CompTIA Network+ Exam N10-008

Lesson 15

Deploying and Troubleshooting Wireless Networks

Objectives

- Summarize wireless standards
- Install wireless networks
- Troubleshoot wireless networks
- Configure and troubleshoot wireless security

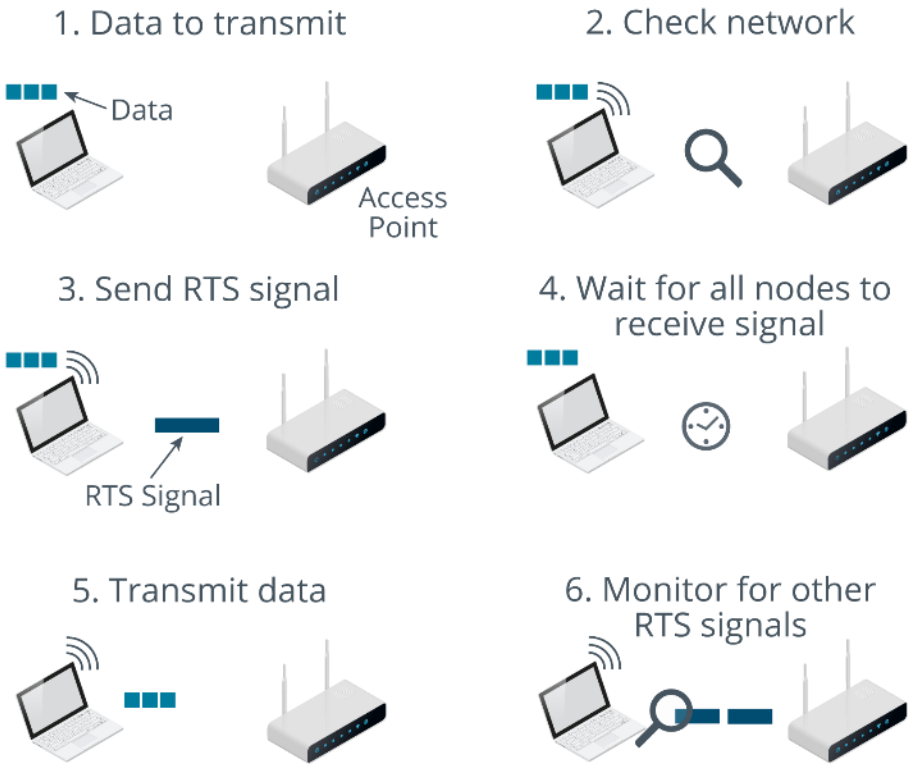
Lesson 15

Topic 15A

Summarize Wireless Standards

IEEE 802.11 Wireless Standards

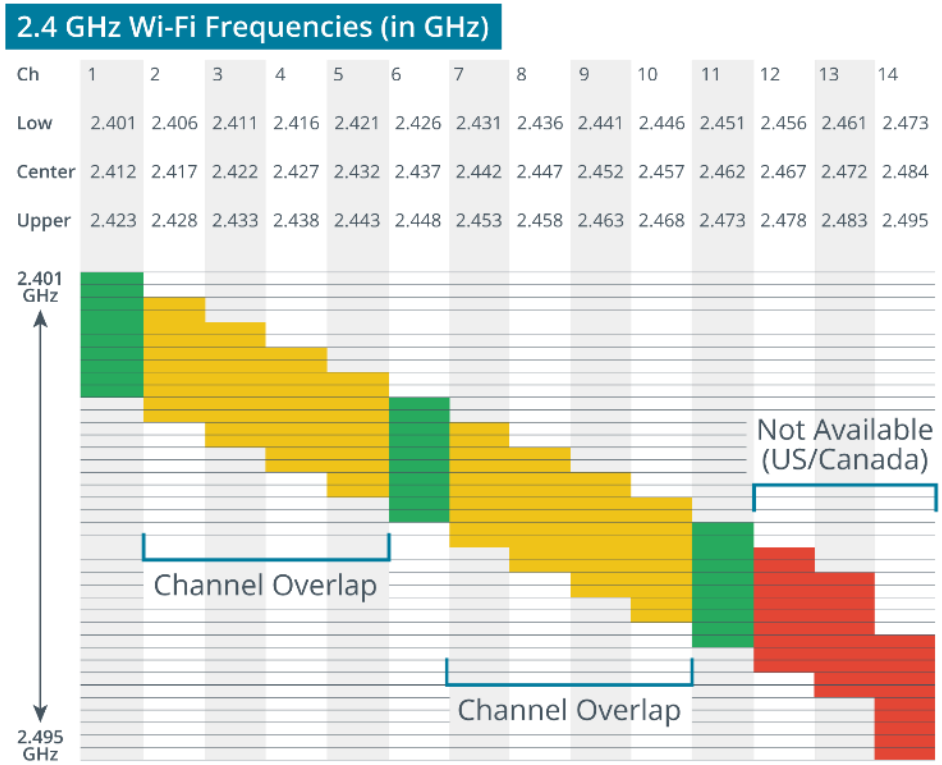
- Wi-Fi modulation and carrier methods
- Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)
  - Ack undamaged frames
  - Request to Send/Clear to Send
- Original data rate just 1 Mbps



IEEE 802.11a and 5 GHz Channel Bandwidth

- 2.4 GHz
  - Better propagation, but fewer channels and greater interference risk
- 5 GHz
  - Lower range, but less congested
- IEEE 802.11a (54 Mbps)
  - Orthogonal Frequency Division Multiplexing (OFDM)
  - 23 x non-overlapping 20 Mhz channels
  - Dynamic Frequency Selection (DFS) and regulatory impacts

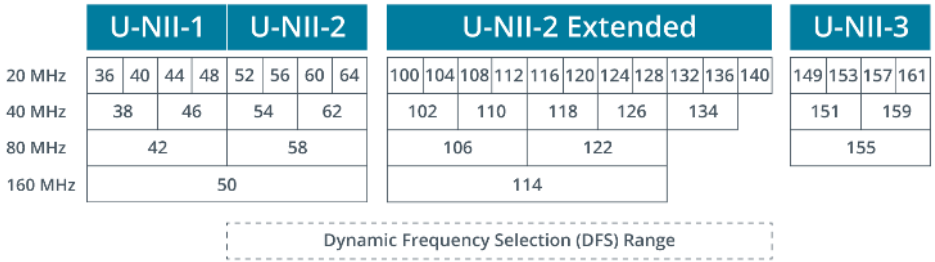
IEEE 802.11b/g and 2.4 GHz Channel Bandwidth



- IEEE 802.11b (11 Mbps)
  - Direct Sequence Spread Spectrum (DSSS), along with Complementary Code Keying (CCK) signal encoding
  - 14 x 5 MHz channels
  - Wi-Fi still needs 20 MHz channel bandwidth
  - Channels require careful configuration to avoid overlap
- IEEE 802.11g (54 Mbps)
  - OFDM
  - 802.11b compatibility mode

IEEE 802.11n, MIMO, and Channel Bonding

- Single User Multiple Input Multiple Output (SU-MIMO)
  - AxB:C transmit and receive antennas plus maximum simultaneous streams
  - Spatial multiplexing and spatial diversity
- Can use 5 GHz or 2.4 GHz bands with channel bonding
- High Throughput (HT)/greenfield
  - 288.8 Mbps for a single channel and 600 Mbps for bonded channels
  - HT mixed mode for compatibility with older standards
- Wi-Fi 4



Wi-Fi 5 and Wi-Fi 6

- Wi-Fi 5 (802.11ac)
  - 5 GHz only
  - 80 or 160 MHz channel bonding
  - Up to 8 spatial streams
- Wi-Fi 6 (802.11ax)
  - High Efficiency (HE)
  - 2.4 GHz or 5 GHz (plus new 6 GHz band)
  - Enhancements to support Internet of Things (IoT) devices
    - OFDM with multiple access (OFDMA)
    - Not so much throughput, but reduced latency

Multiuser MIMO

- Beamforming
- Downlink MU-MIMO (DL MU-MIMO)
  - Separate signals by alignment
  - Up to 4 in Wi-Fi 5 and up to 8 in Wi-Fi 6
- Uplink MU-MIMO (UL MU-MIMO)

2G and 3G Cellular Technologies

- 2G cellular radio
  - Global System for Mobile Communication (GSM)
    - Initially used Time Division Multiple Access (TDMA)
    - Subscriber Identity Module (SIM) allows number portability between handsets
  - Code Division Multiple Access (CDMA)/IS-95
  - Circuit Switched Data (CSD)
- 3G packet radio for cellular networks
  - General Packet Radio Services/Enhanced Data Rates for GSM Evolution (GPRS/EDGE) for 2.5G on GSM
  - Universal Mobile Telecommunications System (UMTS)/Evolved High Speed Packet Access (HSPA+) for 3G on GSM networks (now using a form of CDMA)
  - CDMA2000 Evolution Data Optimized (EV-DO) for 3G on CDMA networks

4G and 5G Cellular Technologies

- Long Term Evolution (LTE) for 4G
  - Convergence between the GSM and “CDMA” camps – uses Orthogonal Frequency Division Multiple Access (OFDMA)
  - 150 Mbps downlink (nominally)
  - 20 Mbps more typical of actual conditions
- Long Term Evolution (Advanced) (LTE-A)
  - 300 Mbps downlink (nominally)
  - 90 Mbps more typical of actual conditions
- 5G
  - Aims for 1 Gbps but achieves 50 – 300 Mbps
  - Uses hundreds of small antennas in different frequency bands, unlike with current wireless cells
  - Fixed-wireless broadband solutions

Review Activity: Wireless Standards

- IEEE 802.11 Wireless Standards
- IEEE 802.11a and 5 GHz Channel Bandwidth
- IEEE 802.11b/g and 2.4 GHz Channel Bandwidth
- IEEE 802.11n, MIMO, and Channel Bonding
- Wi-Fi 5 and Wi-Fi 6
- Multiuser MIMO
- 2G and 3G Cellular Technologies
- 4G and 5G Cellular Technologies

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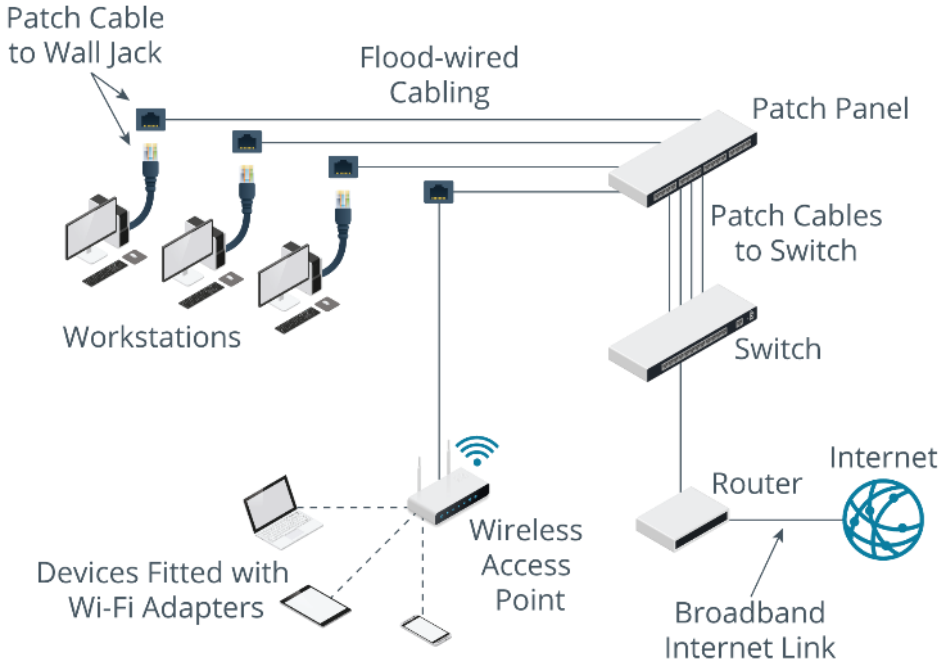
Topic 15B

Install Wireless Networks

Infrastructure Topology and Wireless Access Points

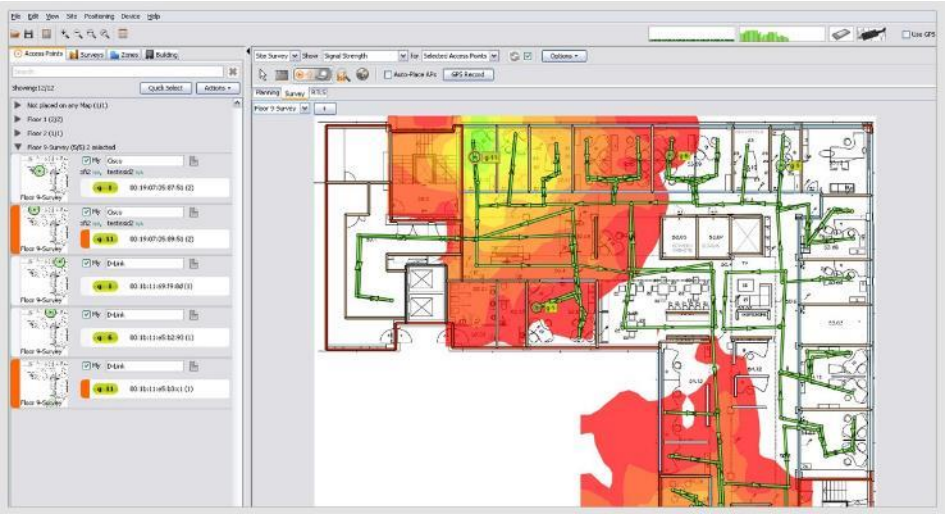
- Access point (AP)
  - Bridges wireless stations (STA) and cabled network
- Basic Service Set (BSS)
  - MAC address of AP is used as Basic Service Set Identifier (BSSID)
  - More than one BSS can be grouped together in Extended Service Set (ESS)



Wireless Site Design

- Service Set Identifier (SSID)
  - Multiple BSSs with the same SSID form an extended service set (ESS)
- SSID broadcast and beacon frame
- Speed and distance requirements
  - Maximum indoor and outdoor ranges
  - Dynamic Rate Switching/Selection (DRS)
  - Built environment obstructions
  - Radio source interference
    - Competing wireless networks
    - Other devices/standards

Site Surveys and Heat Maps



- Inspect floor plan and rooms to identify obstructions
- Plan cells to provide good coverage of the area
  - Device density
  - Bandwidth per device (uplink/downlink)
- Use wireless survey tools to identify signal strength and channel utilization (heat map)

Wireless Roaming and Bridging

- Extended service area (ESA)
  - Distribution System (DS) where wired network connects access points via switches
  - Access points use different channels to avoid interference
  - Access points all use the same SSID (Extended SSID/ESSID) and security configuration
- Disassociation/reassociation
- Wireless Distribution System (WDS)
  - Repeater mode
- Wireless bridges

Wireless LAN Controllers

- Manage tens or hundreds of access points
- Appliance or software solution
- Access point governed by controller is “thin” or “lightweight”
- Lightweight Access Point Protocol (LWAPP)
- VLAN pooling
- Power over Ethernet

Ad Hoc and Mesh Topologies

- Ad hoc
  - Peer-to-peer or Independent Basic Service Set (IBSS)
- Mesh
  - Self-forming network with path discovery and routing

Review Activity: Wireless Network Installation

- Infrastructure Topology and Wireless Access Points
- Wireless Site Design
- Site Surveys and Heat Maps
- Wireless Roaming and Bridging
- Wireless LAN Controllers
- Ad Hoc and Mesh Topologies

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Topic 15C

Troubleshoot Wireless Networks

Wireless Performance Assessment

- Specifications and limitations
- Speed versus throughput
- Distance
  - Radio frequency (RF) attenuation or free space path loss
  - Doubling distance quadruples signal loss
  - dBm measures signal strength as ratio to 1 milliwatt (mw)
  - 1 mw = 0 dBm
  - Negative dBm represents fractional mw values

Signal Strength

- Received Signal Strength Indicator (RSSI)
  - Up to -65 dBm is a good signal
  - -80 dBm is at the limit
- Signal-to-noise ratio (SNR)
- Wi-Fi analyzers

Antenna Types

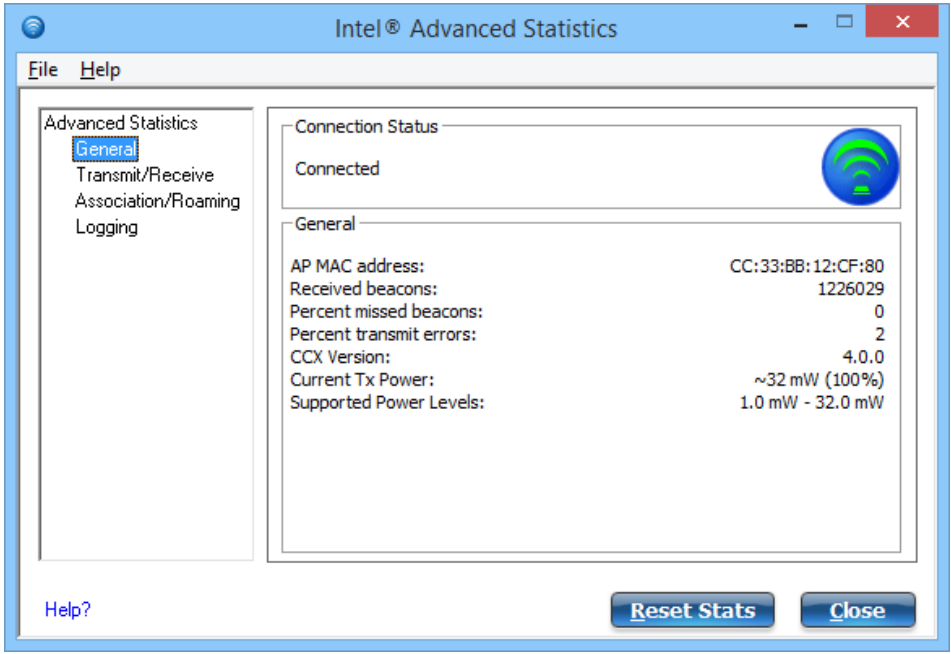
- Omnidirectional
  - Same signal in all directions - torus (donut) shape
- Unidirectional (Yagi and parabolic)
  - Signal can be focused in one direction to increase signal strength
  - Gain measured in dBi (decibel isotropic) units
  - Beamwidth
- Polarization

Insufficient Wireless Coverage Issues

- Insufficient wireless coverage
  - Add access point
  - Configure wireless bridge
- Antenna placement
- Antenna cable attenuation
- Effective isotropic radiated power (EIRP)
  - Transmit Power + Cable Loss + Antenna Gain
  - Maximum transmit power and regulatory limitations
  - Client must be able to transmit back

Channel Utilization and Overlap Issues

- Co-channel interference (CCI)
- Adjacent channel interference (ACI)
- Channel layout
- Transmit power and site survey
- Overlap for roaming
  - Access point association time



Overcapacity Issues

- High number of stations overwhelming access point
- Manage client density
- Analyze associations through controller

Interference Issues

- Reflection/bounce
- Refraction
- Absorption/environmental factors
- Electromagnetic interference (EMI)
  - Spectrum analzyers

Review Activity: Wireless Network Troubleshooting

- Wireless Performance Assessment
- Signal Strength
- Antenna Types
- Insufficient Wireless Coverage Issues
- Channel Utilization and Overlap Issues
- Overcapacity Issues
- Interference Issues

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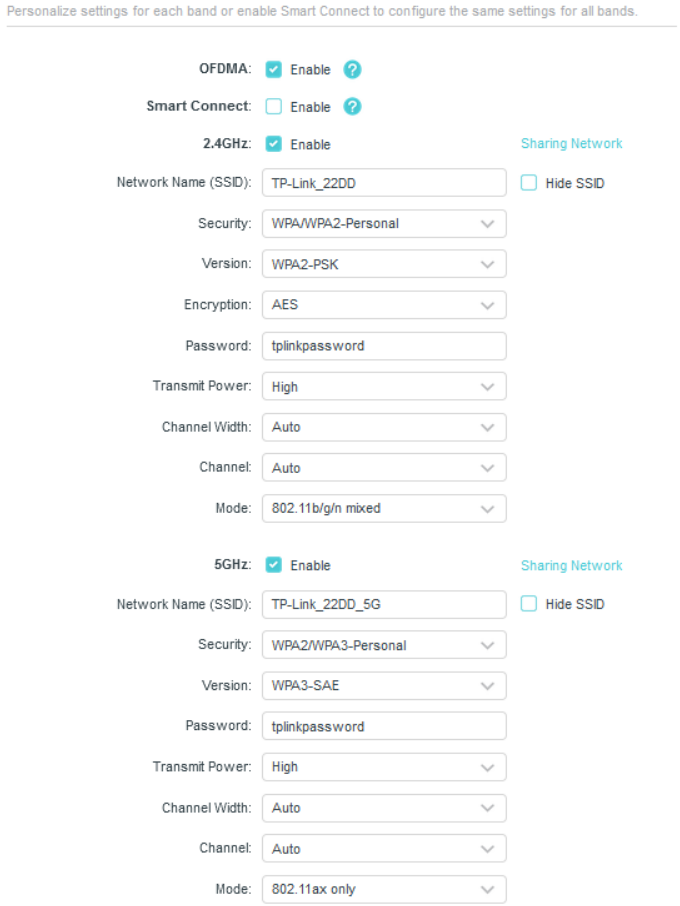
Topic 15D

Configure and Troubleshoot Wireless Security

Wi-Fi Encryption Standards

- Cryptographic protocols and authentication mechanism
- Wi-Fi Protected Access (WPA)
  - Based on RC4 cipher from Wired Equivalent Privacy (WEP)
  - Adds Temporal Key Integrity Protocol (TKIP)
  - Both WEP and WPAv1 are too weak to use safely
- WPA2
  - Uses strong Advanced Encryption Standard (AES) cipher
  - Counter Mode with Cipher Block Chaining Message Authentication Code Protocol (CCMP)
- WPA3



Personal Authentication

- WPA2 Pre-Shared Key Authentication
  - Group authentication
  - All stations configured with same passphrase
  - Passphrase used to generate master encryption key
  - 4-way handshake generates session keys
- WPA3 Personal Authentication
  - Still based on group passphrase
  - Key generation improved by Password Authenticated Key Exchange (PAKE)
  - Simultaneous Authentication of Equals (SAE) generates session keys

Enterprise/IEEE 802.1X Authentication

- Uses Extensible Authentication Protocol (EAP) to authenticate to a network server
- IEEE 802.1X allows only EAP over Wireless (EAPoW) until station is authenticated
- User's network credential is used to generate session keys

Wi-FI Security Configuration Issues

- Wrong SSID and incorrect passphrase issues
  - Incorrect manual configuration of SSID
  - Selecting wrong SSID
- Encryption protocol mismatch issues
  - Check client support for WPA version

Client Disassociation Issues

- Disassociation and deauthentication
  - AP or station can initiate
  - Station might be roaming
- Malicious attacks
  - Spoof frames to disconnect station from WLAN
  - Try to force new connection to rogue AP
  - Sniff authentication process

Open Authentication and Captive Portal Issues

- Access point configured with no security
- No encryption
- Secondary authentication mechanisms
  - Captive portal
- Connection security
  - Use SSL/TLS-protected services (HTTPS and secure email)
  - Use a secured VPN

Review Activity: Wireless Security

- Wi-Fi Encryption Standards
- Personal Authentication
- Enterprise/IEEE 802.1X Authentication
- Wi-FI Security Configuration Issues
- Client Disassociation Issues
- Open Authentication and Captive Portal Issues

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Summary