WIRELESS PERSONAL AND LOCAL AREA NETWORKS

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• WSN

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NETWORKS

Transportation Networks

Energy Networks

Social Networks

Wireless Networks

Computer Networks

Financial Networks

Biological (Human) Networks

Internet

Sensor Networks
COMPUTER NETWORKS

• consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications.

• The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams.
<table>
<thead>
<tr>
<th>Specifications</th>
<th>Wired network</th>
<th>Wireless network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of operation</td>
<td>Higher</td>
<td>Lower compared to wired networks</td>
</tr>
<tr>
<td>System Bandwidth</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Cost</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>Installation</td>
<td>Wired network installation is cumbersome and it requires more time</td>
<td>Wireless network installation is easy and it requires less time</td>
</tr>
<tr>
<td>Mobility</td>
<td>Limited</td>
<td>Not limited</td>
</tr>
<tr>
<td>Transmission medium</td>
<td>Copper wires, optical fiber cables, Ethernet</td>
<td>EM waves or radio waves or infrared</td>
</tr>
<tr>
<td>Specifications</td>
<td>Wired network</td>
<td>Wireless network</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Network coverage extension</td>
<td>Requires hubs and switches for network coverage limit extension</td>
<td>More area is covered by wireless base stations which are connected to one another.</td>
</tr>
<tr>
<td>Channel Interference and signal power loss</td>
<td>Less</td>
<td>High</td>
</tr>
<tr>
<td>QoS (Quality of Service)</td>
<td>Better</td>
<td>Poor</td>
</tr>
<tr>
<td>Reliability</td>
<td>High</td>
<td>Reasonably high, This is due to failure of router will affect the entire network</td>
</tr>
<tr>
<td>Applications</td>
<td>LAN (Ethernet), MAN</td>
<td>WLAN, WPAN(Zigbee, bluetooth), Infrared, Cellular(GSM,CDMA, LTE)</td>
</tr>
</tbody>
</table>
Wireless and Mobility

Wireless:
- Limited bandwidth
- Broadcast medium: requires multiple access schemes
- Variable link quality (noise, interference)
- High latency, higher jitter
- Heterogeneous air interfaces
- Security: easier snooping

Mobility:
- User location may change with time
- Speed of mobile impacts wireless bandwidth
- Need mechanism for handoff
- Security: easier spoofing
Wireless Network

- **Wireless** --"having no wires".
- Network is connected by radio waves and/or microwaves to maintain communications.
- NICs, APs and routers in place of wires (copper or optical fiber) for connectivity.
LOCAL AREA NETWORK

• A **LAN** is a group of computers and associated devices that share a common communications line or wireless link and typically share the resources of a single processor or server within a small geographic area.

• The defining characteristics of LANs in contrast to WANs are:
  - much higher data rates
  - smaller geographic range - at most a few kilometers
WLAN

• uses radio waves as its carrier
• Area may range from a single room to an entire campus
• The backbone network usually uses cables, with one or more wireless access points connecting the wireless users to the wired network.
WIRELESS LAN: The need

- An increasing number of LAN users becoming mobile
- Wireless LANs are easy to install
- Portability
Frequency Fundamentals

• Narrowband Technology
  • Uses fixed carrier frequency
  • Easy to implement (inexpensive).
  • Prone to jamming or interference
    (two transmitters at the same carrier frequency, $F_0$.)
  • Least secure modulation scheme.

[Graph of signal strength vs. frequency]
Frequency Fundamentals

• Spread Spectrum
  – Frequency hopping Spread Spectrum
    • Uses a carrier frequency that varies with time
    • Relatively easy to implement (inexpensive)
    • Resistance to noise
    • Hopping rates may be ~1600 hops/second (Bluetooth).
    • Limited throughput
    • Very secure modulation scheme (used in military for decades).
Frequency Fundamentals

- Direct Sequence Spread Spectrum
  - Much higher throughput than FH (11 Mbps)
  - More difficult to implement (more expensive).
  - Most complicated scheme (of these presented).
  - Most secure modulation scheme.
  - Better range
  - Less resistant to noise
Frequency Fundamentals

• Orthogonal Frequency Division Multiplexing
  • Offers higher bandwidth than that of DSSS
  • Operates in the 5 GHz range
• Multiple Input Multiple Output
WLAN - Modes of operation

• Peer-to-peer
  – Scalability and security issues

• Access Point
  – BSS
  – ESS
WLAN - Applications

• Retail
• Warehousing
• Health Care
• Hospitality
Types of Wireless Networks

• Wireless LAN (WLAN)
• Wireless Personal Area Networking (WPAN)
• Wireless Metropolitan Area Networking (or WiMax).
• Wireless Wide Area Networks (WWAN)
<table>
<thead>
<tr>
<th>Type of Network</th>
<th>Coverage Area</th>
<th>Function</th>
<th>Cost</th>
<th>Data Rate</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>WLAN</td>
<td>In buildings or campuses; typically 100 meters</td>
<td>Mobile extension of wired networks</td>
<td>Low-Medium</td>
<td>1-100 Mbps</td>
<td>802.11a, b,g,n, Wi-Fi and HiperLAN/2</td>
</tr>
<tr>
<td>WPAN</td>
<td>within reach of a person, typically 10 meters</td>
<td>Cable Replacement Technology, personal networks</td>
<td>Very Low</td>
<td>0.1-4 Mbps</td>
<td>IrDA, Bluetooth, 802.15</td>
</tr>
<tr>
<td>WMAN</td>
<td>Within a city</td>
<td>Fixed Wireless between homes and businesses and the Internet</td>
<td>Medium-High</td>
<td>134 Mbps</td>
<td>IEEE 802.16 and WIMAX</td>
</tr>
<tr>
<td>WWAN</td>
<td>Coverage provided on national basis from multiple carriers.</td>
<td>Mobile access to the Internet from outdoor areas</td>
<td>Medium-High</td>
<td>8 Kbps-2 Mbps</td>
<td>GSM, TDMA, CDMA, GPRS, EDGE, WCDMA</td>
</tr>
</tbody>
</table>

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Wireless PAN and LAN
Family of complementary devices
IEEE 802

• 802.11 Base Standard
  – 2.4GHz Frequency Hopping Spread Spectrum (1Mbit/s)
  – 2.4GHZ Direct Sequence Spread Spectrum (2Mbit/s)
  – Infrared (1Mbit/s)
• 802.11a 5GHz Extension (>20Mbit/s)
• 802.11b 2.4GHz Extension (>8Mbit/s)
• 802.15 Wireless Personal Area Networks

“IEEE 802 is the focal point for Wireless LAN standards.” Jim Carlo
802.11 Standard

• 802.11 Basic standard for Physical layer & MAC (1997)—FHSS, DSSS, 1 or 2 Mb/s, 2.4 GHz
• 802.11a OFDM-based physical layer for 5 GHz, 0-54 Mb/s (1999)
• 802.11b DSSS-based physical layer for 2.4 GHz, 5.5 and 11 Mb/s (1999, 2001)
• 802.11g OFDM-based (also other optional modes) physical layer for 2.4 GHz, ...54 Mb/s (2003)
• 802.11n High-throughput enhancements (active, 2008), >100 Mb/s
<table>
<thead>
<tr>
<th></th>
<th>802.11</th>
<th>802.11a</th>
<th>802.11b</th>
<th>802.11g</th>
<th>802.11n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range (meters)</td>
<td>35-120</td>
<td>35-120</td>
<td>38-140</td>
<td>38-140</td>
<td>70-250</td>
</tr>
<tr>
<td>Unlicensed frequency of operation &amp; Transmission</td>
<td>2.4 GHz FHSS, DSSS</td>
<td>5GHz OFDM</td>
<td>2.4 GHz FHSS</td>
<td>2.4GHz DSSS,OFDM</td>
<td>2.4 and /or 5 GHz MIMO</td>
</tr>
<tr>
<td>No. of non overlapping channels</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Data rate per channel</td>
<td>1,2 Mbps</td>
<td>54 Mbps</td>
<td>11 Mbps</td>
<td>54 Mbps</td>
<td>248 Mbps</td>
</tr>
<tr>
<td>Compatibility</td>
<td>None</td>
<td>None</td>
<td>With 802.11g and the original 802.11</td>
<td>With 802.11b</td>
<td>With 802.11a,b and g</td>
</tr>
</tbody>
</table>
PERSONAL AREA NETWORK

• A PAN is a computer network used for communication among computer devices (including telephones and personal digital assistants) close to one person.
• The reach of a PAN is typically a few meters.
• PANs can be used for communication among the personal devices themselves (intrapersonal communication), or for connecting to a higher level network and the Internet.
WPAN: The Need

• Used to interconnect portable computers and/or devices like peripherals and sensors
• These devices may be carried or worn by a person and/or may be located nearby Home/Office computers, printers, phones, LANs, GPS or other car resources can be connected as needed.
• Two or more devices communicate on the same physical channel.
• must include at least one FFD that operates as the PAN coordinator.
• The PAN coordinator initiates, terminates, or routes communication around the network. The PAN coordinator is the primary controller of the PAN.
• The WPAN may operate in either of two topologies: the star topology or the peer-to-peer topology.
Star Topology

PAN coordinator

- Full Function Device (FFD)
- Reduced Function Device (RFD)
- Communications Flow
Device Terminology

• Full Function Device (FFD)
  – Any topology
  – Can talk to RFDs or other FFDs
  – Operate in three modes
    • PAN coordinator
    • Coordinator
    • Device.

• Reduced Function Device (RFD)
  – Limited to star topology
  – Can only talk to an FFD (coordinator)
  – Cannot become a coordinator
  – Unnecessary to send large amounts of data
  – Extremely simple
  – Can be implemented using minimal resources and memory capacity
Example

PAN coordinator

- RFD
- FFD
- RFD
- FFD
- RFD
- RFD
- FFD
Peer-to-peer Topology

• In a peer-to-peer network, each FFD is capable of communicating with any other FFD within its radio sphere of influence. One FFD will be nominated as the PAN coordinator.

• A peer-to-peer network can be ad hoc, self-organizing and self-healing, and can combine devices using a mesh networking topology.
WLAN and WPAN

- A WLAN consists of an Access Point (AP) to which individual client stations (STAs) associate through a management frame exchange.
- A radio provides connectivity to an infrastructure network (WLAN) for access to the Internet and infrastructure peripherals such as a backup store or printer.

- A WPAN is an ad-hoc arrangement, typically the short term pairing of devices to exchange information.
- The same radio provides ad-hoc connectivity (WPAN); linking smart phones to a notebook computer, computers to televisions for wireless display, digital camera to computer to transfer picture files.
Infrared Data Association

• IrDA is a very short-range.
• IrDA interfaces are used in palmtop computers and mobile phones.
• communication via IrDA requires direct line of sight.
Bluetooth

• Specifications and Features

• The Bluetooth specification was first developed by Ericsson, and was later formalized by the Bluetooth Special Interest Group (SIG). The SIG was formally announced on May 20, 1999. It was established by Sony Ericsson, IBM, Intel, Toshiba and Nokia, and later joined by many other companies as Associate or Adopter members. Bluetooth is also known as IEEE 802.15.1.
Bluetooth

• Bluetooth is an industrial specification for wireless personal area networks (PANs).
• Blue-tooth (BT) is the radio technology that allows the devices to communicate with one another within a range.
• it does not require the line of sight mode of communication. Thus devices can communicate even though walls and barriers as long as they are within the range.
Bluetooth

• Bluetooth is a radio standard primarily designed for low power consumption, with a short range (power class dependent: 10 centimeters, 10 meters, 100 meters) and with a low-cost transceiver microchip in each device.
Bluetooth

- Bluetooth products are available in one of three power classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Power</th>
<th>Range (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class1</td>
<td>100 mW</td>
<td>~100 meters</td>
</tr>
<tr>
<td>Class2</td>
<td>2.5 mW</td>
<td>~10 meters</td>
</tr>
<tr>
<td>Class3</td>
<td>1 mW</td>
<td>~1 meters (max)</td>
</tr>
</tbody>
</table>
Bluetooth

• **Connection & Communication**
  • Piconet
  • Round-robin fashion.
  • Either device may switch the master/slave role at any time.
  • Scatternet
  • Handshaking
ZigBee

• ZigBee is a published specification set of high level communication protocols designed to use small, low-power digital radios based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs)
• The technology is designed to be simpler and cheaper than other WPANs such as Bluetooth
ZigBee

- A general-purpose, inexpensive self-organizing mesh network
- Very small amounts of power
- Less Software when compared with Bluetooth
- ZigBee chip vendors announced 128-kilobyte devices.
- CSMA/CA
ZigBee

• There are three different types of ZigBee devices
  – ZigBee coordinator (ZC)
  – ZigBee Router (ZR)
  – ZigBee End Device (ZED):
Bluetooth Vs. ZigBee

### Bluetooth
- Modulation Technique: FHSS
- Battery: Intended for frequency recharging
- Protocol Stack Size: 250 Kbytes
- Maximum network speed: 1 M bit/sec
- Network range: 1 or 100 meters
- Typical network join time: 3 seconds

### ZigBee
- Modulation Technique: DSSS
- Battery: Not rechargeable
- Protocol Stack Size: 28Kbytes
- Maximum network speed: 250 K bit/sec
- Network range: Upto 70 meters
- Typical network join time: 30 milliseconds
<table>
<thead>
<tr>
<th>IEEE Standard</th>
<th>802.15.1 Bluetooth</th>
<th>802.15.3 High rate WPAN</th>
<th>802.15.4 Low rate WPAN (ZigBee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>1 Mbps</td>
<td>&gt;20 Mbps</td>
<td>250 Kbits/s</td>
</tr>
<tr>
<td>Frequency Band</td>
<td>2.4 GHz</td>
<td>3.1—10.6 GHz</td>
<td>868 MHz, 915 MHz, 2.4 MHz</td>
</tr>
<tr>
<td>Data Rate</td>
<td>3 Mbps</td>
<td>110Mbps-1 Gbps</td>
<td>250Kbps</td>
</tr>
<tr>
<td>Applications</td>
<td>Cell phones,</td>
<td>Low power, low cost</td>
<td>Industrial, agricultural,</td>
</tr>
<tr>
<td></td>
<td>Computers, PDAs,</td>
<td>solutions suitable for</td>
<td>vehicular, residential,</td>
</tr>
<tr>
<td></td>
<td>printers,</td>
<td>portable consumer of</td>
<td>medical applications,</td>
</tr>
<tr>
<td></td>
<td>microphones,</td>
<td>digital imaging</td>
<td>sensors and actuators</td>
</tr>
<tr>
<td></td>
<td>speakers, headsets,</td>
<td>and multimedia</td>
<td>with low power</td>
</tr>
<tr>
<td></td>
<td>barcode readers,</td>
<td>applications</td>
<td>consumption and low</td>
</tr>
<tr>
<td></td>
<td>pagers etc.</td>
<td></td>
<td>cost</td>
</tr>
</tbody>
</table>

Wireless PAN and LAN
# The Wireless Market

<table>
<thead>
<tr>
<th>TEXT</th>
<th>GRAPHICS</th>
<th>INTERNET</th>
<th>HI-FI AUDIO</th>
<th>STREAMING VIDEO</th>
<th>DIGITAL VIDEO</th>
<th>MULTI-CHANNEL VIDEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHORT</td>
<td>RANGE</td>
<td>LONG</td>
<td>802.11b</td>
<td>802.11a/HL2 &amp; 802.11g</td>
<td>Bluetooth 2</td>
<td>Bluetooth1</td>
</tr>
</tbody>
</table>

**Data Rate Range:**
- LOW < DATA RATE > HIGH
Body Area Network

- Definition by IEEE: “A communication standard optimized for low power devices for their operation on, in or around the human body (but not limited to humans) to serve a variety of applications including medical, consumer electronics or personal entertainment and other.”
Wireless Sensor Networks

• Distribution of sensors in a definite area for the purpose of monitoring and collecting some set of data.

• Monitors physical or environmental scenarios like temperature, humidity, sound and pressure at various locations.
Contributions

- Connectivity in WSN
- Coverage in WSN
Limitations

1) Wireless network is bit more difficult to set up properly.
2) The speed of wireless network is significantly slower than wired network (2-50 times slower).
3) Wireless network is less stable.
4) There are security issues in wireless networks.
Conclusion

• Interactive and high definition video applications
• Web surfing with multi media experience
• File storage with high Bandwidth having both reliability and limited delay
• Less power consumption
• Handling enormous traffic
• Cost
References


References


References


Thank You