What You’ll Learn Today

– What is radio? What are radio waves?
– What did that surfing professor dude create out in Hawaii?
– How do we measure the speed/performance characteristics of a network?
– What is WiFi? How secure is it?
What is Radio?

Radio waves are electromagnetic radiation, which travel through the air.

Wave length is length (e.g. in meters) of a radio wave.

Frequency is the number of occurrences of a repeating event per unit time (cycles per second, called Hertz).

Electromagnetic Spectrum

AM radio waves are about 100 meters
FM radio/TV waves are about 1 meter
Light waves are about 0.000005 meters
How Radio Works

Radio transmissions are sent from a transmitter to a receiver.
- Transmitter usually has a high-powered antenna; receiver usually uses low power antenna.
- Limited by power, line of sight

Most wireless data is sent via radio waves including “radio”, television, cell phones, WiFi, and Bluetooth.

Recall: Aloha Net

Originally sender/receiver used different frequencies.
Later, multiple senders/receivers shared one frequency.
Lessons from AlohaNet

– Many transmitters/receivers shared one medium (radio frequency).
– Limited efficiency because of blocked packets.
– Let to the creation of “carrier sense multiple access/collision detection” -- CSMA/CD
  • Used by Ethernet, WiFi

Ethernet

– Ethernet developed at Xerox PARC in 1973-75
  • Used CSMA/CD
  • Speeds up to 3 Mbit/sec

– IEEE 802.3 standard (1983) was 10 Mbit/sec
  • Later, speeds of 100Mbit, and 1000Mbit (1 Gbit) have come to market.

Bits: 1s or 0s of digital communication.
BitRate: how many bits can be sent per second.
“WiFi” is only a trade name for IEEE 802.11

Left: an IBM laptop with built in WiFi, and a Linksys wireless access point; Right: a municipal wireless access point.

Comparing WiFi Generations

<table>
<thead>
<tr>
<th>802.11 Protocol</th>
<th>Release</th>
<th>Freq. (GHz)</th>
<th>Typ throughput (Mbit/s) [citation needed]</th>
<th>Max net bitrate (Mbit/s)</th>
<th>Mod.</th>
<th>r_in. (m)</th>
<th>r_out. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>--</td>
<td>1997</td>
<td>2.4</td>
<td>0.9</td>
<td>2</td>
<td>IR/FH/DS(s)</td>
<td>~20 ~100</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>1999</td>
<td>5</td>
<td>23</td>
<td>54</td>
<td>OFDM</td>
<td>~35 ~120</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>1999</td>
<td>2.4</td>
<td>4.3</td>
<td>11</td>
<td>DSSS</td>
<td>~38 ~140</td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>2003</td>
<td>2.4</td>
<td>19</td>
<td>54</td>
<td>OFDM</td>
<td>~38 ~140</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>-- March 2010</td>
<td>2.4 5</td>
<td>74</td>
<td>600</td>
<td>OFDM</td>
<td>~70 ~250[2]</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>2008</td>
<td>3.7</td>
<td>23</td>
<td>54</td>
<td>OFDM</td>
<td>~50 ~5000</td>
<td></td>
</tr>
</tbody>
</table>

- BitRate: how many bits can be sent per second.
- Note the frequency of WiFi is in the GHz range.
  - by contrast, AM radio is in the KHz range; FM radio is in MHz range.
WiFi Limitations

The popular 802.11g uses the 2.4 GHz frequency spectrum, which is crowded:
- microwave ovens, Bluetooth devices, baby monitors, (in the USA) digital cordless telephones operate on this frequency

5GHz (802.11a) isn’t as crowded, but the smaller wave length is more easily absorbed by walls/structures.

WiFi Security (NOT)

WiFi is a BUS network -- every node is communicating on the same frequency.

Example…
Securing your (wireless) data

The main strategies for securing data sent via WiFi involve encrypting the data.

– Wireless Protected Access (WPA) -- encryption between host and wireless access point.
– Virtual Private Network (VPN) -- encryption between host and remote VPN server.

What You Learned Today

– Radio waves, frequency, wavelength
– AlohaNet, CDMA/CD
– Bitrates
– Ethernet
– WiFi
– Wireless network (in)security
Announcements and To Do List

– HW05 due Wednesday 10/11
– Readings:
  • http://en.wikipedia.org/wiki/Radio
  • http://en.wikipedia.org/wiki/Wi-Fi
  • http://en.wikipedia.org/wiki/Radio_waves
  • Reed ch 5, pp 83-87, 89-90 (for next Thursday)