Chapter 4 Network Designs

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Physical Topologies

- The way devices on the network are physically connected is known as the topology.
- Topologies specify which of these devices are used to connect systems on the network.
- The four main topologies are:
  - Bus
  - Star
  - Ring
  - Mesh

Bus Topology

- The bus topology is the simplest to install. All devices on the network are connected to one primary trunk cable.
- Bus topology is typically used with a contention network.
- Bus networks are important to pay careful attention to termination. Each end of the trunk cable needs to be properly terminated.
- Without termination the signal will bounce back down the cable causing collisions.

Bus Topology (Continued)

- Bus topologies use coaxial cable.
- Bus topology sections are connected with BNC connectors.
- T connectors are often used to connect the computer to the trunk cable. The T connector can connect the computer to two sections of cable with the bus extending in both directions.
- The end devices on the bus have terminators on one connector of the T.

Bus Topology (Continued)

- The advantages of using bus:
  - Easy to install and configure
  - Inexpensive
  - Easily extended
- The disadvantages of using bus:
  - Performance degrades
  - Barrel connectors used to extend the cable lengths can weaken the signal
  - Troubleshooting a bus can be quite difficult

A Bus Topology Network
Star Topology

- The star topology uses a separate cable for each workstation.
- The cable connects the workstation to a central device, typically a hub.
- If there is a problem with the cable, only the station connected to that cable is affected.
- To add more workstations, simply connect another hub.

Star Topology (Continued)

- Advantages of the star topology include:
  - Easily expanded
  - Easier to troubleshoot
  - Multiple cable types supported by hubs
- The disadvantages of using star include:
  - The hub can be a single point of failure.
  - Requires more cable than most other topologies
  - May require a device to rebroadcast signals across the network

Hub

- Hubs can be used as more than just a central connection device.
  - When a workstation wishes to transmit, it sends a signal to the hub. How the hub handles the message can vary according to the network and the hub type.
- Hub Types:
  - Passive hub
  - Active hub
  - Switched hub

Passive Hub

- It is used to connect computers in a broadcast network.
- The signal sent to a passive hub is sent to all workstations with no regeneration or amplification.
- Passive hubs are simple devices that require no external power.

Active Hub

- Uses an external power source and regenerates the signal before sending it out to all workstations in a broadcast network.
- Active hubs
  - Regenerates the signal
  - Allows greater cable distances
- Certain active hubs are capable of switching.
- Active hubs also contain diagnostic features to aid in network troubleshooting.

Switched Hub

- Directs the signal directly to the recipient.
- Switched hubs can greatly reduce network traffic.
Star Topology Network

Ring Topology

• The ring topology looks like the bus topology with connected ends.
• Rings differ greatly from the bus in function.
  – Ring networks provide high performance for a large number of users.
• Data flow on a ring network travels from computer to computer in one direction.
• The signal is actually retransmitted by each system when passed on to its neighbor.

Token Passing

• Token passing is frequently used on the ring topology.
• With this system, a token is passed around the network. The workstation that has control of the token can transmit data. The data travels the ring to its destination. The destination device returns an acknowledgment to the sender.
• The token is then given to another device, giving it the ability to transmit.

Token Passing (Continued)

• Ring networks using the token-passing media access method can provide many advantages over a star or bus for a large network
  – The signal is regenerated by each system, it can travel a longer distance without degrading.
• Token passing helps to create an orderly network where every device has an opportunity to transmit.
• Under heavy loads, this provides a smoother-functioning network than those using a contention system involving collisions.

Ring Topology (Continued)

• Advantages of using ring include:
  – It provides an orderly network in which every device has access to the token and can transmit.
  – It performs well under heavy load.
• The disadvantages of using ring include:
  – Malfunctioning workstations and cables create problems for the entire network.
  – Changes made when adding or removing a device affect the entire network.
Mesh Topology

• Provides the highest level of fault tolerance.
• A true mesh network uses separate cables to connect each device to every other device on the network, providing a straight communications path.
• Hybrid mesh topology—utilize star, ring, or bus topologies with redundant links for added fault tolerance.

Mesh Topology (Continued)

• Advantages of using mesh include:
  – Enhanced fault tolerance provided by redundant links
  – Easy to troubleshoot.
• The disadvantages of using mesh include:
  – Difficult to install and maintain
  – Costly to provide redundant links

Mesh Topology (Continued)

Network Types

• Network types combine Physical layer protocols with the physical topology to form the basic network.
• The different types of networks are:
  – ARCNET
  – Ethernet
  – Token Ring
  – FDDI

Network Types (Continued)

• Network types are defined by many different characteristics.
  – Maximum number of clients
  – Speed
  – Distance
  – Media access type
• Physical topology may also be part of the specification, as some network types can only use certain physical topologies.
• Costs can vary greatly between the different types, as well as speed and ease of installation.
**ARCNET**

- Characteristics of ARCNET networks:
  - Topology: Star or bus
  - Cable types: RG-62, 90-ohm or 93-ohm coaxial, UTP, and fiber optic.
  - Transmission speed: 2.5Mbps or 20Mbps for ARCNET Plus
  - Maximum number of network nodes: 255

**ARCNET (Continued)**

- Maximum number of nodes per segment: Varies
- Maximum number of segments: Varies
- Minimum distance between nodes: Varies
- Maximum network length: 20,000 feet
- Maximum segment length:
  - Coaxial cable: 2,000 feet
  - UTP cable: 400 feet
  - Fiber-optic cable: 11,500 feet

**ARCNET (Continued)**

- ARCNET’s advantages include:
  - Reliable, mature technology
  - Uses simple technology that is easily installed
  - Operates over several cable types
- The disadvantages of ARCNET include:
  - Limited to 255 devices
  - Operates at a low speed of 2.5Mbps

**ARCNET Cabling**

- ARCNET utilizes UTP or coaxial cable and hubs to connect as many as 255 computers.
- For a more reliable network, RG-62 93-ohm coaxial cable is used with low-impedance NICs.
- When ARCNET is configured in a linear bus, up to eight systems are allowed to share the same cable using BNC T connectors similar to those used in Ethernet.
- ARCNET over UTP calls for 22-AWG or 24-AWG cable with at least two twists per foot.

**Installing and Configuring ARCNET Adapters**

- ARCNET adapters do not have their physical address coded onto the adapter by the manufacturer. ARCNET adapters use switches to set the physical address, which can vary from 1 to 255.
- It is important to maintain addressing standards and to carefully track physical addresses.
- ARCNET networks cannot be interconnected due to the limitation in the number of systems.
- For the greatest speed, it is important to have devices with sequential physical addresses located close to one another.
**ARCNET Troubleshooting**

- Physical addresses are set manually, it is possible to have duplicate addresses on the network, it can cause intermittent problems.
- Make sure you use the correct cable type.
- Be sure to terminate unused ports on hubs using 93-ohm terminators.
- Remember not to connect two passive hubs.
- Do not exceed the maximum cable length to avoid errors on the network.
- As with any other adapter, check your hardware resources (DMA, IRQ, I/O settings, and so on) to be sure no conflicts exist.

**The Future of ARCNET**

- ARCNET Plus will operate at a speed of 20Mbps, it is designed to work with the original ARCNET.
- ARC-NET Plus also allows eight times as many nodes as original ARCNET.
- In ARCNET, each node advertises its transmission capabilities to the other nodes.
  - Ex: if a fast node needs to communicate to a slow node, it steps down to the slower speed for the duration of that session.

**The Future of ARCNET (Continued)**

- ARCNET Plus has the ability to connect with Ethernet, Token Ring, and Transmission Control Protocol/Internet Protocol (TCP/IP) networks using bridges and routers. This is possible because the new version supports the IEEE 802.2 logical link control standard.
- ARCNET Plus makes ARCNET an option for today’s LANs.

**Ethernet**

- Ethernet is the most common network. It offers support for a variety of protocols and computer platforms.
- The Ethernet 802.3 standard was developed by the IEEE 802 Committee.
- Ethernet’s successful due to its varied support and its relatively low cost.

**Cabling standards**

- There are many options for cabling on an Ethernet network.
- Different cable types allow for a variety of network speeds and cabling lengths.
- Ethernet is available in three main standards:
  - 10Base-5: Thick Ethernet.
  - 10Base-2: Thin Ethernet.
  - 10Base-T: Twisted-pair Ethernet.

**Cabling standards**

- There are also several variations.
- Other Ethernet standards include:
  - 10Base-FL
  - 100VG-AnyLAN
  - Fast Ethernet
  - Switched Ethernet
10Base-5

• 10Base-5 is the original Ethernet standard.
• 10Base-5 became known as Thick Ethernet due to the RG-8 cable used in the standard.
• The RG-8 cable uses external transceivers
• 10Base-5 follows the 5-4-3 rule — there can be five segments with four repeaters, and only three of the segments can have workstations.

10Base-5 (Continued)

• The coax cable must be terminated on both ends with one of the terminators providing a ground.
• 10Base-5 Characteristics:
  – Topology: Bus
  – Media access method: CSMA/CD
  – Cable types: 50-ohm RG-8 coax cable
  – Transmission speed: 10Mbps

10Base-5 (Continued)

– Maximum number of network nodes: 300
– Maximum number of nodes per segment: 100
– Maximum number of segments: 5; 3 of which can have connected nodes
– Minimum distance between nodes: 2.5 meters
– Maximum network length: 2,500 meters
– Maximum segment length: 500 meters

10Base-2

• 10Base-2 standard uses RG-58 cable along with T connectors wired in a linear bus configuration.
• Thinner cable is much easier to work with and provides a more cost-efficient Ethernet network.
• The transceiver was moved onto the NIC to provide a simpler network.
• Another limitation is the amount of space between the trunk of the bus and the workstation.

10Base-2 (Continued)

• The coax cable used is RG-58 50-ohm cable using 50-ohm terminators on each end.
• Follow the 5-4-3 rule
• 10Base-2 networks have a maximum length of 925 meters (1,000 m)
• Support as many as 30 devices which must be 0.5 meters apart.
• 10Base-2 is a simple and inexpensive solution for many small networks.
10Base-2 (Continued)

- Characteristics of 10Base-2:
  - Topology: Bus
  - Media access method: CSMA/CD
  - Cable types: 50-ohm, RG-58 coax cable
  - Transmission speed: 10Mbps
  - Maximum number of network nodes: 90
  - Maximum number of nodes per segment: 30

10Base-2 (Continued)

- Maximum number of segments: 5; 3 of which can have connected nodes
- Minimum distance between nodes: 0.5 meters
- Maximum network length: 925 meters (1,000m)
- Maximum segment length: 185 meters (200m)

10Base-2 Network

10Base-T

- 10Base-T is quite different from the other Ethernet standards. This standard utilizes 22-AWG UTP cable with RJ-45 jacks arranged in a star configuration.
- Star topology provides for a more stable and easily maintained network.
- Each device has a separate UTP cable connecting it to the hub.
- The workstations must be at least 2 feet apart and no more than 328 feet from the hub.

10Base-T (Continued)

- Characteristics of 10Base-T:
  - Topology: Star
  - Media access method: CSMA/CD
  - Cable types: Categories 3-5 UTP
  - Transmission speed: 10Mbps
  - Maximum number of network nodes: 1,024
  - Minimum number of nodes per segment: 1
  - Maximum number of segments: 512
  - Maximum distance between nodes: 2.5 meters
  - Maximum network length: No maximum length
  - Maximum segment length: 100 meters

10Base-T (Continued)

- 10Base-T works well for a growing network.
- It must also follow the 5-4-3 rule.
- There is a limit of 1,024 total devices on the network.
- In segmentation, the smaller networks are connected using bridges or routers, allowing for a large overall network.
10Base-T Network

- This standard operates over fiber-optic cable at 10Mbps using baseband signaling.
- This network utilizes hubs and star wiring. Both active and passive hubs can be used.
  - Active hubs are capable of retransmitting the signal while passive hubs just split the signal, directing it to every port on the hub.
- Fiber-optic cable allows a network segment of up to 2,000 meters.
- Each network can support 1,024 nodes, and up to four hubs can be connected.

10Base-FL

- Characteristics of 10Base-FL:
  - Topology: Star
  - Media access method: CSMA/CD
  - Cable types: Fiber optic
  - Transmission speed: 10Mbps
  - Maximum number of network nodes: 1,024
  - Maximum number of nodes per segment: 1

Future Cabling Standards

- 10Base-5, 10Base-2, 10Base-T, 10Base-FL are only capable of 10Mbps.
- One of Ethernet’s greatest advantages is its ability to evolve and expand.
- 3 New cabling standards:
  - Fast Ethernet
  - 100VG-AnyLAN
  - Switched Ethernet

Fast Ethernet

- Fast Ethernet can transmit at either 10Mbps or 100Mbps.
- Fast Ethernet can transmit across UTP or fiber optics.
- The three standards developed are dependent on the type of cable used:
  - 100Base-TX using two-pair Category 5 UTP and STP cable
  - 100Base-T4 using four-pair Category 3 through 5 UTP cable
  - 100Base-FX using fiber-optic cable
**Fast Ethernet** (Continued)

- For 100Mbps Fast Ethernet, the adapters and hub must be capable of 100Mbps transfer rates.
  - If any 10Mbps adapters are detected, the entire network will run at 10Mbps.
- With UTP, you are limited to two hubs between workstations, and the hubs must be connected using a 5-meter cable.
- Fiber optics allow a distance of 400 meters between hubs.

**Gigabit Ethernet**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Media</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000BaseLX</td>
<td>Long wavelength laser (1300nm) over single and multi-mode fiber</td>
<td>5km (Single-mode) / Up to 550m (Multi-mode)</td>
</tr>
<tr>
<td>1000BaseSX</td>
<td>Short wavelength laser (850nm) over multi-mode fiber</td>
<td>Up to 550m</td>
</tr>
<tr>
<td>1000BaseCX</td>
<td>Short haul copper twisted pair (STP) cable</td>
<td>25m</td>
</tr>
<tr>
<td>1000BaseT</td>
<td>Four pairs of 100-ohm Category 5 (CAT-5) or better cable</td>
<td>Up to 100m</td>
</tr>
</tbody>
</table>

**100VG-AnyLAN**

- 100VG-AnyLAN uses voice grade fiber optic, as well as Categories 3, 4, or 5 twisted-pair cable to provide a possible transmission rate of 100Mbps.
- Uses hubs in a star topology.
- The media access method used by 100VG-AnyLAN is different from the methods used by standard Ethernet or Token Ring but can be integrated into both types of networks.

**100VG-AnyLAN** (Continued)

- Demand priority method:
  - In which computers that want to transmit send a demand to the hub. The hub allows the computer to transmit.
  - This method allows the hubs to control the media access, preventing packets from being broadcast to the entire network.
  - This method also allows prioritization so the more important items are transmitted first.

**100VG-AnyLAN** (Continued)

- 100VG-AnyLAN can be integrated into a Token Ring network, as well as Ethernet. NICs can transmit Token Ring frames when using the correct driver. A bridge is used to allow 100VG-AnyLAN and Token Ring to coexist.
100VG-AnyLAN (Continued)

- Characteristics of 100VG-AnyLAN
  - Topology: Star
  - Media access method: Demand priority
  - Cable types: Fiber optic, Categories 3–5 UTP, and STP
  - Transmission speed: 100Mbps
  - Maximum number of network nodes: 1,024
  - Maximum number of nodes per segment: 1

100VG-AnyLAN (Continued)

- Maximum number of segments: 1,024
- Minimum distance between nodes: 2.5 meters
- Maximum network length: No maximum length
- Maximum segment length:
  - Category 3 UTP: 100 meters
  - Category 5 UTP: 150 meters
  - STP: 100 meters
  - Fiber optic: 2,000 meters

Switched Ethernet

- Bridges are used in standard Ethernet to reduce the traffic in a segment of the network and to connect segments containing multiple hubs.
- Switches use software to learn the node address of every workstation on its ports.
  - When a packet is directed at a workstation, the switch receives the packet and sends it directly to the destination port, helping prevent network collisions and allowing for a more orderly network.

Frame Type

- Packets can be sent across an Ethernet network in one of several frame types. These frame types are actually syntax for the messages being transmitted.
- IEEE developed the standards for the various frame types used across Ethernet networks.
  - The most common are
    - Ethernet_802.3
    - Ethernet_802.2
    - Ethernet_II.

Installing and configuring Ethernet adapters

- Ethernet adapters are easily installed and configured.
- When installing Ethernet adapters be sure to use the proper resources such as IRQ, I/O settings, DMA, and so on.
- Some adapters use a switch to specify whether the transceiver is external or internal; this needs to be configured properly for your setup.
- Many of the current adapters have connections for the three main standards of Ethernet. They have the 15-pin DIX connector, a coax connector, and a RJ-45 connector for UTP cable.

Troubleshooting

- Different devices need to be examined when troubleshooting the different Ethernet standards.
- 10Base-5 problems:
  - attributed to the transceiver,
  - due to a problem with termination or grounding,
  - a damaged cable can cause problems across the network.
Troubleshooting (Continued)

- 10Base-2 problems
  - associated with incorrect termination a bad connector, or a damaged cable.
- Problems of 10Base-5 and 10Base-2 are more difficult to track down.

Token Ring

- Characteristics:
  - Topology: Physical star, logical ring
  - Media access method: Token passing
  - Cable types: STP, UTP, and fiber optic
  - Transmission speed: 4 or 16Mbps
  - Maximum number of network nodes:
    - UTP: 72
    - STP: 260

Token Ring (Continued)

- Maximum number of segments: 33
- Minimum distance between nodes: 2.5 meters
- Maximum network length: No maximum length
- Maximum segment length:
  - UTP: 45 meters
  - STP: 101 meters
- Frame size:
  - 4Mbps: 4k
  - 16Mbps: 16k

Hardware

- Token Ring uses a physical star to connect systems in a logical ring.
- Inside the central device, the ports are connected in a ring. The ring configuration does have one major weakness: there is a single point of failure. If there is a break in the ring, the entire ring goes down.
- Token Ring hubs can detect a break in the ring and disconnect that portion of the ring, allowing them to route the ring around the failed area.

Hubs

- Multistation Access Unit (MAU): a Token Ring hub.
- MAU is sometimes known as an IBM 8228 MAU and an MSAU.
- MAU internally links the workstations into a ring.
- MAUs have special ring-in and ring-out ports used to connect several MAUs to the ring.
- Controlled Access Unit (CAU): A CAU is an intelligent MAU.
Cables

- **Type 1**: STP cable made of two twisted pairs of solid-core. This type of cable is run to wiring closets. It is also used to connect terminals to distribution panels. It is run through conduit, walls, and so on.
- **Type 2**: STP cable similar to Type 1 but uses four twisted pairs of telephone wires. This cable is used to connect terminals to distribution panels located in the same area.
- **Type 3**: UTP cable with four pairs, each twisted two times every 12 feet. This cable is subject to cross talk and is limited to shorter distances than Type 1 and 2.

Cables (Continued)

- **Type 5**: Fiber-optic cable. Type 5 cable is used only on the main ring path.
- **Type 6**: STP cable. Type 6 STP is much easier to work with but is limited in distance and is typically only used as a patch cable or as an extension in a wiring closet.
- **Type 8**: STP cable. Type 8 cable is run under carpets.
- **Type 9**: STP cable. Type 9 cable is fire retardant and designed for use in ceilings with ventilation systems.

Connectors

- STP cables are connected to the MAU using a hermaphroditic connector, and to the NIC using a 9-pin AUI connector.
- A special patch cable using hermaphroditic connectors on both ends is used to connect the ring-in and ring-out ports on the MAU.
- STP is the most frequently used cable type.
- Category 5 UTP and fiber-optic cable are also allowances.
- When a computer enters the Token Ring network, a click can be heard as the station inserts into the ring.

Installation and configuration of Token Ring adapters

- Token Ring adapters are more intelligent than other network adapters.
- Newer adapters have a BIOS on-board, which stores the configuration parameters. These cards can typically handle either Plug and Play or manual resource settings.
- Ring speed is an important consideration. If the adapter is configured for the wrong speed, this can cause problems for that workstation and others on the ring.

Troubleshooting

- The first station to be activated in a Token Ring network becomes the active monitor.
- The other workstations are known as standby monitors and are potential active monitors.
- The active monitor has several responsibilities. It creates the token and initiates the process of identifying devices on the network.

Troubleshooting (Continued)

- Some of the other responsibilities of the active monitor
  - dealing with lost tokens
  - exterminating tokens that have finished their trip around the ring
  - checking for more than one active monitor
  - correcting problems that occur with a short ring that can’t hold the token.
Beaconing

- If a computer doesn’t hear from its neighbor every seven seconds it assumes there is a problem and alerts the authorities.
- The workstation sends its address, the address of its nearest active upstream neighbor, and the type of error known as a beacon.
- Beaconing helps identify fault domains, which are areas on the ring with a problem.
- When a computer beacons the network, the failing system tries to repair itself; this is known as auto-reconfiguration.
- Beaconing and auto-reconfiguration allow a Token Ring network to attempt to diagnose and repair itself.

Token Ring Summary

- Advantages:
  - Performs well under heavy load
  - Uses intelligent adapters for self-diagnosis and repair
  - High-speed network capable of 4 or 16Mbps
- Disadvantages:
  - Expensive
  - Difficult to troubleshoot

FDDI

- Fiber Distributed Data Interface, or FDDI, is a token-passing ring network similar to Token Ring, but running over a fiber-optic cable.
- FDDI allows several devices to transmit at once.
- Instead of using hubs, FDDI uses concentrators to connect devices.
- FDDI utilizes fiber-optic cable, it is capable of transmitting at the rate of 100Mbps.

FDDI(Continued)

- FDDI allows many frames to be transmitted simultaneously. This is possible because the station that controls the token can send several frames without waiting for the previous frame to complete its journey around the ring.
- FDDI has other methods for further increasing the speed of the network
  - Synchronous frames. This method assigns transmission times to certain devices that do not require a token.
  - Multiframe dialogs utilize limited tokens. This allows two devices to transmit to one another without interference.
- FDDI creates a faster, more reliable network is to utilize two rings that run counter to one another.
  - This provides fault tolerance on the network. If the cable is damaged, a connection is made between the two rings before and after the break; this is known as wrapping. Wrapping forces the packets to travel twice the distance but enables the packets to reach their destination.
FDDI

• There are several adapters and concentrators used in FDDI to allow for a single- or dual-ring configuration.
  – Class A systems are those that are configured to connect to only one ring.
  – Class B systems can be connected to both rings.
• Because a workstation can bring down the ring, be sure that systems connected to both rings are highly reliable.

FDDI

• Summary:
  – Topology: Ring
  – Media access method: Token passing
  – Cable types: Fiber optic
  – Transmission speed: 100Mbps
  – Maximum number of network nodes: 500
  – Maximum number of nodes per segment: No maximum number of nodes per segment

Cabling

• In a fiber cable, light only moves in one direction. For two-way communication to take place, a second connection must be made between the two devices.
  – A laser at one device will send pulses of light through this cable to the other device.
  – These pulses are translated into 1’s and 0’s at the other end.
• No electrical fields are created around the cable, so you could run a bundle of fiber together with no ill effects.

Cabling

• In the center of the fiber cable is a glass strand, or core. Around the internal core is a reflective material known as cladding.
  – This way all light is reflected through the glass since no fiber installation will be an exact straight line with no light leaving the internal glass core.

Single mode and Multimode fiber

• Single-mode Cable
  – only allows for one light path through the cable
  – allows for a faster transmission time and longer distances.
  – normally only used for long distances, as in tens of miles.
• Multimode Cable
  – has many paths
  – If you are just connecting close buildings, stick with multimode.
Installation and configuration of FDDI networks

- High speeds
  - Fiber-optic cable currently has a bandwidth of more than 2Gbps.
  - FDDI has a bandwidth of 100Mbps
- Distances
  - A fiber-optic cable can run tens of miles, so attenuation is not a problem.
  - This allows the greatest distance of any bound network media. FDDI is limited to a distance of 200 kilometers.
- There is also no susceptibility to EMI since the transmission occurs over light, not electricity.

Troubleshooting

- The major component to examine when troubleshooting a FDDI network is cabling.
- Remember to be careful when installing fiber-optic cable. Too sharp a bend can cause problems with the signal.
- Be sure to use the proper cable type for the distance the signal needs to travel. Multimode fiber should only be used for distances less than 2 kilometers.

FDDI Summary

- Advantages:
  - FDDI is the fastest network and is capable of 100Mbps transfers.
  - Fiber-optic cable allows signals to travel great distances, up to 200 kilometers.
  - Dual rings provide a higher level of fault tolerance.
- Disadvantages:
  - Expensive cable and equipment is required.
  - Workstations can be a single point of failure for both rings.
  - FDDI requires a high level of expertise to install, troubleshoot, and maintain.