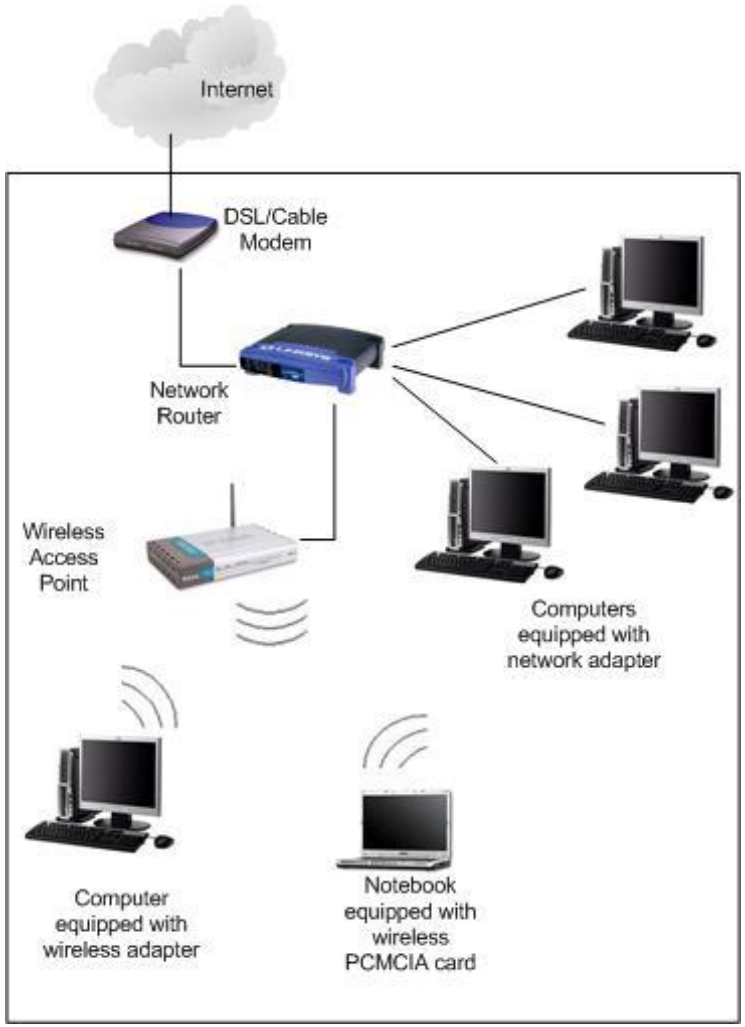
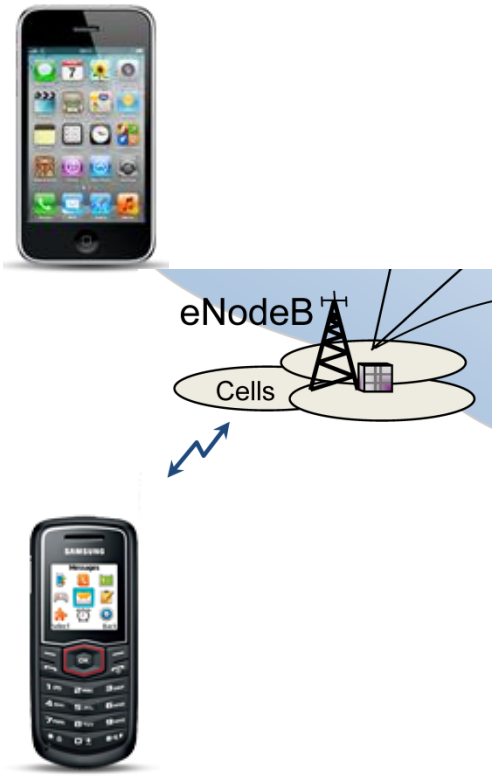
Wireless Networks

Lecture 01: The Overview





The Unit Structure

- Follow the contents as in Moodle
- Alternatively use my web page
- Expect modifications and improvements throughout the semester

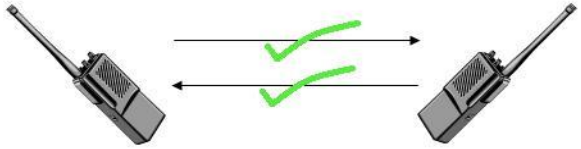
Where and when it started

- Wireless networks transmit data by means of electromagnetic waves.
- **Maxwell's equations** are a set of partial differential equations that underlie wireless communications technologies.
- **Wardenclyffe Tower** (1901–1917) also known as the **Tesla Tower**, was an early wireless telecommunications tower designed by **Nikola Tesla** and intended for commercial trans-Atlantic wireless telephony and broadcasting.
- **Guglielmo Marconi** was an Italian inventor, known as the father of long distance radio transmission.

Early types of wireless networks

- Unidirectional, broadcasting networks: analog radio and television.
- Radio communication systems.

e.g. Bidirectional, Duplex system:



- **Citizens' Band (CB) radio** is a system of short-distance radio communications between individuals on a selection of 40 channels within the 27-MHz (11 m) band.

Modern wireless networks

- Five main types of the wireless networks:
  - Wireless computer networks
  - Wireless/mobile telephony
  - Digital TV and radio
  - Wireless Personal Area Networks
  - Wireless sensor networks
- Other wireless networks include:
  - Satellite networks
    - Iridium satellite constellation
    - Satellite Internet access
  - Microwave link
- Each of the above network operates in **different frequency spectrum.**
- Consider also the **range of the transmission** and the **mobility**.

Wireless Local Area Networks

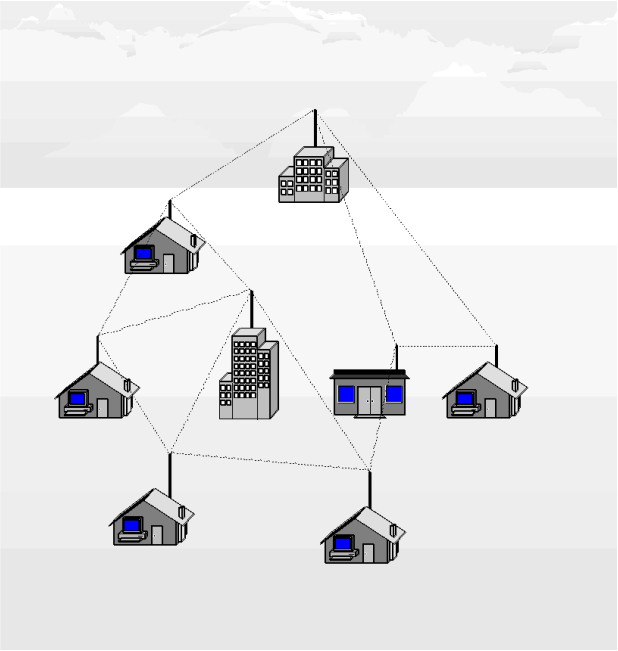
- A wireless local area network (WLAN) links two or more devices using a wireless distribution method, providing a connection through an **access point** to the wired Ethernet and then the Internet.
- WLANs are based on the **IEEE 802.11 standards** and are marketed as **WiFi** networks.
- WLANs operate in the 2.4GHz and 5 GHz frequency bands.
- The range is typically around 20m

Mobile Cellular Networks

- **GSM** (Global System for Mobile Communications) is a standard set developed by the European Telecommunications Standards Institute and is known as 2G cellular network.
- GSM has been originally optimized for full duplex voice telephony.
- **UMTS** (Universal Mobile Telecommunications System) is a third generation (3G) mobile cellular technology for networks based on the GSM standard.
- Developed by the **3GPP** (3rd Generation Partnership Project), UMTS is a component of the International Telecommunications Union IMT-2000 standard set.
- **HSPA+** (High-Speed Packet Access) aka 3.5G, is the next addition to this standard.
- **LTE** (Long Term Evolution) is the latest, 4G technology standardized by ITU-T and 3GPP
- Show this to impress students: Local pdf

Mesh and Ad-hoc Wireless Networks

- A **wireless mesh network** (**WMN**) is a communications network made up of radio nodes organized in a mesh topology.
- Wireless mesh networks can be implemented with various wireless technologies including 802.11, 802.15, 802.16, cellular technologies or combinations of more than one type.
- A wireless mesh network can be seen as a special type of wireless **ad-hoc network**.



- A wireless mesh network often has a more planned configuration, and may be deployed to provide dynamic and cost effective connectivity over a certain geographic area.
- An ad-hoc network is formed ad hoc when wireless devices come within communication range of each other.
- IEEE 802.11s (incorporated in 802.11-2012) standard for mesh and ad-hoc networks

Wireless Personal Area Networks

- Wireless Personal Area Networks (WPANs) interconnect devices within a relatively small area, that is, generally within a person's reach.
- **Bluetooth** (SIG standards) is a typical example of a WPAN and interconnects headsets to laptops and phones.
- Bluetooth operates in 2.4 GHz frequency range with the range similar to WiFi (5-100m)
- ZigBee based on IEEE 802.15.4 is another example of a WPAN. In this case the emphasis is on low bit-rate and resulting simplicity and low energy consumption. See also WSN

Wireless Sensor Networks

- A **wireless sensor network (WSN)** consists of spatially distributed autonomous sensors to *monitor* physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location.
- The more modern networks are bi-directional, enabling also to *control* the activity of the sensors.
- The development of wireless sensor networks was motivated by military applications such as battlefield surveillance.
- Today WSNs are used in many industrial and consumer application, such as industrial process monitoring and control, machine health monitoring, and so on.
- Several standards are currently either ratified or under development for wireless sensor networks, ZigBee/802.15.4 being one of them.

Wireless Revolution

- Three stages of the wireless revolution:
  - Cellular phones in 1990s
  - WiFi in 2000s
  - Broadband wireless internet access (BWIA) – now
- Follow the Cisco White paper:

  Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2014–2019

  Local copy
- See also IDC reports

Major Standards Bodies

- ISO (International Organization for Standardization)
  - Technical recommendations for data communication interfaces
  - Composed of each country's national standards orgs.
  - Based in Geneva, Switzerland (www.iso.ch)
- ITU-T (International Telecommunications Union – Telecom Group
  - Technical recommendations about telephone, telegraph and data communications interfaces
  - Composed of representatives from each country in UN
  - Based in Geneva, Switzerland (www.itu.int)

Major Standards Bodies (Cont.)

- ANSI (American National Standards Institute)
  - Coordinating organization for US (not a standards- making body)
  - www.ansi.org
- IEEE (Institute of Electrical and Electronic Engineers)
  - Professional society; also develops mostly LAN standards
  - standards.ieee.org
- IETF (Internet Engineering Task Force)
  - Develops Internet standards
  - No official membership (anyone welcome)
  - www.ietf.org
- CCSA – China Communications Standards Association

Electromagnetic spectrum

- Fundamental relationship between the frequency f, wavelength λ, and the speed of light $c \approx 3e8$ m/sec

$$\lambda = c / f$$

- Good to remember that for $f = 3\text{GHz} = 3e9$ Hz the wavelength is $\lambda = 3e8/3e9 = 10\text{cm}$
- The frequency range used in wireless networks is in the range 1 to 10 GHz
- Assignment of frequencies is done by the Australian Communications and Media Authority
- Spectrum allocation chart and plan