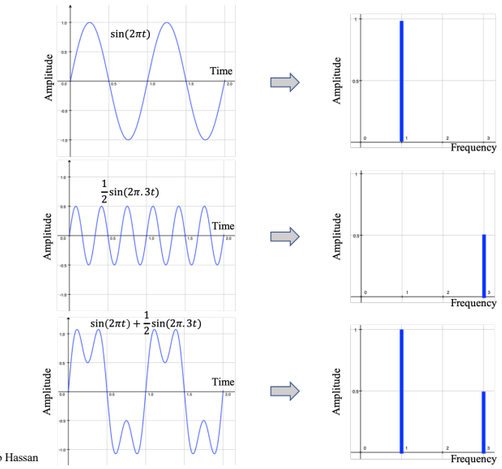
Well-known frequencies & wavelengths

- The higher the frequency, the smaller the wavelength
- 900 MHz has a wavelength of 33.33 cm
- 2.4 GHz has a wavelength of 12.5 cm
- 60 Ghz has a wavelength of only 5 mm (this technology is called *millimeter wave or mmWave*)

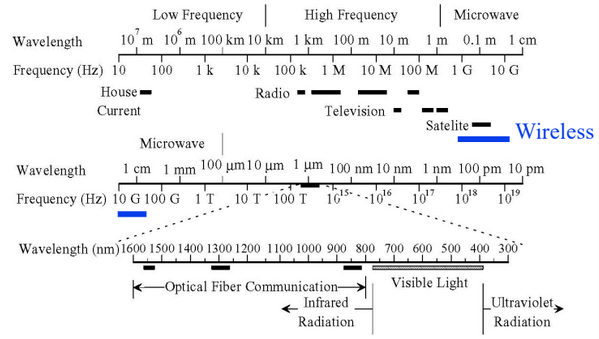
Time and Frequency Domains



Electromagnetic Spectrum

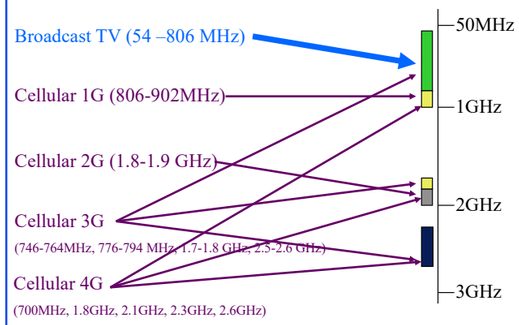
- Wireless transmissions use the airwaves
  - Airwaves are radio frequencies
- Useful frequencies constitute the Spectrum
- Spectrum is 'virtual'
  - We cannot touch and feel
- A gift from nature (the force field)
  - Has been there ever since earth was created
- A (limited) natural resource

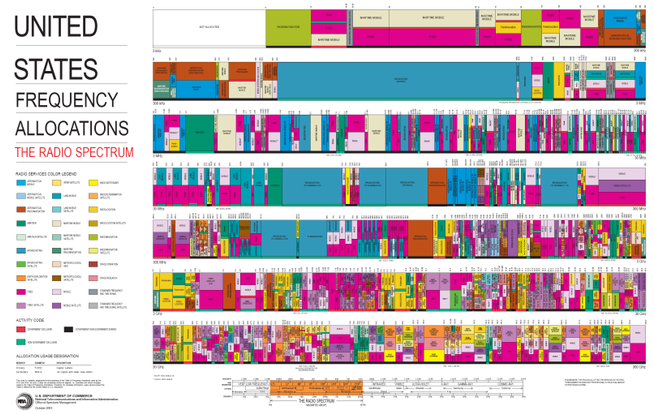
Electromagnetic Spectrum



- Wireless communication mostly uses 100 kHz to 6 GHz
- > 6 GHz are currently being explored and 60 GHz is used in some latest WiFi products

Spectrum use by TV and cellular services





Spectrum regulation and licensing

- Many users use the same airspace
  - Recipe for collision
  - No one would get anything useful done
- Spectrum use is highly regulated
  - By govt. authorities (eg FCC in the USA)
- Spectrum is often licensed
  - By big companies, eg Telstra
  - Gives exclusive rights to certain freq. bands
  - Interference avoidance by regulation

Spectrum allocation

- Bulk of it reserved for government use
  - Scientific exploration
  - Public safety
  - Military
- Some for commercial services
  - TV broadcast
  - Mobile phone
- Some for free-to-use
  - High-speed wireless local area network (WiFi)
  - Cordless phone handsets at home
  - Can you name a few more?

Key principles of spectrum allocation

- Maximize spectrum utilization
- Spectrum made available to new technologies and services
  - Adapt to new market needs
- Fair licensing
- Promote competition
- Ensure spectrum availability for public safety, health, defense, scientific experiments…