Network Topologies

• LANs and WANs - Geographical coverage
• LANs
  – A single geographical location, such as office building, school, etc
  – Typically high speed and cheaper.
• WANs
  – Spans more than one geographical location often connecting separated LANs
  – Slower
  – Costly hardware, routers, dedicated leased lines and complicated implementation procedures.

Network Topologies

• Topology - Physical and logical network layout
  – Physical – actual layout of the computer cables and other network devices
  – Logical – the way in which the network appears to the devices that use it.
• Common topologies:
  – Bus, ring, star, mesh and wireless
Bus topology

- Uses a trunk or backbone to which all of the computers on the network connect.
- Systems connect to this backbone using T connectors or taps.
- Coaxial cablings (10Base-2, 10Base5) were popular options years ago.

Bus Topology

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheap and easy to implement</td>
<td>Network disruption when computers are added or removed</td>
</tr>
<tr>
<td>Require less cable</td>
<td>A break in the cable will prevent all systems from accessing the network.</td>
</tr>
<tr>
<td>Does not use any specialized network equipment.</td>
<td>Difficult to troubleshoot.</td>
</tr>
</tbody>
</table>
Ring Topology

• Logical ring
  – Meaning that data travels in circular fashion from one computer to another on the network.
  – Typically FDDI, SONET or Token Ring technology are used to implement a ring network.
  – Ring networks are most commonly wired in a star configuration.
    • Token Ring has multi-station access unit (MSAU), equivalent to hub or switch. MSAU performs the token circulation internally.

Ring Topology

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable faults are easily located, making troubleshooting easier</td>
<td>Expansion to the network can cause network disruption</td>
</tr>
<tr>
<td>Ring networks are moderately easy to install</td>
<td>A single break in the cable can disrupt the entire network.</td>
</tr>
</tbody>
</table>
Star Topology

- All computers/devices connect to a central device called hub or switch.
- Each device requires a single cable
- point-to-point connection between the device and hub.
- Most widely implemented
- Hub is the single point of failure

Advantages | Disadvantages
--- | ---
Easily expanded without disruption to the network | Requires more cable
Cable failure affects only a single user | A central connecting device allows for a single point of failure
Easy to troubleshoot and isolate problems | More difficult to implement
Mesh Topology

- Each computer connects to every other.
- High level of redundancy.
- Rarely used.
  - Wiring is very complicated
  - Cabling cost is high
  - Troubleshooting a failed cable is tricky
  - A variation hybrid mesh – create point to point connection between specific network devices, often seen in WAN implementation.

Mesh Topology

Advantages | Disadvantages
--- | ---
Provides redundant paths between devices | Requires more cable than the other LAN topologies
The network can be expanded without disruption to current uses | Complicated implementation
Wireless networking

- Do not require physical cabling
- Particularly useful for remote access for laptop users
- Eliminate cable faults and cable breaks.
- Signal interference and security issue.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allows for wireless remote access</td>
<td>Potential security issues associated with wireless transmissions</td>
</tr>
<tr>
<td>Network can be expanded without disruption to current users</td>
<td>Limited speed in comparison to other network topologies</td>
</tr>
</tbody>
</table>
IEEE and Networking standards

- Institute of Electrical and Electronic Engineers (IEEE) developed a series of networking standards
  - Networking technologies developed by manufacturers are Compatible
  - Cabling, networking devices and protocols are all interchangeable under the banner of a specific IEEE

<table>
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<tr>
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<th>Name</th>
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<tr>
<td>802.1</td>
<td>Internetworking</td>
</tr>
<tr>
<td>802.2</td>
<td>The LLC (Logical Link Control) sublayer</td>
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<tr>
<td>802.3</td>
<td>CSMA/CD (Carrier Sense Multiple Access with Collision Detection) for Ethernet networks</td>
</tr>
<tr>
<td>802.4</td>
<td>A token passing bus</td>
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<tr>
<td>802.5</td>
<td>Token Ring networks</td>
</tr>
<tr>
<td>802.6</td>
<td>Metropolitan Area Network (MAN)</td>
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<tr>
<td>802.7</td>
<td>Broadband Technical Advisory Group</td>
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<tr>
<td>802.8</td>
<td>Fiber-Optic Technical Advisory Group</td>
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<td>802.9</td>
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<td>802.10</td>
<td>Standards for Interoperable LAN/MAN Security (SILS) (Network Security)</td>
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<tr>
<td>802.11</td>
<td>Wireless networks</td>
</tr>
<tr>
<td>802.12</td>
<td>100Mbps technologies, including 100BASEVG-AnyLAN</td>
</tr>
</tbody>
</table>
802.3 IEEE standard

- Defines characteristics for Ethernet networks.
- New additions,
  - 802.3u for Fast Ethernet
  - 802.3z for Gigabit Ethernet, referred to as 802.3x.
  - ... ...
  - 802.3ac 10gbits/s, expe. 2009
- Speed: Original 10Mbps, Fast Ethernet 100Mbps, Gigabit Ethernet 1000Mbps
- Topology: bus or star.
- Media: Coaxial and twisted pair cabling, also fiber optic cable.
- Access method: CSMA/CD

802.5 IEEE standard

- Specifies the characteristics for Token Ring Networks.
- Introduced by IBM in the mid 80s, network topology of choice until the rise of the popularity of Ethernet.
- Speed: 4 to 16Mbps
- Topology: logical ring and most often a physical star. Logical ring is often created in the Multistation Access Unit (MSAU)
- Media: twisted pair cabling.
- Access method: token passing.
802.11b IEEE Standard - Wireless

• Specifies the characteristics of wireless LAN Ethernet networks.
  – Special devices called wireless access points to allow communicate.
  – Also connect to wired networks to create wireless portions of entire networks.
  – Access method: Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA), a variation of CSMA/CD.
  – Topology: physical wireless, logical bus
• Protocol
  – 802.11b 1999 2.4GHz, 11Mbits/s
  – 802.11g 2003 2.4GHz, 54 Mbits/s
  – 802.11n 2008 2.4G,5GHz, 248Mbits/s
  – ...

FDDI

• Fiber Distributed Data Interface (FDDI) standard was developed by American National Standards Institute (ANSI)
• Dual ring technology for fault tolerance
• Speed: 100Mbps or higher
• Topology: dual ring topology
• Media: fiber optic cable, > 2 kilometers. Also possible use copper wire as Copper Distributed Data Interface (CDDI).
• Access method: token-passing access method
<table>
<thead>
<tr>
<th>Standard</th>
<th>Speed</th>
<th>Physical Topology</th>
<th>Logical Topology</th>
<th>Media</th>
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<td>Bus and Star</td>
<td>Coaxial and Twisted pair</td>
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<tr>
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<td>Bus</td>
<td>Twisted pair</td>
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<tr>
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<td>4Mbps and 16Mbps</td>
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<td>Ring</td>
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<tr>
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<td>Dual Ring</td>
<td>Ring</td>
<td>Fiber-optic Twisted pair/CDDI</td>
<td>Token passing</td>
</tr>
</tbody>
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