovens

  • Hidden physical interference – difficult to mitigate. Think about: What is inside those walls?
    • An Exterior wall that consists of brick and thick insulation can cause interference and its not easy to see.
    • Lead paint
    • Bulletproof glass (you might think nothing of it but the degree of attenuation is high)

  • Channel interference – Other wireless devices on an overlapping channel.
    • Neighbor APs using channels that is interfering with the AP channel that ones own is on.
Interferences

* Effects of interference:
  
  • Wireless signal range is degraded
  
  • Data throughput decreases
  
  • Client connectivity issues
# Interferences

*Diagram courtesy of Apple*

<table>
<thead>
<tr>
<th>Type of Barrier</th>
<th>Interference Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>Low</td>
</tr>
<tr>
<td>Synthetic material</td>
<td>Low</td>
</tr>
<tr>
<td>Glass</td>
<td>Low</td>
</tr>
<tr>
<td>Water</td>
<td>Medium</td>
</tr>
<tr>
<td>Bricks</td>
<td>Medium</td>
</tr>
<tr>
<td>Marble</td>
<td>Medium</td>
</tr>
<tr>
<td>Plaster</td>
<td>High</td>
</tr>
<tr>
<td>Concrete</td>
<td>High</td>
</tr>
<tr>
<td>Bulletproof glass</td>
<td>High</td>
</tr>
<tr>
<td>Metal</td>
<td>Very high</td>
</tr>
</tbody>
</table>
Important factors to consider that may interfere with a wireless signal:

- If WLAN is deployed for an open environment – take into consideration large structures that block the signal, moving objects or even weather.

- If WLAN is deployed in a warehouse/office - take into consideration steal beams, concrete pillars, large filing cabinets that can cause wireless signal interference

- Always know your surroundings – Take into consideration electronic devices, cordless phones, type of office lighting, satellite dishes, radars, microwave ovens, xbox consoles, and anything else that can generate interference or block wireless signals
Best Practices

- Usage of Channels
- Tx Power
- Data Rates
- AP Placement
- Security
- Wireless Survey
Best Practices

Usage of Channels

- Use non-overlapping channels
- Avoid channels with high co-channel interference
- Neighboring APs should be on a non-overlapping channel
- Use the RRM algorithms
- Enable DCA
Best Practices

* Tx Power

Jason Hintersteiner
@EmperorWiFi

Setting Tx power is like drinking scotch: The right amount is great, but "more" does not mean "better", & too much will make you sick...
Best Practices

* Tx Power
* **Tx Power**
  * High Power != Better Signal
    * RSSI >= 67 dBm
    * SNR 25 dB or better
    * Channel Utilization under 50%
  * Keep in mind that mobile devices have different Tx Power VS AP
  * Use RRM (high density is a special case) – Not meant to replace a site survey
  * What is RRM? Dynamic channel assignment, transmit power, cove hole detection working together.
  * Don’t use ‘maximum power...’
Bad design Example:
Mobile device @ 12 dBm
Access Point @ 20 dBm

End result = Client message is too weak, AP does not ACK until rate falls to 12 Mbps
Each message takes much longer time to be transmitted
Clients are not Maximum Power

I TALK TO MY CLIENTS VERY LOUD.... SO I’m PRETTY SURE THEY CAN HEAR ME!!!

20 dBm = 100 mw

14 dBm = 25 mw
### Best Practices

```
(Cisco Controller) > show advanced 802.11a txpower
.../...
<table>
<thead>
<tr>
<th>AP Name</th>
<th>Channel</th>
<th>TxPower</th>
<th>Allowed Power Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP702W</td>
<td>157</td>
<td>*1/8 (20 dBm)</td>
<td>[20/17/14/11/8/5/2/-1]</td>
</tr>
<tr>
<td>AP2602</td>
<td>48</td>
<td>1/4 (14 dBm)</td>
<td>[14/11/8/5/5/5/5/5]</td>
</tr>
<tr>
<td>AP3702</td>
<td>(52,56)</td>
<td>*2/5 (12 dBm)</td>
<td>[15/12/9/6/3/3/3/3]</td>
</tr>
<tr>
<td>AP3602</td>
<td>(40,36)</td>
<td>*2/7 (12 dBm)</td>
<td>[14/12/10/8/5/-1/-4/-4]</td>
</tr>
</tbody>
</table>
```

- AP is on 40 MHz channel
- Power is dynamically assigned by WLC
- Current level is 2 (12 dBm), there are 7 levels
- Allowed levels, 7 to 8 are the same, so AP is configurable down to level 7
Best Practices

* Data Rates
  * Disable 802.11b rates
  * Turn off slow data rates
  * Adjust to your environment
  * Configure what works best for your environment
  * Use 5Ghz as much as possible
Best Practices

* Cell Size
  * Try to design small cells with cell overlap
  * Every 40ft to 60ft
  * Special consideration for VoWLAN deployments
  * 20% cell overlap between cells is recommended
  * Neighboring cell should use a non-overlapping channel
  * Enable band steering
Best Practices

* AP Placement
* One example of AP placement:
**Best Practices**

* AP Placement
  * Place below obstructions
  * Not too high
  * Mount APs so the antennas are vertical
  * Don’t place behind metal cages or inside cabinets
  * Avoid mounting APs on the wall that is meant for ceiling mount
Best Practices

* Source – www.badfi.com

Placements. Really? Does it matter?
Best Practices
Best Practices

Integrated Antenna? External Antenna?

Carpeted areas
Integration antenna versions are designed for mounting on a ceiling (carpeted areas) where aesthetics is a primary concern

Rugged areas
Use for industrial applications where external or directional antennas are desired and or applications requiring higher temperature ranges
Wall Mounting AP-1260e, 3500e, 3600e and 3700e

Orientation of the Dipoles if Wall Mounting

Dipoles pointing UP or Down are in **vertical polarity**

This is ideal for uniform coverage.

Dipoles pointing sideways are in **horizontal polarity**

Note: Cisco recommends transmitting antennas use **vertical polarity**
Best Practices

- More than 1 controller
  - Configure high availability
  - Configure Sub-second failover

- SSID
  - Try to keep the number of SSIDs to a minimum
  - Avoid more than 4 if possible
  - Each SSID will advertise at the minimum mandatory data rate
  - Lowest mandatory rate is beacon rate
  - Highest mandatory rate is default mcast rate
Best Practices

SSIDs and Low Rates Consume Air Time

- Before: 8 SSIDs, all rates allowed
- After: 2 SSIDs, 802.11b rates disabled

Assess your CU often

60% Before
5% After
Best Practices

* Security

![Statistics](image)

- **Unique WiFi networks in DB:** 226,657,388
- **Unique networks w/ location:** 226,196,720
- **Unique WiFi locations in DB:** 3,226,957,847
- **Unique Cell towers in DB:** 5,946,883
- **Unique Cells w/ location:** 5,916,700
- **Registered Users:** 170,695

**Networks with default SSID:** 8,282,679 (3.61%)
- **New unique networks today:** 16,268
- **New today with location:** 16,247
- **New yesterday with location:** 135,596

**Total Files parsed:** 1,299,436
- **Files uploaded today processed:** 63
- **Files 1 day ago / 2 days ago:** 470 / 505
- **Files queued to process:** 0

**Wireless Encryption**
- **WPA:** 17,948,480 (51.54%)
- **WPA2:** 23,963,983 (69.17%)
- **WEP:** 27,815,788 (12.16%)
- **????:** 43,397,442 (18.94%)
- **None:** 18,132,440 (8.37%)

Source: wigle.net
Best Practices

* Security best practices

  * WPA2 should be the bare minimum
  * WPA2 (PSK) is for home
  * WPA2 Enterprise (802.1x) for business
  * Use RBA (role based access) with ISE
  * Use a wIPS solution (wireless intrusion prevention)
  * Use VPN on public wifi
**What is Cisco ISE?**

* Next-generation identity and access control policy platform that enables enterprises to enforce compliance, enhance infrastructure security and streamline their service operations.

**What is wIPS?**

* Intrusion prevention system used to detect, locate, mitigate and contain wired and wireless rogue and threats.
Best Practices

Wireless Survey

Survey Phase

Predictive site surveys (network plan, simulation)

Pre-Deployment site surveys (AP on a stick)

Post-Deployment site surveys (validation)

Periodic site surveys (health check)

Question


“What does the real world RF look like”

“Does this network actually work?”

“Does it still work? What has changed?”
Best Practices

* Come up with a design before you begin
  * On-site survey before you begin
  * On-site survey after the install to see if your design is met
  * Use spectrum analysis to review what interference is there
  * Post install survey to check if what you designed is actually okay
For best results

- You need all 4 surveys
  - Predictive
  - Passive
  - Active
  - Post install

- Airmagnet Survey Pro
- Ekahau Site Survey
Yes... it was a 5 KM walk...
Best Practices

THERE IS ALWAYS SOMEONE

WILLING TO DO IT CHEAPER
Wireless Certifications

* Wireless is a specialty - Get Certified
* Take the time to learn and understand 802.11
  * CCNA Wireless (Basic)
  * CCNP Wireless (If you want more knowledge)
  * If you want to be a legend.... CCIE
References and Key Terms

- **Attenuation** – a loss in force or intensity – As radio waves travel in media such as coaxial cable attenuation occurs.
- **BER** – Bit Error Rate - the fraction of bits transmitted that are received incorrectly.
- **Channel Bonding** – act of combining more than one channel for additional bandwidth
- **dBd** – abbreviation for the gain of an antenna system relative to a dipole
- **dBi** – abbreviation for the gain of an antenna system relative to an isotropic antenna
- **dBm** – decibels milliwatt – abbreviation for the power ratio in decibels (dB) of the measured power referenced to one milliwatt of transmitted RF power.
- **Isotropic antenna** – theoretical “ideal” antenna used as a reference for expressing power in logarithmic form.
- **MRC** – Maximal Ratio Combining a method that combines signals from multiple antennas taking into account factors such as signal to noise ratio to decode the signal with the best possible Bit Error Rate.
- **Multipath** – refers to a reflected signal that combines with a true signal resulting in a weaker or some cases a stronger signal.
- **mW** – milliwatt a unit of power equal to one thousandth of a watt (usually converted to dBm)
- **Noise Floor** – The measure of the signal created from the sum of all the noise sources and unwanted signals appearing at the receiver. This can be adjacent signals, weak signals in the background that don’t go away, electrical noise from electromechanical devices etc.
- **Receiver Sensitivity** – The minimum received power needed to successfully decode a radio signal with an acceptable BER. This is usually expressed in a negative number depending on the data rate. For example the AP-1140 Access Point requires an RF strength of at least negative -91 dBm at 1 MB and an even higher strength higher RF power -79 dBm to decode 54 MB
- **Receiver Noise Figure** – The internal noise present in the receiver with no antenna present (thermal noise).
- **SNR** – Signal to Noise Ratio – The ratio of the transmitted power from the AP to the ambient (noise floor) energy present.
- **TxBF** – Transmit beam forming the ability to transmit independent and separately encoded data signals, so-called streams, from each of the multiple transmit antennas changing the timing so the client can best decode the information. Sometimes called Cisco Client Link.

Some information on slide deck re-used from courtesy of Cisco Live BRKEWN-2019

Some information on slide deck from Badfi.com
Thank You!

ANY QUESTIONS?
DIDN'T THINK SO...