

# Wi-Fi For Beginners

## Module 3

### Access Points

# Introduction

Hello, my name's Nigel Bowden. Welcome to module 3 of the Wi-Fi for beginners podcast. This is a series of podcasts discussing the fundamentals of wireless LAN networking.

In each episode, we'll take a look at a different aspect of Wi-Fi to build your understanding and knowledge of wireless LAN networks.

Each episode is be accompanied by a set of slides describing the topics covered in that episode. Although you don't need to review these slides whilst listening to the podcast, they will be useful for reviewing the material we discuss and may provide some visual aids to more fully understand some of the concepts and equipment described.

All recordings and supporting material can be found at [WiFiForBeginners.com](https://WiFiForBeginners.com)

# Aims of Podcast Series

- Present the fundamentals of Wi-Fi in a series of audio presentations
  - Hopefully in an easy-to-understand format
  - Useful to those on a daily commute, driving, running etc.
- Who is it aimed at?
  - Most likely IT professionals, students, people interested in career move
- Assumed knowledge:
  - Fundamentals of the 7 layer OSI model
  - Ethernet, switching and routing
  - IP addressing
  - Local Area Networks (LAN)
  - You have reviewed previous episodes! :)
- WiFi in commercial/professional environment - not home

# Who Am I?



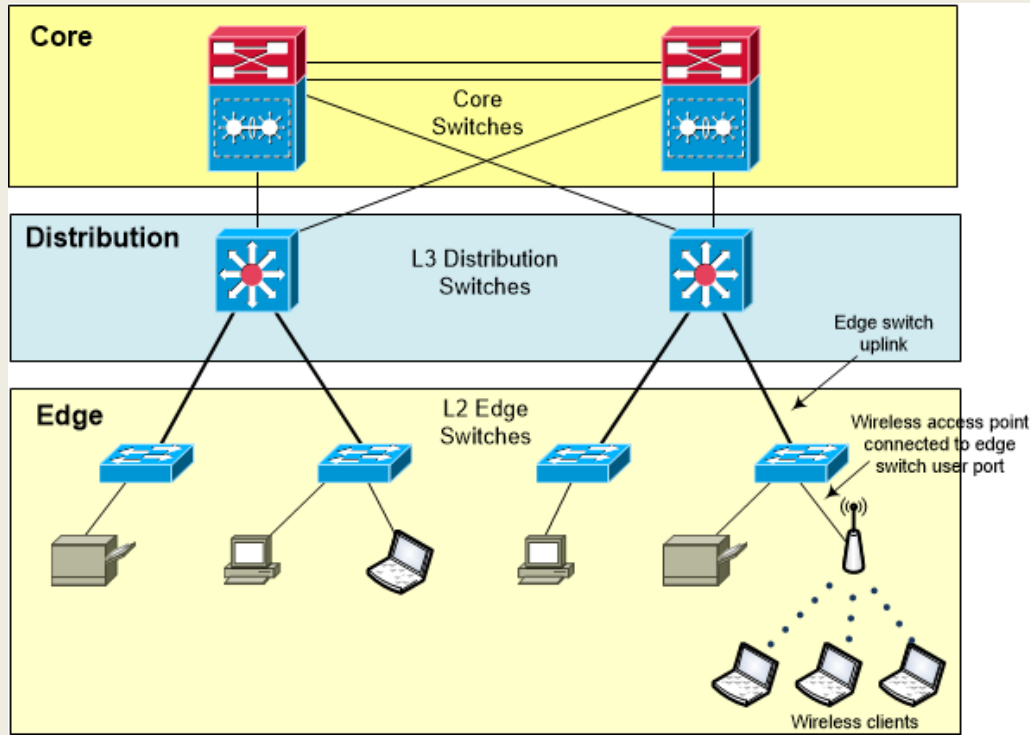
- Nigel Bowden
- UK Based
- IT Industry for 30+ years
- Specializing in Wireless LANs for 5+ years
- Industry certifications:
  - CWNP: Certified Wireless Network Expert (CWNE #135)
  - Cisco CCNP R&S
  - Cisco CCNP Wireless
  - Miscellaneous other vendor specific certs
- Roles: Design, Consultancy & Deployment of WLANs (mainly Cisco)
- Prolific social media participant:
  - @WiFiNigel (Twitter)
  - WiFiNigel.com (Blog)

# In This Module

- What is an Access Point?
- What does an AP look like?
- AP Functions
- AP Components
- AP Installation
- AP Configuration
- IEEE Standards

# Reference Model

Extended edge (access point):



# What is an access point?



# What is an access point?

- Primary job is to convert radio frequency signals carrying data to/from clients into data to flow through its Ethernet port
- Acts as a “bridge” between clients data (over RF link) and the Ethernet network
  - converts between 802.11 & 802.3 frames
  - both are layer 2 protocols - layer 3 (IP) unaware of data link method
- Ethernet network is edge layer of wired network
- Two halves:
  - wireless : radio & antenna
  - wired: Ethernet port



# What is an access point?

- Often more than one radio as AP may support more than one band
  - 2.4GHz
  - 5GHz
- Multiple antennas - generally 2 or more
  - internal
  - external
- Coverage provided by each access point limited, so generally have them installed throughout a facility
  - Generally suspended from ceilings or walls

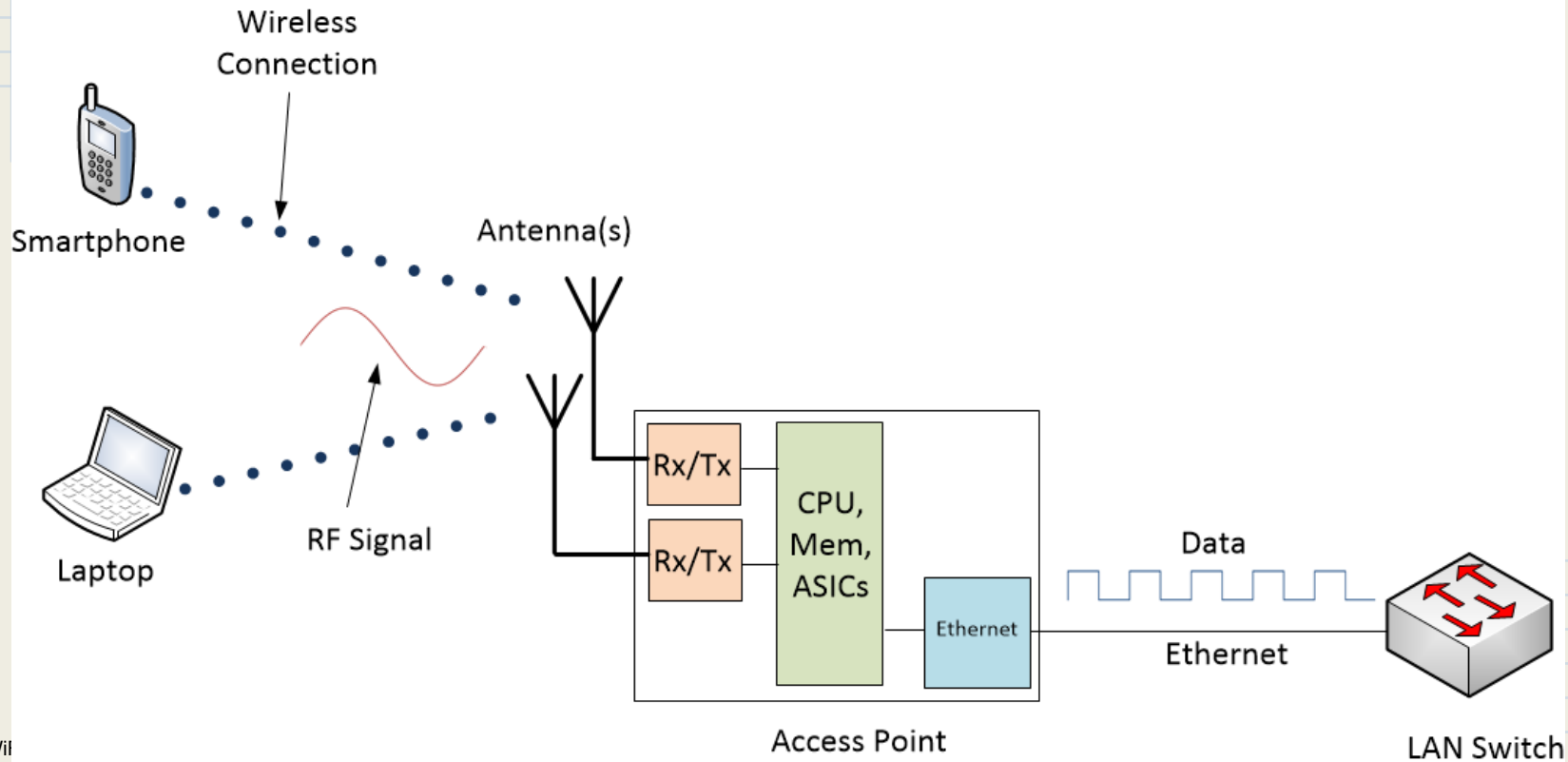
# Access Points: Appearance



# Access Points: Appearance



# AP Functions & Components



# AP Functions

- Core function:
  - Convert “modulated” RF signals to or from clients in to Ethernet data
    - layer 2 translation: 802.11 → 802.3
  - Allows client device data to be handled by wired network even though using a wireless link
- Modulation: change a characteristic of the radio signal to represent data
  - an RF signal on its own carries no data - just an AC signal
  - if we can change it in response to an incoming binary data stream of ‘1’s and ‘0’s, we can use it to convey binary data
  - example, use two frequencies very close to each other - one represents ‘1’, other represents ‘0’.
  - shifting between two frequencies called FSK (Frequency Shift Keying)
  - Allows us to represent binary data over a radio link

# AP Components: Antenna

- Antennas
  - All APs have at least one antenna
  - used to receive and transmit signals to and from clients
  - APs may have more than one radio (generally two) to allow operation on 2 bands
    - at least one antenna per radio
  - Modern APs use techniques to transmit and receive at higher speeds and require 2, 3 or 4 antennas per radio (up to 8 for 2 radio AP!)
  - Antennas may be
    - internal to an AP (you can't see them) - inside AP mounted on AP chassis of main circuit board
    - external - can be screwed on to an external connector or connected to an external antenna unit

# AP Components: Antenna

- Antennas
  - Which to use? Internal/External
    - Performance/Design considerations
    - Aesthetic considerations
  - In simple terms, two types of antenna we can use:
    - Omni-directional
    - Directional
  - Generally, internal antennas tend to be omnidirectional in nature
  - External antennas may be omnidirectional or directional
    - selected as appropriate for the venue
    - attached via external connectors and cables

# AP Components: Antenna

- Antennas - Omnidirectional
  - AP internal antennas generally omnidirectional radiation pattern
  - Radiated energy travels in all directions
  - Think of light bulb hanging from ceiling radiating light in all directions, or
  - Dropping a pebble in to a pond





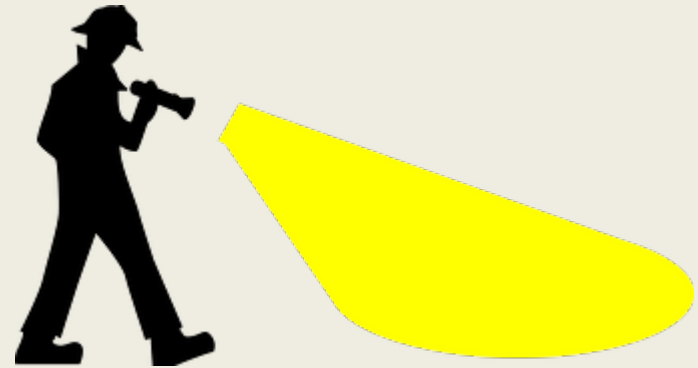
# AP Components: Antenna



Courtesy of George Stefanwick: <http://www.my80211.com/home/2010/5/15/take-a-peek-inside-ciscos-wireless-gear-literally.html>

# AP Components: Antenna

- Antennas - directional
  - Focus RF energy towards one direction
  - Analogy of single lamp (omnidirectional) compared to torch with reflector behind lamp



# AP Components: Radio

- Radio:
  - Signal from clients are received by antenna and passed to “receiver” circuitry of AP radio
  - Signals to be sent to client from AP generated by the “transmitter” circuitry of the AP
  - Each AP radio can transmit or receive signals
    - even though a radio may have multiple antennas, only transmitting or receiving at any point in time
    - known as “half duplex”
      - talking or listening, but never both
    - MAJOR difference between WiFi and Ethernet networks:
      - Ethernet: full duplex, tx & rx and same time
      - WiFi: half duplex: tx or rx, but never both - lower speed

# AP Components: Radio

- Radio:
  - Most times, an AP radio can only operate on one band (fixed to one band)
    - 2.4GHz
    - 5GHz
  - If AP has two radios, generally have one radio which can operate on 2.4GHz band, one that operates on 5GHz band
  - Although both radio are half duplex, both radios may pass data at the same time, independant of each other
    - AP will tx & rx data on both the 5GHz and 2.4GHz radio at same time

# AP Components

- CPU, Memory, ASICs
  - Although we have talked about core function of converting wireless data to Ethernet, many other functions
    - traffic filtering
    - rate limiting
    - IP stack
    - VLAN support etc...
  - Like any other processor-based item, needs memory to operate
  - Often has custom silicon (ASICs) to perform in-silicon functions for high-speed or specialized functions

# AP Components: Ethernet

- Ethernet interface
  - Provides connection to the edge of the wired network for user data and management/control traffic
  - Speed: 1Gbps or greater (mGig)
    - Higher rates support by WiFi now require Gig Ethernet connection
  - POE: Many APs powered by power over Ethernet as locally providing mains power cost prohibitive
    - Two main POE standards
      - 802.3af (up to 15.4W)
      - 802.3at (up to 25.2W)
    - Most recent standard APs tend to need higher spec of 802.3at
      - (may need new switches!)

# AP Components: Console

- Console:
  - Many APs have a serial console port
    - Configuration - initial setup
    - Diagnosis of issues
    - Out of band management
  - Access speeds of console ports vary across products:
    - 9600bps - 115200bps

# AP Installation

- As coverage area of each AP limited, need to deploy APs throughout a facility
  - provide “cells” or pools of coverage
  - client devices will “roam” from cell to cell as a user moves through a facility
- Generally, want to mount APs high up - e.g. ceiling height
  - light bulb analogy - think how light travels
  - if you can see AP, AP can see you
- APs often mounted on
  - ceilings - suspended ceiling grids
    - many APs supplied with mounting kit for this
  - solid ceilings
  - walls



# AP Installation

- APs can also be mounted on:
  - poles
  - external walls
  - beams
  - ....expect to find them in unusual places!
- Rules of thumb:
  - Keep them high up, in line of sight of clients
  - Avoid putting near metal objects
  - Avoid putting behind obstructions (reduce available signal)
  - Avoid putting near to known sources of interference
    - e.g. microwave ovens, DECT phone systems, security cameras
  - Avoid putting in closets, ceiling voids, boxes

# AP Installation

- Cabling
  - Need to remember cable length restrictions when installing APs
    - Need to keep within 100m limit (must support 1G or greater)
    - Is there going to be a cable run greater than 100m from proposed AP position to switch? New switch required?
      - Remember vertical distances & patch lead lengths at each end
- Power
  - Often, best to use power over Ethernet switches to supply power over the Ethernet cable to the AP
  - Local mains socket to each AP gets very expensive
  - Can also use power injectors at the switch if don't have POE switch ports

# AP Indicator Lamps

- Most APs have some type of indicator lamp to indicate some type of status, including:
  - Powered on
  - Radio(s) active
  - Data received/sent
  - Loading software
  - Disconnected from network
- Each AP has different number of indicators, different colors, different flashing sequences
  - very useful to know for diagnostics
  - check vendor docs
- Sometimes need to turn them off - e.g. schools & hospitals

# AP Configuration

- Basic configuration:
  - Management IP address
    - Needed to allow remote access to AP:
      - Web GUI
      - CLI (SSH)
      - Wireless controller access to AP
      - Network management access to AP
    - Generally initially configure via
      - AP physical console port
        - maybe during pre-build of APs?
      - DHCP
        - Need to provide scope & possible scope options

# AP Configuration

- Additional configuration:
  - May be completed from:
    - Wireless LAN controller, Web GUI, CLI (SSH), Management platform
  - SSID
    - Service Set Identifier
      - “Name” of the network/service
      - Allows users to select the network they require
      - Same SSID used across all APs so users may remain connected to same service as they move about (“roam”)
      - May have number of SSIDs for different services
        - AP may broadcast a number of SSIDs at same time
      - Best to keep number of SSIDs to 4 or less

# AP Configuration

- Additional configuration:
  - VLANs
    - APs support VLANs for segmentation of traffic
    - Often map an SSID to a VLAN
      - Example
        - “Corp” SSID → VLAN 10
        - “Guest” SSID → VLAN 20
        - “BYOD” SSID → VLAN 30

# AP Configuration

- Additional configuration:
  - Security
    - Security requirements may be different for each SSID, so configured per-SSID
    - Many options for security which we will look at later in this series
    - Options include:
      - WPA2 Personal (Pre-shared key)
      - WPA2 Enterprise (802.1x)
      - Web Authentication
    - Note: MAC address filtering & SSID hiding are not security
    - Obviously, very important to get right in terms of correct configuration and selection of appropriate security option

# AP Configuration

- Advanced configuration:
  - Many other options available for advanced features, these include:
    - Radio settings
      - Channel settings
      - Power levels
      - Standards/speeds supported
    - Traffic management
      - Rate limiting
      - Application control
      - ACLs/Firewall
    - Security:
      - RADIUS
      - TACACS



# AP Configuration

- Advanced configuration:
  - Many other options available for advanced features, these include:
    - Guest web portals
    - Guest account management

# Standards Support

- 802.11 standard created by Institute of Electrical and Electronic Engineers: IEEE
  - 802.11 group part of the overall “802” IEEE LAN/MAN committee
  - “.11” signifies WLAN standard - all WLAN standards are 802.11 followed by suffix (e.g. 802.11n)
  - OSI layer 1 & 2 standard only
  - Standard is constantly evolving amendments added
  - Amendments are added and are given a letter designation
  - First 802.11 standard just called “802.11” - release in 1997
  - Amendments given designation in alphabetic order: 802.11a, 802.11b etc.
  - When single letters ran out, started doubling up: 802.11aa, 802.11ab, 802.11ac

# Standards Support

- 802.11 amendments relate to a whole variety of updates to the 802.11 standard:
  - 802.11e - QoS
  - 802.11i - Security update
  - 802.11a- Orthogonal Frequency Division Multiplexing on 5GHz band
- Support for individual amendments used as a reference to describe the capabilities of APs or clients
- “Well known” standards:
  - 802.11b - speeds up to 11Mbps on 2.4GHz
  - 802.11a - speeds up to 54Mbps on 5GHz
  - 802.11g - speeds up to 54Mbps on 2.4GHz
  - 802.11n - 2.4GHz (up to 215Mbps) and 5GHz (up to 450Mbps)
  - 802.11ac - speeds up to 1.3Gbps on 5GHz

# Summary

- What is an Access Point?
  - High level view of an AP
- What does an AP look like?
  - Looked at size & shape
- AP Functions
  - Converting RF signals to/from Ethernet
  - Looked at concept of modulation of an RF signal
- AP Components
  - Antennas, radios, CPU & components, Ethernet port, console port
- AP installation
  - Mount up high, provide cells of coverage, avoid obstructions, be mindful of cabling requirements and power requirements

# Summary

- AP Configuration
  - Basic IP configuration, console access, SSIDs, VLANs, Security
  - Advanced configuration: RF settings, traffic management, admin authentication
- IEEE Standards
  - 802.11 IEEE committee defines WLAN standard
  - Additions made through amendments which are give letter designation
  - Amendment support often used when describing device capabilities
  - 802.11 OSI layer 1 & 2 only