Cabling and Connectors

• General media considerations
  – Broadband versus baseband
    • Baseband transmissions use digital signaling and Time Division Multiplexing (TDM)
    • Broadband transmissions use analog and Frequency Division Multiplexing (FDM)
  – Dialog modes: Simplex, half duplex and full duplex
  – Media interference
    • Electromagnetic interference (EMI) and cross talk
    • Network media vary in their resistance to the effect of EMC.
      – UTP is susceptible and fiber is resistant

– Attenuation
  • Resistance: Coaxial cable > UTP, STP > UTP, Fiber > all
  • Maximum distance
  • Repeaters
  • Attenuation-related problems require a network analyzer to detect

– Bandwidth
  • Transmission capacity of a media
  • Data throughput is measured in bits per second (bps), Mbps, and Gbps
  • For today’s application-intensive networks, Old 10Mbps is not enough, 100Mbps is very common and 1000Mbps is used too.
Network Media

- Carry signals between computers: Cable-based media and wireless networking.
- Cable-based media
  - Coaxial
    - Copper wire to conduct the signals electronically
    - Was the choice for LAN for many years.
    - Retiring
  - Twisted pair
    - Copper wire to conduct too
    - More popular than coaxial
  - Fiber-optic
    - Uses glass or plastic conductor and transmits the signals as light
    - High Cost. Restricted to where segment length and higher speeds are needed.
      - Server room, backbone

Coaxial cable

- Success in both TV transmission and network implementations
- Insulation, ground, insulation, main wire

- Networks use two types of coaxial cabling: thin coaxial and thick coaxial.
Thin coax

- More likely to be seen than thick coax
- Only .25 inches in diameter
- Prone to cable breaks.

<table>
<thead>
<tr>
<th>Cable</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-58 /U</td>
<td>Solid Copper core</td>
</tr>
<tr>
<td>RG-58 A/U</td>
<td>Stranded wire core</td>
</tr>
<tr>
<td>RG-58 C/U</td>
<td>Military specification</td>
</tr>
<tr>
<td>RG-59</td>
<td>Often used for cable TV and cable modems</td>
</tr>
<tr>
<td>RG-62</td>
<td>Used for ARCnet specifications</td>
</tr>
</tbody>
</table>

- BNC connectors: Barrel connector, T-connector, and terminators
Thick coax

- The chance you will encounter a network using thick coaxial cable is slim
- Thick coax, RG-8 is more robust and harder to damage
- More resistant to attenuation, crosstalk and EMI, found popularity to as a network backbone. Faster fiber-optic media has all and taken over in this role.
- Need vampire tap, a special connector that pierces the thick cable to copper core, and a drop cable to connect a LAN device.

Twisted-pair cabling

- Has been around for a long time
- Created for voice transmissions
- Most widely used media for networking
  - Lighter
  - More flexible
  - Easier to install
  - Cheaper
  - Greater speeds
- Two types:
  - Unshielded twisted pair (UTP)
  - Shielded twisted pair (STP)
Twisted-pair cabling

- UTP is more commonplace
- STP
  - provides the extra shielding by using an insulating material wrapped around the wire
  - Greater resistance to EMI and attenuation
  - More cost

<table>
<thead>
<tr>
<th>Category</th>
<th>Maximum data rate</th>
<th>Usual application</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 1</td>
<td>Up to 1 Mbps (1 MHz)</td>
<td>analog voice (POTS), Integrated Services Digital Network (ISDN), Doorbell wiring</td>
</tr>
<tr>
<td>CAT 2</td>
<td>4 Mbps</td>
<td>Mainly used in the IBM Cabling System for Token Ring networks</td>
</tr>
<tr>
<td>CAT 3</td>
<td>16 Mbps</td>
<td>Voice and data on 10BASE-T (Ethernet)</td>
</tr>
<tr>
<td>CAT 4</td>
<td>20 Mbps</td>
<td>Used in 16 Mbps Token Ring, Otherwise not used much</td>
</tr>
<tr>
<td>CAT 5</td>
<td>100 Mbps&lt;br&gt;1000 Mbps (4 pair)</td>
<td>100 Mbps TPDDI&lt;br&gt;155 Mbps ATM&lt;br&gt;No longer supported; replaced by 5E</td>
</tr>
<tr>
<td>CAT 5E</td>
<td>1000 Mbps&lt;br&gt;(10000 Mbps prototype)</td>
<td>100 Mbps TPDDI&lt;br&gt;155 Mbps ATM&lt;br&gt;Gigabit Ethernet&lt;br&gt;Offers better signal-to-noise ratio than CAT 5</td>
</tr>
<tr>
<td>CAT 6</td>
<td>Up to 400 MHz</td>
<td>Super-fast broadband applications&lt;br&gt;Most popular cabling for new installs</td>
</tr>
<tr>
<td>CAT 6E</td>
<td>Up to 625 MHz&lt;br&gt;(field-tested to 500 MHz)</td>
<td>Support for 10 Gigabit Ethernet (10GBASE-T)</td>
</tr>
<tr>
<td>CAT 7</td>
<td>600-700 MHz&lt;br&gt;1.2 GHz in pairs with Siemon connector</td>
<td>Full-motion video&lt;br&gt;Teleradiology&lt;br&gt;Government and manufacturing environments&lt;br&gt;Shielded system</td>
</tr>
</tbody>
</table>
RJ-45 connectors

- RJ-45 are used with twisted-pair cabling.
- Resemble ordinary phone jacks (RJ-11)
- Eight wires instead of four
- Larger.
- Check out this page for how to make cat5 cable.
  http://www.tomax7.com/aplus/cat5.htm

Fiber-optic cable

- Use light transmissions
- EMI, crosstalk and attenuation become no issue.
- Well suited for data, video and voice transmissions
- Most secure of all cable media
- Installation and maintenance procedures require skills
- Cost of cable
- Cost of retrofitting of existing network equipment because incompatible with most electronic network equipment
Fiber-optic cable

- Single mode fiber:
  - A single direct beam of light, allowing for greater distances and increased transfer speeds.
- Multimode fiber:
  - Many beams of light travel through the cable
  - This strategy weakens the signal, reducing the length and speed the data signal can travel.

Fiber-optic connectors

There are a variety of connectors and several ways of connecting these connectors, such as bayonet, snap-lock, and push-pull connectors. A couple here:

- FC
- MIC, Standard FDDI connector
- ST
- LC
- SC
- SC duplex
Wireless media

- Three types:
  - Radio wave
  - Infrared
  - Microwave
- Speeds of wireless solutions don’t keep pace with cable solutions
- Installation and maintenance are far more complicated and costly.
- Some solutions require line-of-sight, such as infrared and microwave.

IEEE 802.3 standards

- IEEE 802.3 standards defines a range of networking systems that are bases on the original Ethernet standard.
- 10Base2
  - Speed 10Mbps
  - Total segment length of 185m (roundup to 2, which is the number in 10Base2) using RG-58 coaxial cable.
  - Allow a maximum of five segments with only three of those segment populated.
IEEE 802.3 standards

- **10Base5**
  - 10Mbps
  - Physical bus topology
  - Allow 500 meters
- **10BaseT**
  - 10Mbps
  - Twisted-pair cabling, UTP 3,4,5
  - Star topology

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<table>
<thead>
<tr>
<th>Standard</th>
<th>Cable type</th>
<th>Segment Length</th>
<th>Connector</th>
<th>Topology</th>
</tr>
</thead>
<tbody>
<tr>
<td>10Base2</td>
<td>Thin Coaxial</td>
<td>185 meters</td>
<td>BNC</td>
<td>Physical bus</td>
</tr>
<tr>
<td>10Base5</td>
<td>Thick Coaxial</td>
<td>500 meters</td>
<td>Vampire Taps</td>
<td>Physical bus</td>
</tr>
<tr>
<td>10BaseT</td>
<td>Category 3,4,5 twisted pair</td>
<td>100 meters</td>
<td>RJ-45</td>
<td>Physical star</td>
</tr>
</tbody>
</table>
IEEE 802.3 standards

- Fast Ethernet, IEEE 802.3u specifications, three variations.
- 100BaseTX
  - Most widely implemented
  - Use two pairs of wire in cat5, can also use STP.
  - Segment 100 meters
- 100BaseT4
  - Can use category 3 or 4 to perform 100Mbps transfer
  - Use all four pairs of wire of cat3,4,5. Not full-duplex.
- 100BaseFX
  - 100 Mbps over fiber-optic cable
  - Maximum segment length 412 meters over multimode fiber and 10,000 meters over single mode fiber.

Fast Ethernet

<table>
<thead>
<tr>
<th>Standard</th>
<th>Cable Type</th>
<th>Segment Length</th>
<th>Connector</th>
<th>Topology</th>
</tr>
</thead>
<tbody>
<tr>
<td>100BaseTx</td>
<td>Category 5 UTP</td>
<td>100 meters</td>
<td>RJ-45</td>
<td>Physical star</td>
</tr>
<tr>
<td>100BaseT4</td>
<td>Category 3,4,5 UTP</td>
<td>100 meters</td>
<td>RJ-45</td>
<td>Physical star</td>
</tr>
<tr>
<td>100BaseFX</td>
<td>Multimode/Single-mode fiber-optic cable</td>
<td>412/Multimode fiber-optic 10,000/single-mode fiber-optic</td>
<td>SC,ST ,MIC</td>
<td>Physical star</td>
</tr>
</tbody>
</table>
Gigabit Ethernet

- IEEE 802.3z and 802.3ab
- 802.3z
  - 1000BaseLX - use long wave length laser
  - 1000BaseSX - use short wave length laser
  - 1000BaseCX – Over STP, 25 meters
- 802.3ab
  - Over cat5 UTP cable.
  - Each of the four pairs transmit 250Mbps, total 1000Bbps.

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<tr>
<th>Standard</th>
<th>Cable Type</th>
<th>Segment length</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000BaseLX</td>
<td>Multimode/ single-mode fiber</td>
<td>550/multimode 5000/single-mode fiber</td>
<td>Fiber connectors</td>
</tr>
<tr>
<td>1000BaseSX</td>
<td>Multimode fiber</td>
<td>550 meters using 50 Micron multimode fiber</td>
<td>Fiber connectors</td>
</tr>
<tr>
<td>1000BaseCX</td>
<td>STP twisted pair</td>
<td>25 meters</td>
<td>9-pin shielded connector, 8-pin fiber channel type 2 connector</td>
</tr>
<tr>
<td>1000BaseT</td>
<td>Category 5 UTP</td>
<td>100 meters</td>
<td>RJ-45</td>
</tr>
</tbody>
</table>