Computer Systems

Lecture 11 : Wireless Technologies

Wireless Introduction

There are many ways to connect devices together or to the internet or any other network.

In the past cables were always required which may prohibit devices communicating with each other.

For ease of use, connecting devices using any form of wireless technology makes our lives much easier. Why?

There are many types of wireless technologies available, each has there own use for different scenarios.

Standards

- You may from time to time hear things like 802.11b/802.11g/802.11n or 802.15
- These are standards or protocols.
- Every communication technology has its own set of standards.
- Manufacturers must adhere to these standards for their devices to communicate with other devices using the same standards.
- Examples :
  - 802.11 – Wi-Fi
  - 802.15 - Bluetooth

Wi-Fi

- Wi-Fi is a wireless technology that provides a simple connection from anywhere within the range of a base station using radio waves.
- Connection distances of 300 feet (91 meters) or more, depending on the environment.
- Ease of access makes Wi-Fi a simple solution for network connectivity.
- Wi-Fi is based on IEEE 802.11 networking standards and specs.
- Four major Wi-Fi, 802.11 standards:
  - 802.11a
  - 802.11b
  - 802.11g
  - 802.11n

Wi-Fi

- 1971 first wireless packet network – ALOHAnet.
- In the 1990's, Dr John O'Sullivan found ways to make processing data more effective and efficient through digital hardware, which led to the Wi-Fi that we use today.
- 1993 first Campus wireless network - Carnegie Mellon University.
- Uses the 2.4 gigahertz UHF and 5 gigahertz SHF ISM radio bands.
- Wi-Fi is sometimes written as WiFi, Wifi, or wifi, but these are not approved by the Wi-Fi Alliance.
- Issues :
  - Security
  - Interference
  - Health

Wireless Ethernet Standards

	Bandwidth	Frequency	Range	Interoperability
802.11a	Up to 54 Mbps	5 GHz band	100 feet (30 meters)	Not interoperable with 802.11b, 802.11g, or 802.11n
802.11b	Up to 11 Mbps	2.4 GHz band	100 feet (30 meters)	Interoperable with 802.11g
802.11g	Up to 54 Mbps	2.4 GHz band	100 feet (30 meters)	Interoperable with 802.11b
802.11n	Up to 540 Mbps	2.4 GHz band	164 feet (50 meters)	Interoperable with 802.11b and 802.11g
802.15.1 Bluetooth	Up to 2 Mbps	2.4 GHz band or 5 GHz band	30 feet (10 meters)	Not interoperable with any other 802.11

WiFi

Laptops access the internet by using wireless adapters

- **Mini-PCI** - Commonly used by older laptops. Mini-PCI cards have 124 pins and are capable of 802.11a, 802.11b and 802.11g wireless LAN connection standards.

- **Mini-PCIe** - Most common type of wireless card in laptops. Mini-PCIe cards have 54 pins and support all wireless LAN standards.

- **PCI Express Micro** - Commonly found in newer and smaller laptops, such as Ultrabooks, because they are half the size of Mini-PCIe cards.

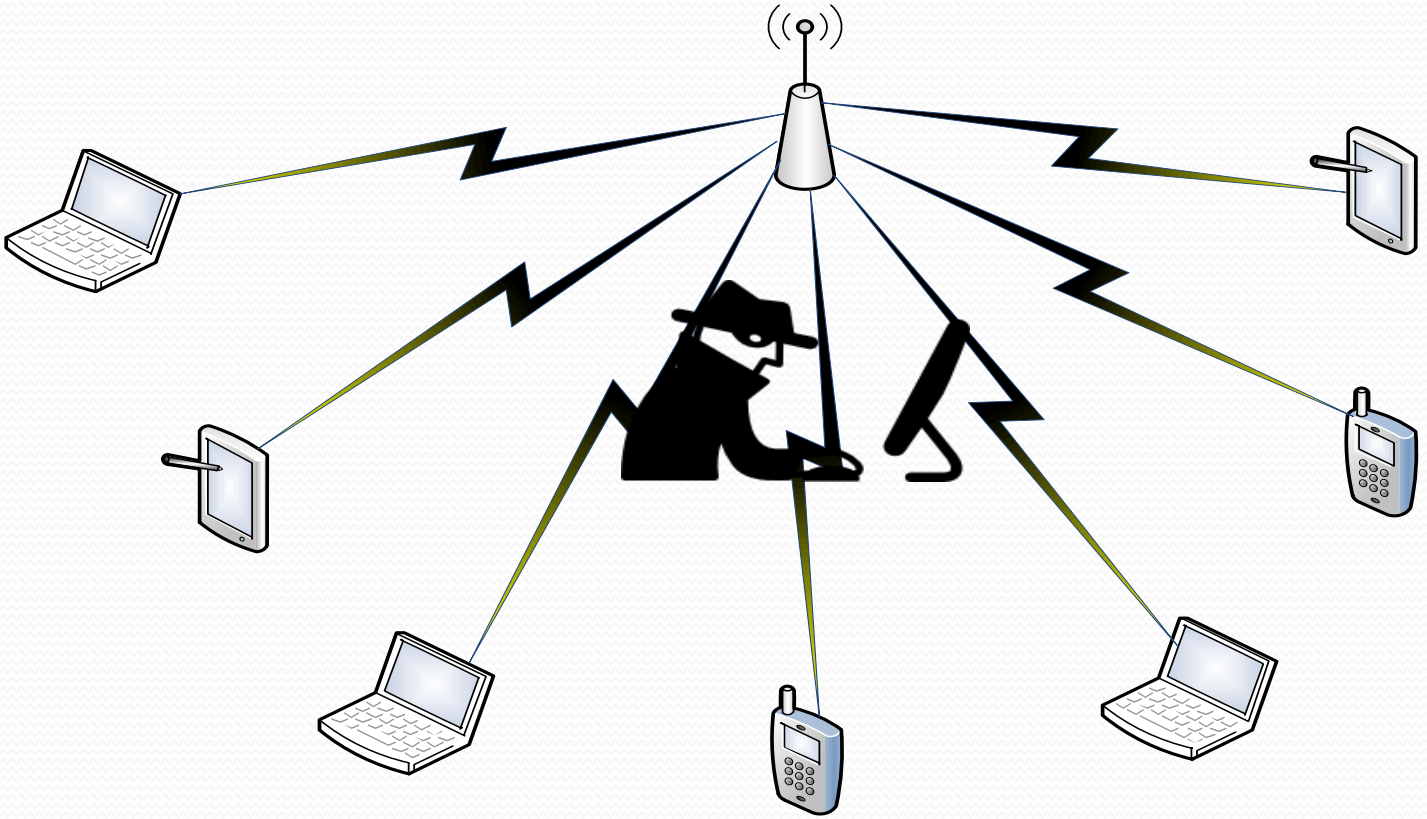
Wireless Terms

- WLAN
  - A group of wireless devices that connect to access points within a specified area.
- Access Point (AP)
  - Provide network access to wireless devices such as laptops and mobiles.
- Roaming
  - Used to describe a portable communications device moving its network connection from one fixed access point to another.

Wi-Fi V's Cables

- Which is faster, Wi-Fi or Wired?
- What about using a Wi-Fi Extender to increase the coverage?
- How do I test the speed of my Wi-Fi?
  - www.speedtest.net

Wireless Security



- Why the need for wireless security??

Wireless Security Modes

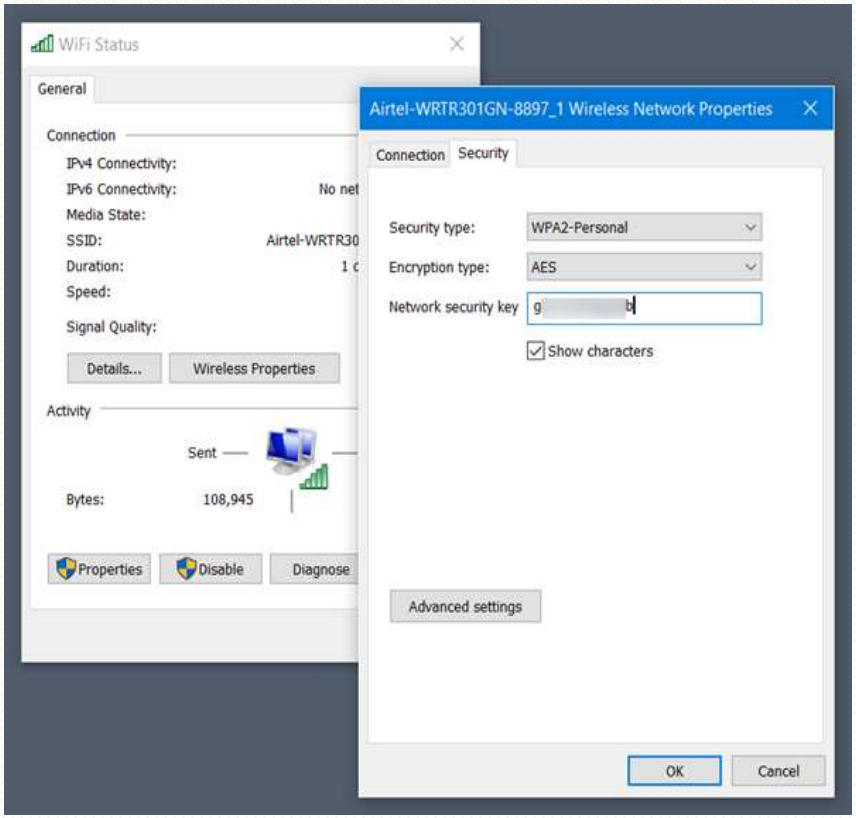
- **Wired Equivalent Privacy (WEP)** – The first generation security standard for wireless. This encrypts the broadcast data between the wireless access point and the client using a 64-bit or 128-bit encryption key. Attackers quickly discovered that WEP encryption was easy to break.

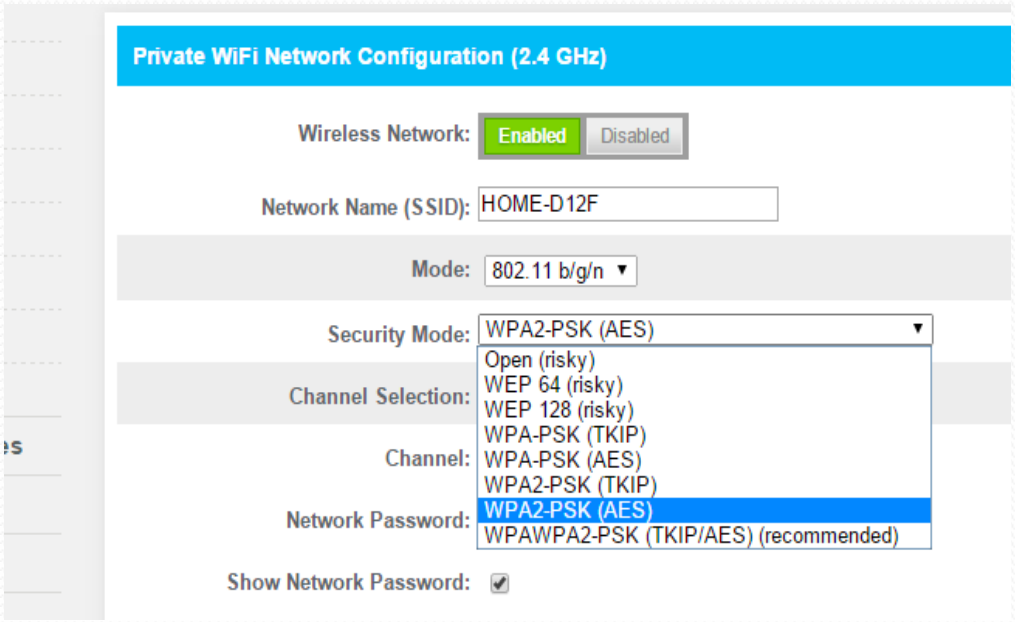
- **Wi-Fi Protected Access (WPA)** An improved version of WEP**,** uses much stronger encryption. Replaced by WPA2.

- **Wi-Fi Protected Access 2 (WPA2)** WPA2 supports robust encryption, providing government-grade security. WPA2 can be enabled with password authentication (Personal) or server authentication (Enterprise).

Wireless Security Modes

- To check what security mode you are using on your laptop, go to the wireless properties.
- On your router, look under security

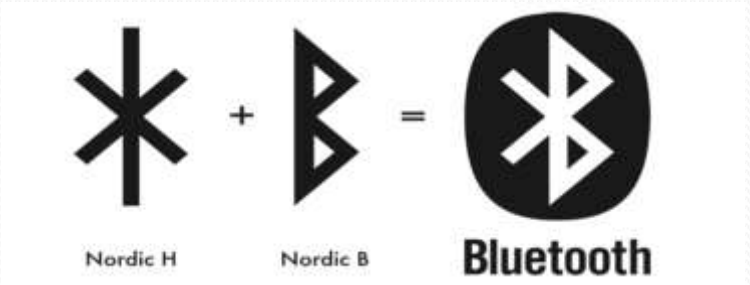




A Wi-Fi Hotspot

Bluetooth

- Developed by Ericsson in 1994.
- Named after 10th century Viking King Harald "Blåtand" Gormsson, King of Denmark (Blåtand is Danish for Bluetooth).
- Bluetooth is a standard for a small, cheap radio chip to be plugged into computers, printers, mobile phones, etc.
- Bluetooth chip is designed to replace cables. Information normally carried by the cable, is transmitted at a special frequency to a receiver Bluetooth chip.
- These devices can form a quick ad-hoc secure network and start communication, even when mobile.



Bluetooth

- A short-range wireless technology designed to eliminate the need for cables between portable or fixed-configuration devices.
- A Bluetooth device can connect up to seven other Bluetooth devices to create a Wireless Personal Area Network (WPAN).
- Facilitate both data & voice communications.
- Low power, low cost, and small size.

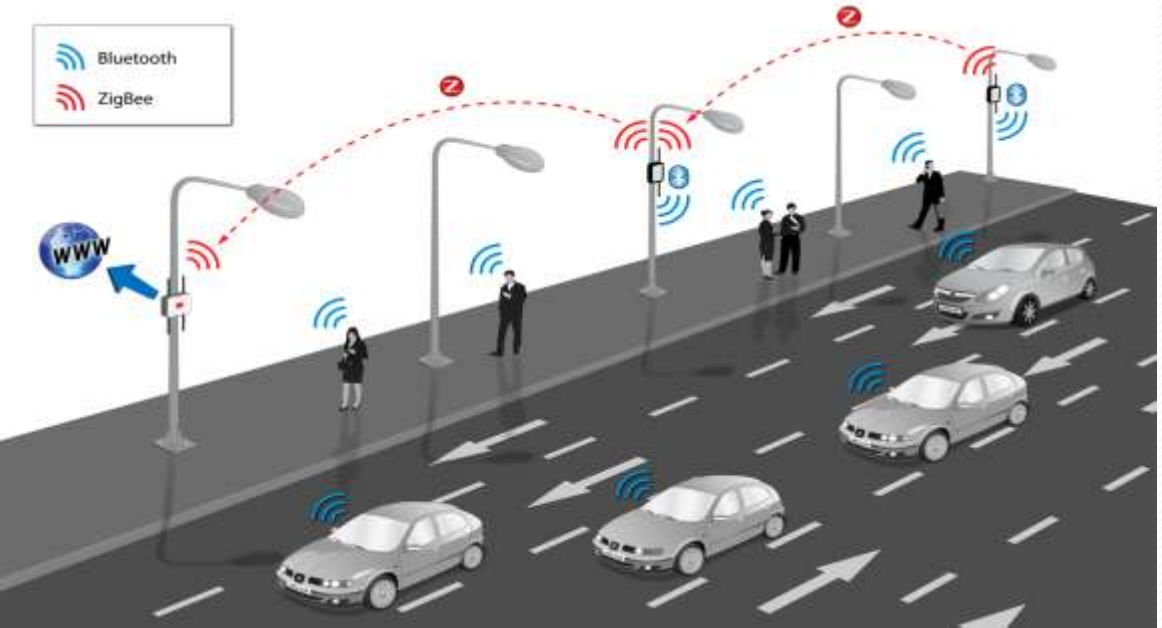
Version	Max Speed	Max Range
3.0	25 Mbit/s	32 feet
4.0	25 Mbit/s	200 feet
5	50 Mbit/s	800 feet

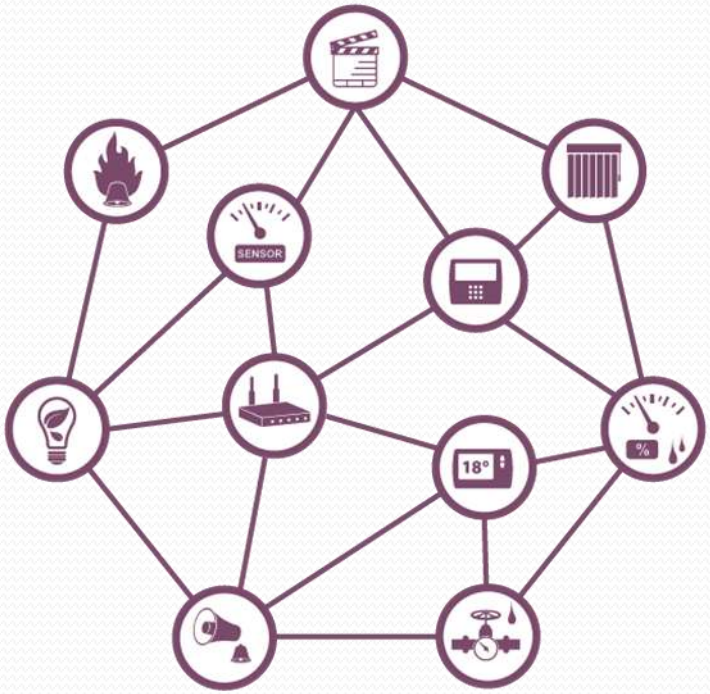
ZigBee / Z Wave

- Two different types of wireless technology available for smart device communication / home automation.
- Low strength, low power, low bandwidth.
- WiFi for large amount of data, Bluetooth for medium amount of data, ZigBee and Z-Wave for small data.
- ZigBee and Z-Wave are completely different and do not work with each other. So for devices to communicate with each other, they are all ZigBee devices or Z-Wave devices.
- ZigBee is an open standard where as Z Wave is not.

ZigBee / Z Wave

- ZigBee and Z-Wave signals use a mesh network to function.
- For data to get to it's destination, it can hope from one device to another until it arrives at it's destination or a router to forward it on.
- Devices must be close by each other.





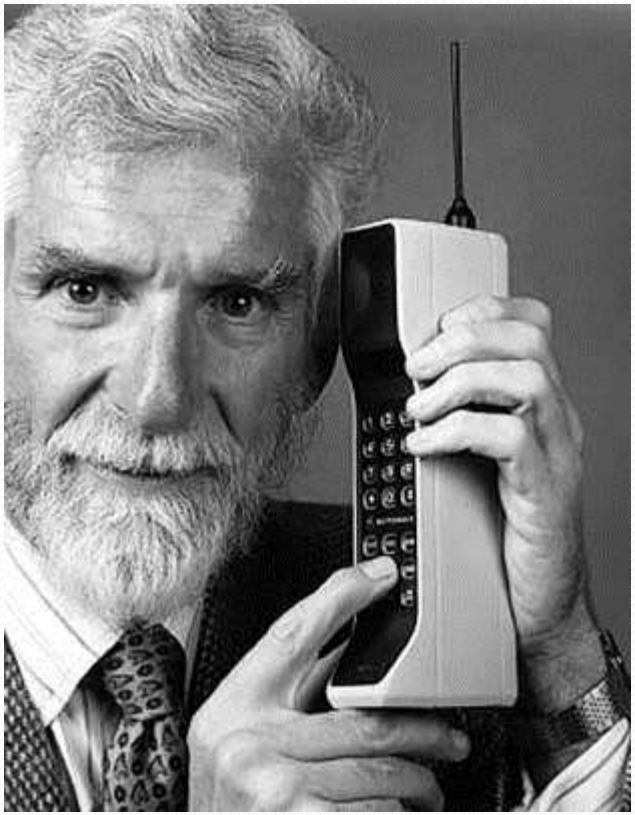
Cellular Technology

- Cellular technology enables the transfer of voice, video, and data. With a cellular WAN adapter installed, a laptop user can access the Internet over the cellular network.
- Although slower than DSL and cable connections, cellular WANs are still fast enough to be classified as a high-speed connection.
- Different Generations has been released:
  - 1G
  - 2G
  - 2.5G
  - 3G
  - 3.5G
  - 4G
  - 5G

Cellular Technology

- To connect a laptop to a cellular WAN, you install an adapter that is designed to work with cellular networks.
  - Cellular WAN cards are plug-and-play.
  - Can be plugged in to the PC card slot or is built in to the laptop.
  - Also, access with a USB adapter or by using a mobile hotspot.
- Laptops with integrated cellular WAN capabilities require no software installation and no additional antenna or accessories.

Cellular Technology



- 1983: Martin Cooper is credited with developing the first cell phone approved for commercial use.

Cellular Technology

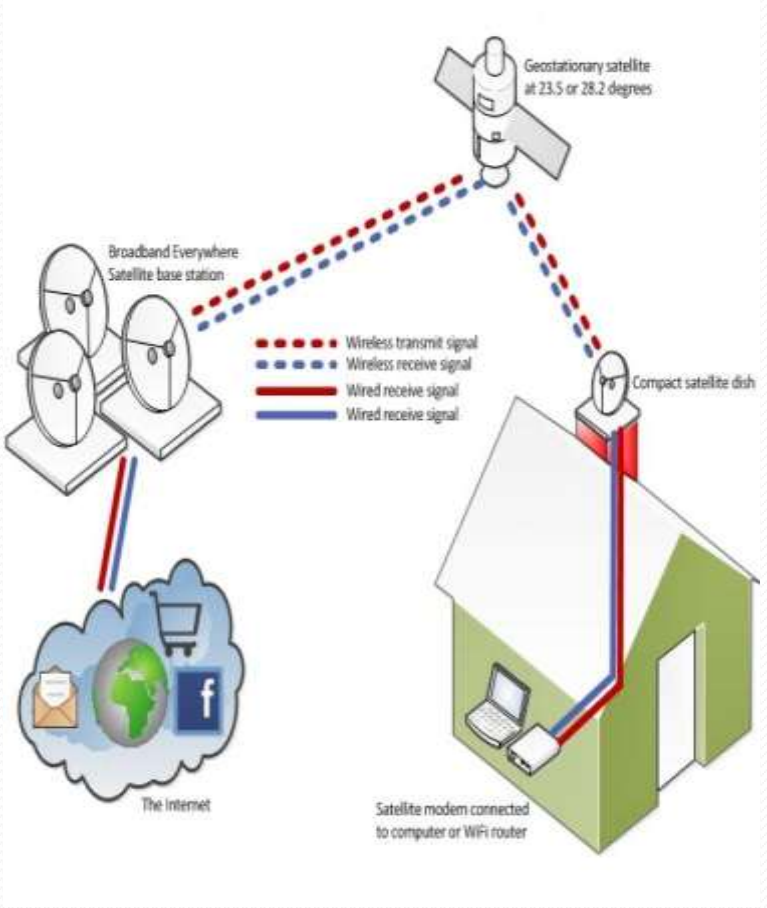
- 1997: Philips introduces an early attempt at a digital "smart phone." The unit, called "The Synergy" provided wireless access to e-mail, internet and faxes.

Mobile Phone Standards

- 1G - First-generation phones primarily used analog standards
- 2G- Second-generation cell phones were marked by a switch from analog to digital standards. 2G standards included Global System for Mobile (GSM)
- 2.5G - As 3G cell phone standards were being developed, extensions to the existing 2G standards were added (e.g. packet switching). 2.5G is not defined as a standard like 2G and 3G. It was created for marketing purposes.
- 3G - Third-generation standards ushered in faster data-transmission speeds and enabled mobile phones to send and receive text, photos, and video, and access the Internet and to use the Global Positioning System (GPS).
- 4G - Fourth-generation standards have higher data rates which allow users to download files, such as video and music.

Satellite

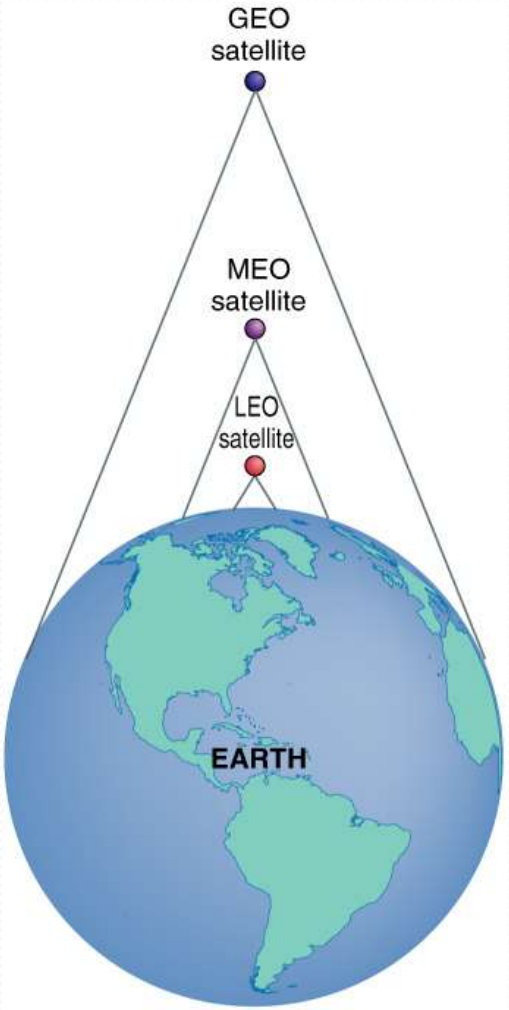
- Uses a satellite dish for two-way communication.
- It takes time for the signal from the satellite dish to relay to your Internet Service Provider (ISP) through the satellite orbiting the Earth.
- Satellite networks are faster than dial-up connections but slower than Cable and DSL connections.
- Satellite service is ideal for the rural or remote Internet users as no other broadband connection may be available.
- Adverse weather conditions can interfere with satellite reception.



Satellite

- Geostationary (GEO): orbits 22,300 miles directly above the equator and maintains a relatively fixed position in relation to a dish on earth; excellent for TV signals.
- Medium-earth-orbit (MEO): are located 6,000 miles above the earth's surface and move; used for the GPS system.
- Low-earth-orbit (LEO): are 400 to 700 miles above the surface, so they move much faster with respect to a point on the earth's surface; require many to cover the earth.

- Global Positioning System: a wireless system that uses MEO satellites to enable users to determine their position anywhere on the earth.



WiMAX

- **Worldwide Interoperability for Microwave Access (WiMAX)** - 4G broadband, high-speed, mobile Internet access for mobile devices.

- Broad coverage like the cell phone network instead of small WiFi hotspots.

- WiMAX has the potential to do to broadband Internet access what mobile phones have done to phone access. In the same way that many people have given up their "land lines" in favour of mobile phones, WiMAX could replace cable and DSL services, providing universal Internet access just about anywhere you go.

WiMAX

- WiMAX could potentially erase blackout areas that have no broadband Internet access.
- A WiMAX system consists of two parts:
  - A WiMAX tower, similar in concept to a mobile-phone tower.
  - A WiMAX receiver - The receiver and antenna could be a small box or PCMCIA card, or they could be built into a laptop the way WiFi access is today.

Line of Sight Wireless Internet Services

- **Line of sight wireless Internet** is an always-on service that uses radio signals for transmitting Internet access.
- Radio signals are sent from a tower to the receiver that the customer connects to a computer or network device.
- A clear path between the transmission tower and customer is required. The tower may connect to other towers or directly to an Internet backbone connection.
- The distance the radio signal can travel and still be strong enough to provide a clear signal depends on the frequency of the signal.
- Extreme weather condition, trees, and tall buildings can affect signal strength and performance.

Line of Sight Wireless Internet Services

- From your ISP there will either be cabling or a radio transmitter that will relay signals to a tower.
- It may go through several towers before it gets to you.
- Once the signal makes it to your nearest tower, it then travels directly to your receiver.
- From your receiver, it will go over networking cable (RJ-45) to your modem.

Infrared

- A short-range, low-throughput wireless technology used as a data transmission medium.
- Infrared light signals operate in the lowest light frequency.
- Distances are limited to a few feet or meters.
- IR cannot penetrate any object that blocks the light signal.

- Three types of IR networks:
  - **Line of sight** - The signal is transmitted only if there is a clear, unobstructed view between devices.
  - **Scatter** - The signal is bounced off ceilings and walls.
  - **Reflective** - The signal is sent to an optical transceiver and is redirected to the receiving device.

Infrared

- An infrared LED (Light Emitting Diode) emits the light.
- A photo-diode in the receiving equipment receives the light.
- A digital code within the controller switches the light on and off, this is then picked up as a digital code at the other end.

- Communication standard is called 'IrDA' (Infrared Digital Association)
- IrDA-SIR (slow speed) infrared supporting data rates up to 115 Kbps
- IrDA-MIR (medium speed) infrared supporting data rates up to 1.15 Mbps
- IrDA-FIR (fast speed) infrared supporting data rates up to 4 Mbps

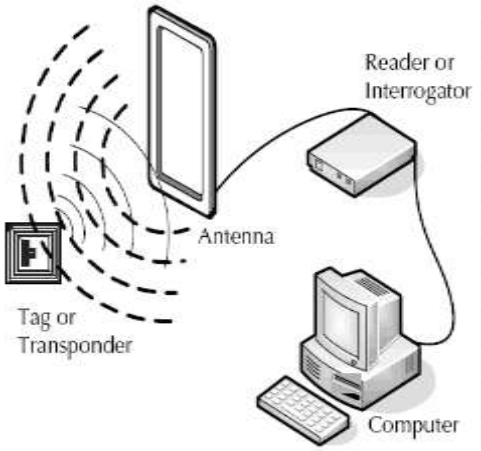
Advantages	Disadvantages
Inexpensive compared to other technologies	Only works line-of-sight
Works over a moderate bandwidth 115 kbps	Short range - a few metres
Works well over a short distance	Low bandwidth

RFID

- Radio Frequency Identification (RFID)
- A micro chip in a label or tag used to transmit data when the label or tag is exposed to radio waves.
- RFID labels or tags contain electronically stored information.
- RFID tags do not need to contain batteries, and can therefore remain usable for very long periods of time.

RFID

- An RFID system comprises a tag, an antenna and a reader.
- When an RFID tag passes through the field of the scanning antenna, it detects the activation signal from the antenna. That "wakes up" the RFID chip, and it transmits the information on its microchip to be picked up by the scanning antenna and passed on to the reader.
- The tag does not need to be within the line of sight of the scanning antenna, so it may be embedded in the tracked object.



www.youtube.com/watch?v=eob532iEpqk

Near-Field Communication (NFC)

- Subset of RFID technology.
- Designed to be a secure form of data exchange by using a very short-range radio transmission.
- NFC devices must be in close proximity to each other, usually no more than a few centimetres.
- Work with passive devices that don't require their own power supply.

Near-Field Communication (NFC)

Three modes of operation:

- Peer-to-peer mode - lets two smartphones swap data.
- Read/write mode - one active device picks up info from a passive one.
- Card emulation - an NFC device such as a smartphone can be used like a contactless credit card.

Security issues :

- If someone can get close enough to you with an NFC reader.
- Dodgy apps.
- Losing smartphone.