What is a network?

• A computer network is two or more computers connected together using a telecommunication system for the purpose of communicating and sharing resources.

• A connection between any two communicating devices (computer and printer, for example) could also be considered a network.
Why have a network?

• To communicate and share resources (files and peripheral devices) between multiple computers
• To connect to other networks (Internet)
Typical shared items in a network

- Internet connection
- Printer
- Storage (hard drives)
Types of Interconnection

- Ethernet
- USB
- RS-232 (Serial Port)
- Parallel port
- Firewire
- Wireless (802.11)
Typical Network Components

- Computers
- Hubs
- Switches
- Routers
- Modems
- Printers
- Print Servers
- Network Drives
- Hardware Firewalls
- Network interface controllers (NICs)
- Wireless access points (WAPs)
- Cameras
- Wiring (cables)
Wired Network

• Ethernet (IEEE 802.3)
  – Originally coax at 10 Mbit/s
  – Now 2-4 differential pairs in cable at 1 Gbit/s
    • 1000Base-T (Gigabit Ethernet): 1 Gbit/s
      – Uses four pairs in Category 5, 5e or 6 cable
    • 100Base-TX (Fast Ethernet): 100 Mbit/s
      – Uses two pairs in Category 5, 5e or 6 cable
    • 10Base-T (Ethernet): 10 Mbit/s
      – Uses two pairs in Category 3, 4, 5, 5e or 6 cable
Ethernet Cables

- Category 5, 5e and 6 specify different levels of far end crosstalk for unshielded twisted pair (UTP) cable (6 is highest performance)
- Cables contain four pairs of 24 gauge copper wires
- Each pair is twisted with typically 3 twists per inch
- Cables use RJ45 connectors
Unshielded Twisted Pair Cabling Standards

- Cat 1: Currently unrecognized by TIA/EIA. Previously used for POTS telephone communications, ISDN and doorbell wiring.
- Cat 2: Currently unrecognized by TIA/EIA. Previously was frequently used on 4 Mbit/s token ring networks.
- Cat 3: Currently defined in TIA/EIA-568-B; used for data networks utilizing frequencies up to 16 MHz. Historically popular for 10 Mbit/s Ethernet networks.
- Cat 4: Currently unrecognized by TIA/EIA. Provided performance of up to 20 MHz, and was frequently used on 16 Mbit/s token ring networks.
- Cat 5: Currently unrecognized by TIA/EIA. Provided performance of up to 100 MHz, and was frequently used on 100 Mbit/s Ethernet networks. May be unsuitable for 1000BASE-T gigabit Ethernet.
- Cat 5e: Currently defined in TIA/EIA-568-B. Provides performance of up to 100 MHz, and is frequently used for both 100 Mbit/s and gigabit Ethernet networks.
- Cat 6: Currently defined in TIA/EIA-568-B. Provides performance of up to 250 MHz, more than double category 5 and 5e.
- Cat 6a: Future specification for 10 Gbit/s applications.
- Cat 7: An informal name applied to ISO/IEC 11801 Class F cabling. This standard specifies four individually-shielded pairs (STP) inside an overall shield. Designed for transmission at frequencies up to 600 MHz.
Ethernet Cable Connectors

- 8P8C - 8 position, 8 conductor modular connector
- Incorrectly referred to as RJ45
- Cables available assembled, or connectors may be crimped on cable.
Ethernet RJ45 Pin Configurations

- Eight connections consist of four wire pairs
- Pairs are solid and stripe of same color
- Two pin configurations, T568A and T568B, which are interoperable.
### T568A/B RJ45 Wiring

<table>
<thead>
<tr>
<th>Pin</th>
<th>T568A Pair</th>
<th>T568B Pair</th>
<th>Wire</th>
<th>T568A Color</th>
<th>T568B Color</th>
<th>Pins on plug face (jack is reversed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>tip</td>
<td>white/green stripe</td>
<td>white/orange stripe</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
<td>ring</td>
<td>green solid</td>
<td>orange solid</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
<td>tip</td>
<td>white/orange stripe</td>
<td>white/green stripe</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>ring</td>
<td>blue solid</td>
<td>blue solid</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>tip</td>
<td>white/blue stripe</td>
<td>white/blue stripe</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>3</td>
<td>ring</td>
<td>orange solid</td>
<td>green solid</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>4</td>
<td>tip</td>
<td>white/brown stripe</td>
<td>white/brown stripe</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>4</td>
<td>ring</td>
<td>brown solid</td>
<td>brown solid</td>
<td></td>
</tr>
</tbody>
</table>

**Pin Position:**
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1
Wireless Network

• Wi-Fi - WLAN (wireless local area network) based on IEEE 802.11 specs
• Uses wireless access points (WAPs) to transmit to and receive from WiFi-enabled devices.
• Most implementations operate in the unlicensed spectrum near 2.4 GHz.
Wireless “Flavors”

- **802.11a** (rare)
  - 54 Mbps max, 75 feet max, uses 5 GHz band
  - Lower interference, higher signal attenuation
- **802.11b** (first and most popular standard)
  - 11 Mbps max, 150 ft max, 2.4 GHz, lowest cost
  - Interference from cordless phones and microwave ovens
- **802.11g** (current leader in new sales)
  - 54 Mbps max, 150 ft max, 2.4 GHz band
  - Backwards compatible with 802.11b
- **802.11n** (standard not yet finalized - due April 2008)
  - 540 Mbps max, 160 ft max, 2.4 or 5 GHz
  - MIMO - multiple-input, multiple-output (uses multiple antennas)
Wired Network Components

• Hubs and switches connect multiple Ethernet devices together

• Hub
  – repeats the signal received at one port out each of the other ports (broadcast)

• Switch
  – connects devices to form a local area network (LAN), isolates ports, passing only data meant for that port
Network Router

• Acts as a junction between two networks to transfer data between them
  – Between WAN (wide area network) of Internet and LAN (local area network) in home
• Provides additional networking and security features
  – DHCP, NAT, DMZ, firewall, VPN
• Router devices also typically incorporate a switch
Routers give multiple machines access to the internet under one external IP address, whereas a switch is only a splitter. Compare the router to an intersection with street signs, and switches as neighborhood streets.
Router Features

- **DHCP - Dynamic Host Configuration Protocol**
  - Service that automatically assigns IP addresses to connecting devices

- **NAT - Network Address Translation**
  - Allows the router to present a single IP address to the Internet

- **DMZ - Demilitarized Zone**
  - Perimeter network that sits between an internal private network and external public network, protecting internal network from external attack

- **Firewall**
  - Security device that controls traffic between networks with different levels of trust
DMZ Illustration

Firewall Illustration
IP Address

• A unique address that devices use to identify and communicate with each other on a network
• Format of xxx.xxx.xxx.xxx, where xxx is 0 to 255
• Allows 4.29 billion possible unique addresses
Client/Server Network
Peer-to-Peer or Workgroup
Typical Network Layout
Basic Broadband Networks
Router in Network
Firewall in Network
Acknowledgements

• Information, tables and diagrams from Wikipedia (entries include Router, Ethernet, 100Base-TX and Category 5 Cable), January 2007

• Information and network diagrams from C/net’s Advanced Home Networking web course, 2006