Purpose of wireless networks:

- Mobility- the ability to move freely using our devices
- Flexibility- the ability to use our devices anywhere within coverage range

Access points: are pan wan lan they're station that transmit and receive data they connect users to other users within a network

Service Set Identifier (SSID): Is name associated with 802.11 wireless local area network it is essential the name to distinguish Wi-Fi networks. Usually a string of text. Allows multiple access points to act as single network

Wifi Frequency Bands: 2.4 GHz more wifi coverage or 5 GHz for faster speed. Within bands you have channels

- **2.4Ghz frequency band:**
  - 14 channels available, each 20Mhz wide and only 3 channels do not overlap **(1,6,11)**
  - Better for propagation and object penetration properties (wifi coverage)
  - Alternate between the 3 channels to avoid overlap in large deployment
- **5Ghz frequency band:**
  - 24 channels available and channels don't overlap
  - Less crowed so faster but object penetration and range (wifi coverage) is lower.

- **Wireless channel (Frequency):** is the medium through which our wireless networks can send and receive data. Has to be different or minimal on same channel to reduce the chance of collisions and congestion occurring with other students.

Wireless security: is the prevention of unauthorized access or damage through encryption 802.11

- **WEP:** Different levels of encryption based on key strength. A computer is given a key that is allowed to access wireless network but vulnerable because the first bytes of output keystream are non-random therefore you can break it and piece together all packets and find key
- **WPA:** Use a temporary key integrated protocol to encrypt. Each packet gets unique encryption so even if you piece a packet it's just for a single packet instead of all
- **WPA 2:** Uses advanced encryption standard which has a strong algorithm harder to break and counter mode with block chaining message authentication code protocol (replaces temporal key protocol). Disadvantage uses a lot of processing power to protocol so some hardware doesn't suit it

Differences with Categories of wireless technologies:

*Important is distant being that **https://www.techopedia.com/2/29090/networks/lanwanman-an-overview-of-network-types

	PAN	LAN	MAN	WAN
Standards	Bluetooth, 802.11ad	802.11	802.11 802.16	GSM, CDMA, LTE, ... Satellite
Speed	Up to 7 Gbps	11 Mbps to 1+ Gbps	10 - 100+ Mbps	10 kbps – 50 Mbps
Range	Short	Medium	Medium-Long	Long
Applications	Peer-to-Peer	Enterprise nets	Last mile access	Mobile data

EG: PAN (wireless headphones, mouse) Lan(office wifi) wan(college campuses)

Personal Area Network: (PAN)

- **Radio Frequency Identification:** (think anz tap to pay)
  - Wireless technology used for Identification and tracking
  - Uses 13.56Mhz and 125Mhz spectrum
  - Passive and active versions depending on range
  - For: building access, public transport payment and animal microchips
- **Near-Field communication:**
  - Set of communication protocols that allows two devices to communicate
  - Short range wireless technology related to Radio frequency ID
  - In most smart phones
  - For: Contactless payment, initialising Wi-Fi/Bluetooth connection, payments (difference is with this it is programmable. So we program a acceptance screen etc)
- **Bluetooth:**
  - Known as IEEE 802.15.1
  - Replaces cables over short distances <10m
  - For: headphones, microphones, and mice
- **ZigBee:**
  - 802.15.4
  - Used to support sensor networks and in many internet of things/smartphone connected appliances
  - For: light bulbs to create a network with all devices in home so they can work together

Local Area Network:

- **Wi-Fi:**
  - Designed to provide network access around homes or offices
  - Operates on 2.4ghz and 5ghz frequency range
  - For: smartphones, tv and internet access, printers

Wireless Area Network:

- **3G & HSDPA:**

    - Wireless area network for mobile networks usually operated by telecommunication providers
    - Data transfer→ 384kbps and 42.3MB
    - For: mobile internet access by smartphones and mobile broadband modems
- **Long term evolution (4G)**
    - Successor to 3G
    - Maximum download speed of 300Mbps
    - Frequencies in use vary by country
    - Superseded by LTE advanced which allows 1GPS
    - For: mobile internet access by smartphones and mobile broadband modems
- **5G**
    - Successor to 4G
    - Download speeds of 100Mbps -20Gbps
    - Goal is to reduce latency (1ms)
    - Improves network density without increasing congestion
- Licensed Microwave (ADD)
- **Satellite:**
    - Slower and higher latency than other wireless technologies (<=20Mbps). Since we need to communicate with station and the speed
    - Type types: Geosynchronous orbit and low earth orbit
    - For: provide internet connectivity to very remote areas, aircraft and ships

Properties of Wireless:

- **Wireless Range:**
    - So with wireless technologies they suffer from attenuation the most this concept is called: **Inverse square law**
        - Every time the distance doubles the energy from wireless transmission is spread over four times the area this results in signal strength being reduced by ¼
        - Therefore, short range technologies (3G/Wifi in terms of range) will be faster than long range ones
    - We can improve wireless transmission/reduce attenuation by increasing **transmission power** but regulated by
        - Licensing restriction + power requirements and constraints in order to reduce congestion and interfere with other users
        - But requires more power usage so with phone it may drain battery
    - We can also improve wireless transmission/reduce attenuation through **frequencies:**
        - Frequencies are wireless transmission using electromagnetic spectrum
        - Lower frequencies mean the transmission can propagate further distance and higher frequencies mean it's for speed
        - 900mhz 2.4ghz 5ghz for unlicensed used but they have rules like maximum transmission power and other rules

802.11 (WIFI) Standards

- Original Wifi Standards in 1997
- Provides: 1Mbps and 2Mbps data rate/link rate
- Frequency band: 2.4GHz

802.11a

- Standardised in 1999 by IEEE introduces **orthogonal frequency division multiplexing** (ADLS to vdls everything use)
- Provides: <=54Mbps data rate /link rate
- Frequency band: 5Ghz

802.11b

- Standardised by IEEE in 1999 first commonly used wifi standards
- Provides: <11Mbps data rate /link rate
- Frequency band: 2.4Ghz (propagated better)

802.11g

- Standardised by IEEE 2003 and backwards compatible to b
- Provides: <=54Mbps data rate/link rate
- Frequency band: 2.4Ghz (propagated better) + **orthogonal frequency division multiplexing**

802.11n

- Standardised by IEEE 2009 + Introduces Multiple-Input Multipe-Output (multiple antennas) + channel bonding (multiple channels) + **OFDM**
- Provides: <=600Mbps data rate/link rate
- Frequency band: 2.4Ghz (propagated better) + 5Ghz

802.11ac

- Standardised by IEEE 2014 + Introduces Multi User -Multiple-Input Multipe-Output (multiple antennas + **ODFM**
- Provides: <=6.9Gbps data rate/link rate
- Frequency band: 5Ghz (propagated better)

802.11ax

- Standardised by IEEE late 2019
- Provides: <=10Gbps data rate/link rate
- Frequency band: 2.4Ghz (propagated better) + 5Ghz

802.11 Attributes:

- Network types
- SSID

- Frequency channels/Bands
- Security

802.11 network modes:

- **Infrastructure mode:** describes networks that have a dedicated wireless access point through which all devices will communicate (think router and how all devices communicate)
- **Ad-hoc networks:** devices communicate directly without the need of access point (peer to peer)

Link rate: maximum speed at which data can be sent over a link

Throughput: total amount of data transferred per second (current not potential)

Goodput: is the amount of application data transferred per second (without any lower layer protocol)

802.11 Performance Overhead/Overhead factors: Are extra resources needed to get performance (data transfer) to potential the link rate. The link rate will general be < goodput and throughput. *The overheads that affects and limits performance are*

Wifi (Not Ethernet)

- **Link layer acknowledgement for every packet we send reduces full performance as it takes time.**
- **CSMA/CA: so the packets sent may collide in traffic which reduces performance**
- Larger packet headers
- Channel conditions-
    - **Distance from access point as attenuation causes it.**
    - **Contention from other nearby devices because the access point can only communicate with one device at a time and when we add more devices we make the device have to wait longer in order to complete our task**
    - External interference

Add: Hardware controller, software control, clojud control??