Wireless Technologies

Multiple Standards and Services

• There are many wireless systems that differ in
  – Data rate
  – Range
  – Frequency
  – Ability to penetrate barriers
  – Cost
• The federal government licenses and regulates the use of the radio spectrum

Taxonomy of Wireless Networks

Personal Area Networks (PANs)

• A PAN technology provides communication over a short distance
• It is intended for use with devices that are owned and operated by a single user. For example
  – between a wireless headset and a cell phone
  – between a computer and a nearby wireless mouse or keyboard

Figure 16.1 A taxonomy of wireless networking technologies.
Wireless protocol utilizing short-range communications technology
- 2.4 GHz short-range radio frequency
- 3 Mbits/second

<table>
<thead>
<tr>
<th>Class</th>
<th>Maximum Power</th>
<th>Range (approximate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>100 mW</td>
<td>~100 meters</td>
</tr>
<tr>
<td>Class 2</td>
<td>2.5 mW</td>
<td>~10 meters</td>
</tr>
<tr>
<td>Class 3</td>
<td>1 mW</td>
<td>~1 meter</td>
</tr>
</tbody>
</table>

Wireless Sensor Networks
- Small sensors contain
  - Processor
  - Memory
  - Wireless communication
  - Battery
- There are several sensor programming systems
- Sensors can include light, temperature, motion and almost anything else

Sample Applications
- Detect forest fires
- Building environment monitoring
- Detect troop movement
- Farm soil monitoring
- Supply chain management
- Pollution monitoring

Ad Hoc Networks
- Sensor networks frequently communicate by forwarding messages to other nearby sensors
Batteries Not Included

- Wireless sensors run on batteries.
- Batteries (especially small batteries) have limited power and life span.
- About 1000 times more power is usually spent in communication than computation.

ZigBee

- ZigBee is a low-cost, low-power, wireless mesh networking standard
- Based on the IEEE 802.15.4-2006 standard
- Intended to be simpler and cheaper than other WPANs such as Bluetooth
- Uses 902-928 MHz in North America at 20 Kbits/sec
- Uses 2.4 GHz at 250 Kbits/sec

RFID

- An RFID chip replies with its ID information when requested by a reader
- Passive RFID chips contain no battery and get their power from their antenna
- Active RFID chips have batteries which gives them greater range and ability to penetrate

Wireless LAN

- Wireless LANs are defined by the IEEE 802.11 standards
- They are often referred to as WiFi
- Wireless LANs usually connect to an access point although they can connect in ad hoc networks
IEEE 802.11 Standards

<table>
<thead>
<tr>
<th>std</th>
<th>Introduced</th>
<th>Data Rate (Mb/s)</th>
<th>Distance (feet)</th>
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<tbody>
<tr>
<td>-</td>
<td>June 1997</td>
<td></td>
<td>66</td>
</tr>
<tr>
<td>a</td>
<td>Sept 1999</td>
<td>6 to 54</td>
<td>115</td>
</tr>
<tr>
<td>b</td>
<td>Sept 1999</td>
<td>5.5 and 11</td>
<td>125</td>
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<tr>
<td>g</td>
<td>June 2003</td>
<td>22 and 54</td>
<td>125</td>
</tr>
<tr>
<td>n</td>
<td>Oct 2009</td>
<td>15 to 150</td>
<td>230</td>
</tr>
</tbody>
</table>

Access Points

- Computers can be in the range of one or more access points
- There can be dead zones with no coverage

Cellular Communication Systems

- Cellular systems were originally designed to provide voice services to mobile customers
- Currently, cellular systems are being used to provide data services and Internet connectivity
- In terms of architecture
  - each cell contains a tower
  - a group of (usually adjacent) cells is connected to a Mobile Switching Center (MSC)
- The center tracks a mobile user and manages handoff as the user passes from one cell to another.
Cells
• Perfect cellular coverage occurs if each cell is a hexagon
• Most cell towers use omnidirectional antennas that transmit in a circular pattern
• Obstructions and electrical interference can attenuate a signal or cause an irregular pattern. In some cases, cells overlap and in others, gaps exist with no coverage

Generations of Cellular Technologies
Telecommunications industry divides cellular technologies into four generations
• 1G
  – Began in the late 1970s, and extended through 1980s
  – Originally called cellular mobile radio telephones used analog signals to carry voice
• 2G and 2.5G
  – Began in the early 1990s and continues to be used
  – The main distinction between 1G and 2G arises because 2G uses digital signals to carry voice
  – The label 2.5G is used for systems that extend a 2G system to include some 3G features

Generations of Cellular Technologies
• 3G and 3.5G
  – Began in the 2000s
  – Focuses on the addition of higher-speed data services
  – A 3G system offers download rates of 400 Kbps to 2 Mbps, and is intended to support applications such as web browsing and photo sharing
  – 3G allows a single telephone to roam across the world
• 4G
  – Began around 2008
  – Focuses on support for real-time multimedia such as a television program or high-speed video
  – They include multiple connection technologies at any time, the phone automatically chooses the best connection technology available

Global Positioning System
• Global Positioning System (GPS) provides accurate time and location information
• Location information is increasingly used in mobile networking, location-based services
• The key features are:
  – Accuracy between 2-20 meters
    • (military ones have higher accuracy)
  – 24 total satellites orbit the earth
  – Satellites arranged in 6 orbital planes