red Backbone Design of CNs

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Outline

1. Enterprise Backbone Basics
2. Structured Cabling
3. Types of Backbones
4. Backbone Examples
5. The Network Development Life Cycle (NDLC)

rise Backbone Basics

- Modern organizations have
  - » Large networks
  - » Complex communication requirements
    - ï Access to mainframe data
    - ï Internetworking of several LANs
    - ï Connectivity to a WAN (the Internet)
    - ï Transmission of data and non-data

kbone Basics (Cont.)

- Complex requirements mandated the structuring of enterprise-wide information distribution.
- Such structuring is effectively achieved through a system called **Backbone**.
- Structured wiring combined with Backbone solution provide a powerful and efficient networking solution to company-wide communication needs.

kbone Basics (Cont.)

- Key Factors in assessing network topologies:
  - » **Performance**
    - ï Highest network availability.
    - ï Lowest latency.
    - ï Most appropriate connectivity for users.
  - » **Scalability**
    - ï Ability to expand the network in terms of end-points and aggregate bandwidth without affecting existing users.

kbone Basics (Cont.)

- » **Cost of administration:**
  - ï The inherent ease of moves, adds, and changes, plus the capability to efficiently diagnose, remedy, or prevent network outages.
- **Structured Backbone solutions offer**
  - » **Flexibility**
  - » **Scalability**
  - » **Troubleshooting & Manageability**
  - » **Performance**

uctured Cabling

- Cabling plan should be easy to:
  - » implement, and
  - » accommodates future growth.
- Two standards have been issued that specify cabling types and layout for structured commercial buildings wiring.
- A network should follow a cabling plan:
  - » **Selection of cable types**
  - » **Cable layout topology**

red Cabling Standards

- **EIA/TIA-568:** Issued jointly by the Electronic Industries Association and the Telecommunications Industry Assoc.
- **ISO 11801:** Issued by the International Organization for Standardization.
- Both Standards are similar.

ctured Cabling (Cont.)

- It is a generic wiring scheme with the following characteristics:
  - » Wiring within a commercial building.
  - » Cabling to support all forms of information transfer.
  - » Cable selection and layout is independent of vendor and end-user equipment.
  - » Cable layout designed to encompass distribution to all work areas within the building (relocation wouldn't need rewiring).

ctured Cabling (Cont.)

- Based on the use of a hierarchical star-wired cable layout.
  - » External cables terminate at **Equipment Room** (**ER**).
  - » Patch panel and cross-connect hardware connect ER to Internal Distribution Cable.
  - » Typically, first level of distribution consists of Backbone cables.
  - » Backbone cable(s) run from ER to Telecom Closets (Wiring Closets) on each floor.

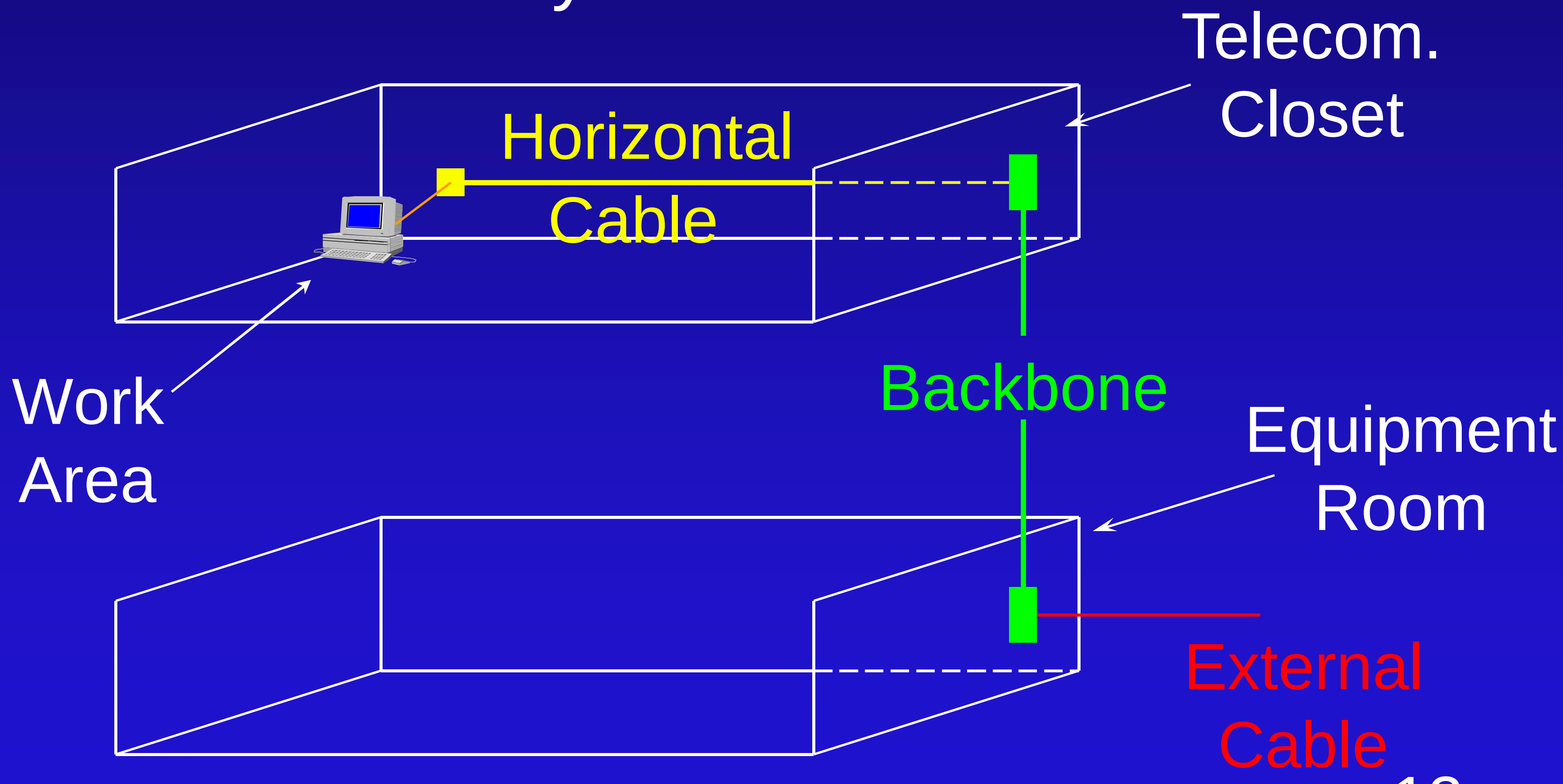
ctured Cabling (Cont.)

- » Wiring Closet contains cross-connect equipment for interconnecting cable on a single floor to the Backbone.

- Cable distributed on a single floor is called Horizontal Cabling, and connects the Backbone to Wall Outlets that service individual telephone and data equipment.

ctured Cabling (Cont.)

- Based on the use of a hierarchical star-wired cable layout.



ed Cabling Terminology

Backbone

A facility between telecommunications closets or floor distribution terminals, the entrance facilities, and the equipment rooms within or between buildings

Horizontal Cabling

The wiring/cabling between the telecom outlet and the horizontal cross-connect

rminology (Cont.)

Cross-Connect

A facility enabling the termination of cable elements & their interconnection, and/or cross-connection, primarily by means of a patch cord or jumper

Equipment Room

A centralized space for telecom equipt that serves the occupants of the building (Bldg/Campus distributor in ISO 11801)

rminology (Cont.)

Telecommunications Closet:

An enclosed space for housing telecom eqpt, cable terminations, and cross-connect cabling; the location for cross-connection between the backbone and horizontal facilities

Work Area

A building space where the occupants interact with the telecom terminal eqpt

rminology (Cont.)

Main Cross-Connect

A cross-connect between 1st and 2nd level backbone cables, entrance cables, and equipment cables (no ISO name)

Intermediate Cross-Connect

A cross-connect between 1st and 2nd level backbone cabling (no ISO name)

rminology (Cont.)

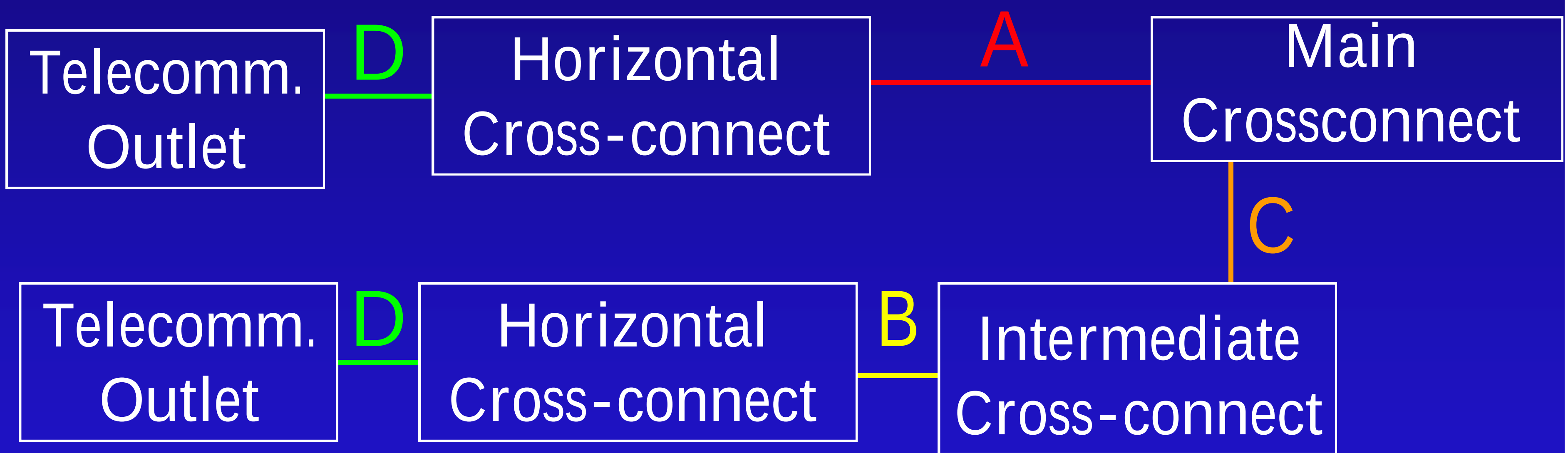
Horizontal Cross-Connect:

A cross-connect of horizontal cabling to other cabling, e.g. horizontal, backbone, or equipment (no ISO name)

Telecommunications Outlet

A connecting device in the work area on which horizontal cable terminates

dia Recommended



Cable Distances

- **UTP (Voice Transmission)**

MC-HC	HC-IC	MC-IC	TO-HC
A	B	C	D
800m	500m	300m	90m

- **Cat 3 or 5 UTP (up-to 16 or 100 MHz), and STP (up-to 300 MHz)**

A	B	C	D
90m	90m	90m	90m

e Distances (Cont.)

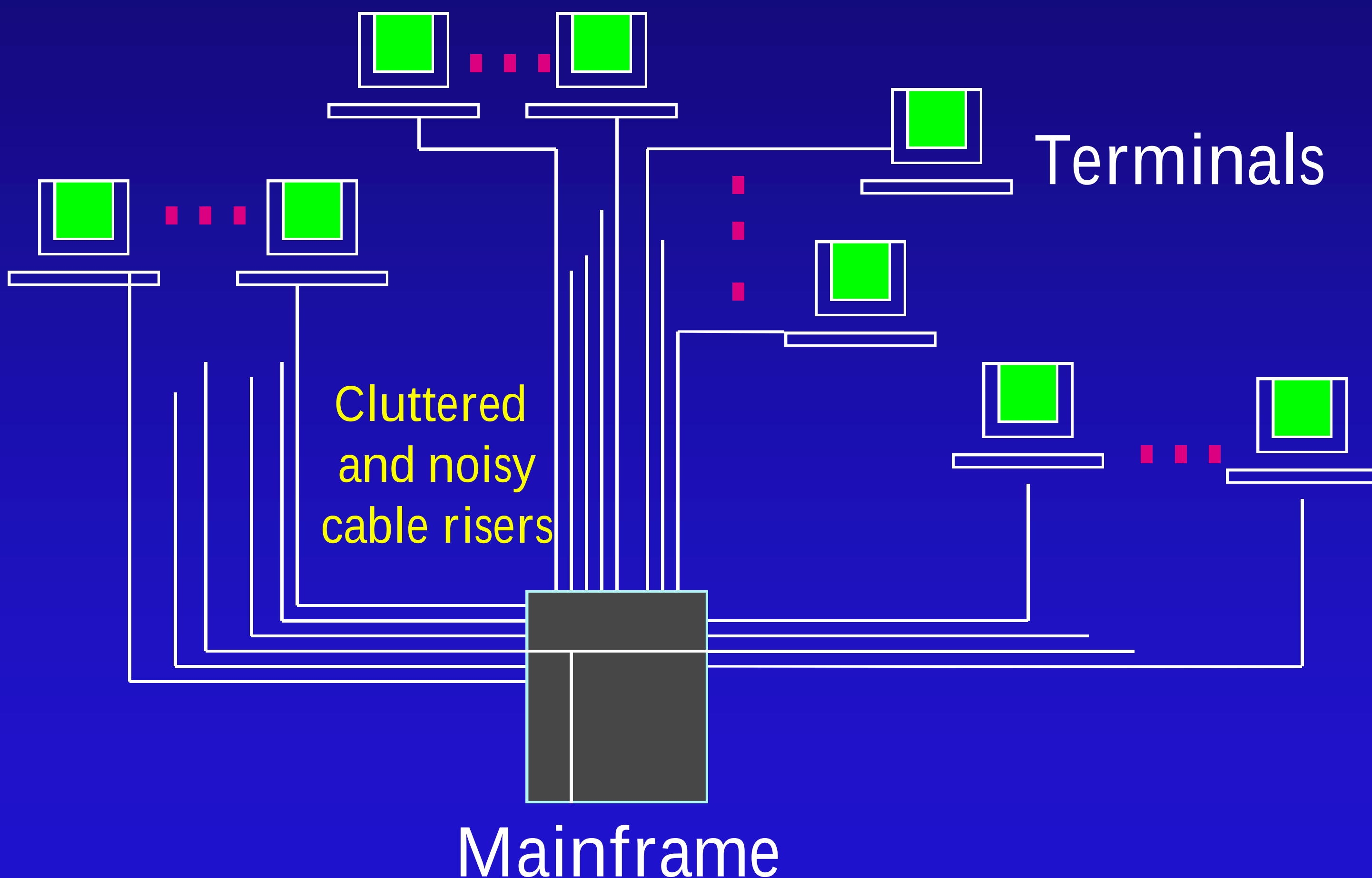
- **62.5 microns Fiber**

MC-HC	HC-IC	MC-IC	TO -HC
A	B	C	D
2000m	500m	1500m	90m

- **Single-Mode Fiber**

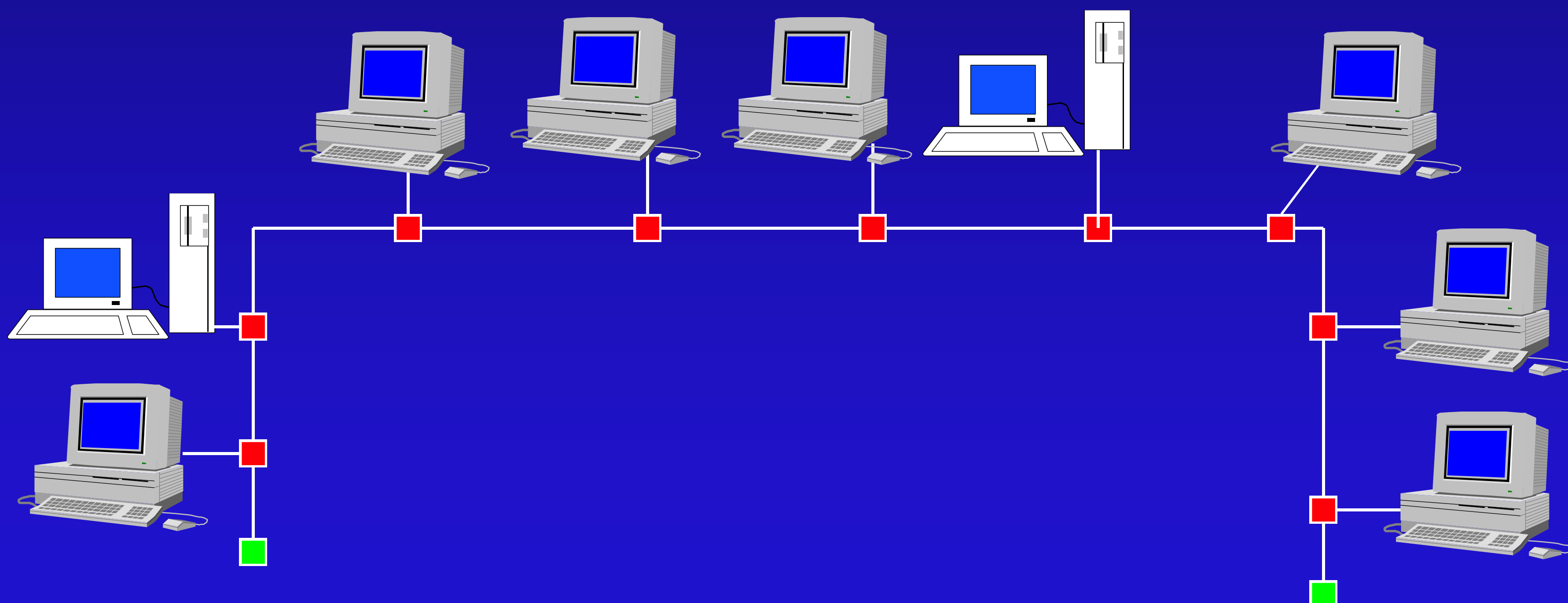
A	B	C	D
3000m	500m	2500m	90m

red Backbone -- Mainframe



ctured Backbone -- LAN

Each station must be physically connected by a thick coax tapped to the LAN coax, running by all stations.

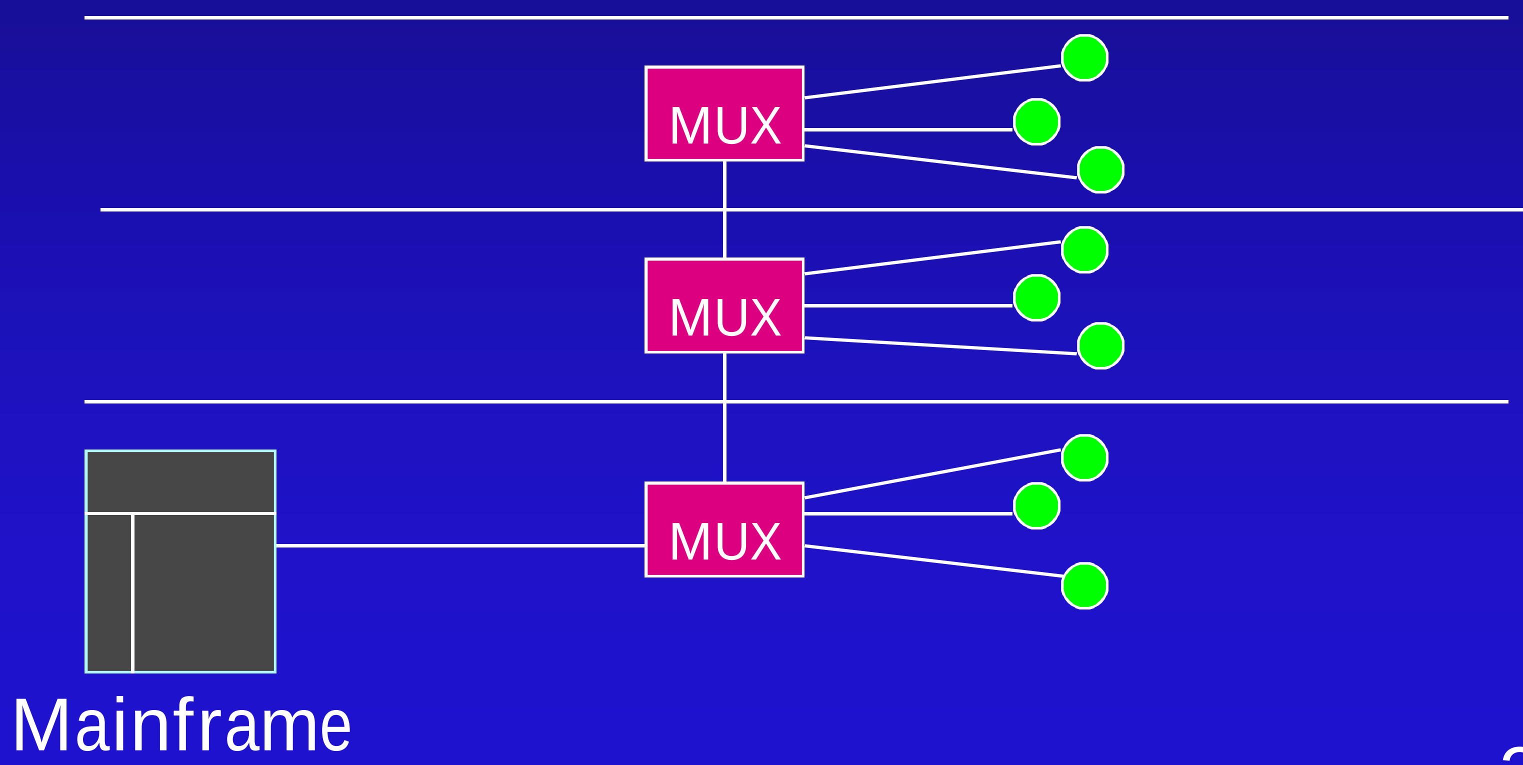


ructured Backbone

- By using a MUX or similar device, a backbone can be structured.
  - » A single fiber pair replaces mounds of coax cable, and
  - » floor-to-floor traffic is systematically organized.
- With Structure comes enhanced
  - » network control
  - » reliability, and
  - » efficiency.

...tured Backbone (Cont.)

- Structured backbone = structured, hierarchical physical star wiring scheme.



tured Backbone(Cont.)

- The first information backbone emerged in the mid 1980’s.
- An enterprise backbone is an aggregate data path (a central communication highway) for the transport of all signals to / from users distributed throughout the enterprise.
- Early backbones were mainly muxes.

tured Backbone(Cont.)

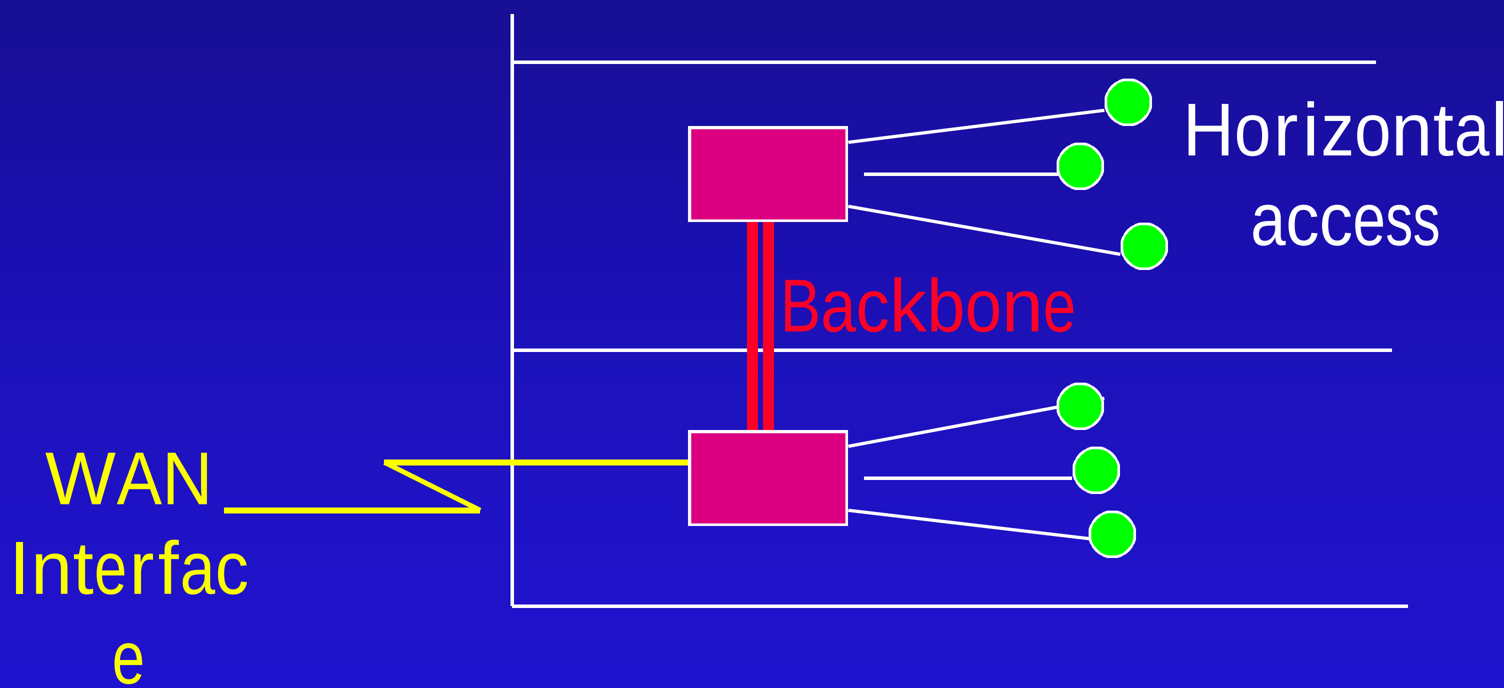
- The enterprise network is usually comprised of three main parts:
  - » The horizontal access portion:

    Connecting individual workstations to wiring closets and most often accomplished via an intelligent cabling Hub.
  - » The Backbone portion:

    Facilitating floor-to-floor or building-to-building connectivity.

ured Backbone (Cont.)

» The Wide Area Network link



are Backbones needed?

- Companies utilizing Backbone technology have typically one or more of the following communication needs:
  - » Multiple data protocols and signals.
  - » Heavy network traffic to be supported simultaneously.
  - » Multiple workgroups, networks, and facilities that need to be internetworked.
  - » Mission critical applications where high reliability and security are mandatory.

Backbones needed? (Cont.)

- » Need to support varying media and device types.
- » A high degree of upgradeability, so that existing equipment can be preserved and higher performance hardware and software solutions can be implemented seamlessly.
- » A high degree of network moves, adds, and changes, requiring that the enterprise network be highly manageable.

…f (private) Backbones

Three broad categories:

(1) **Multiplexers-based.**

(2) **LAN Backbones.**

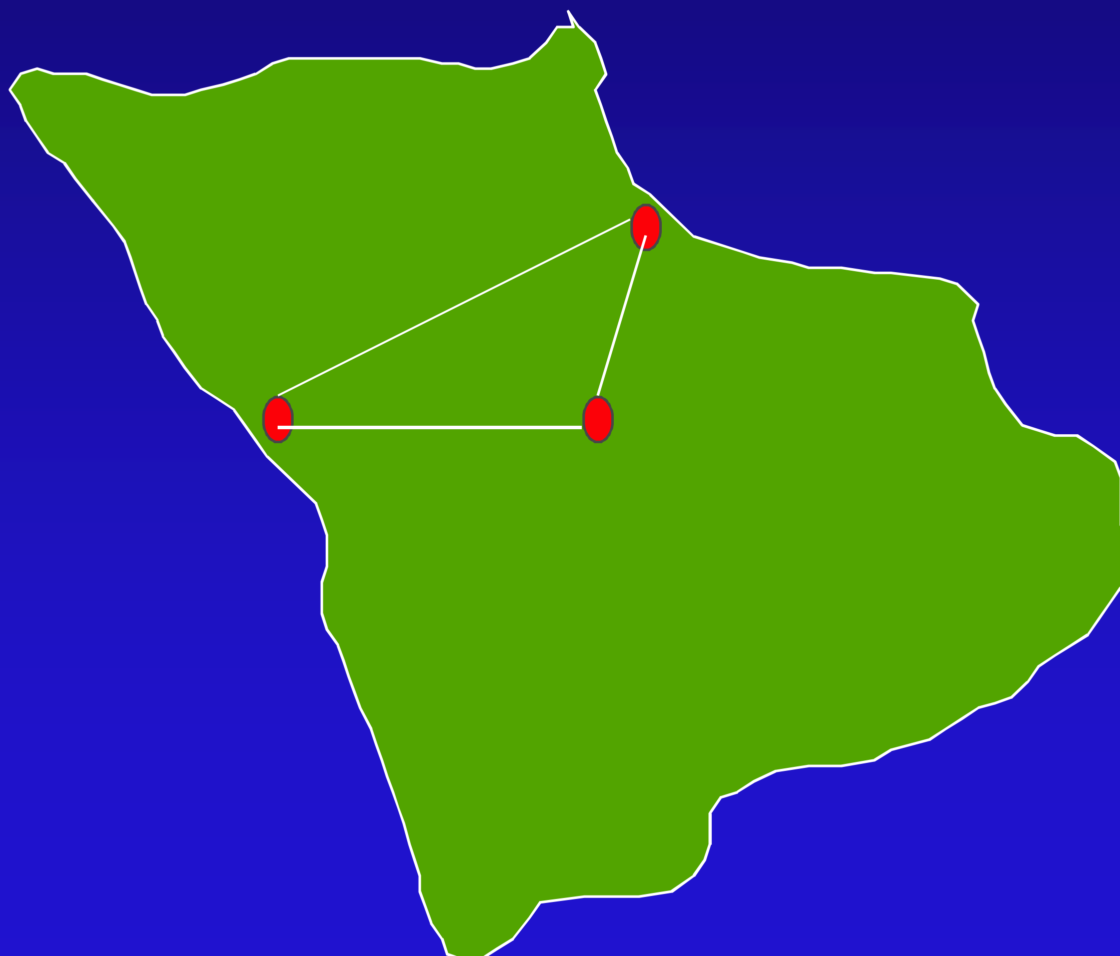
FDDI, Ethernet, Token Ring, etc

(3) **Collapsed Backbones.**

High-speed Router, ATM.

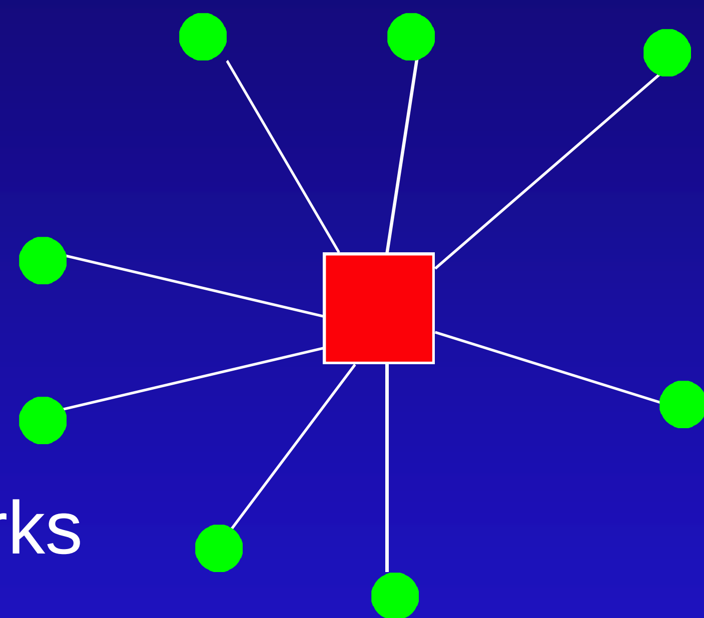
ublic Backbones

Public telephone/data network



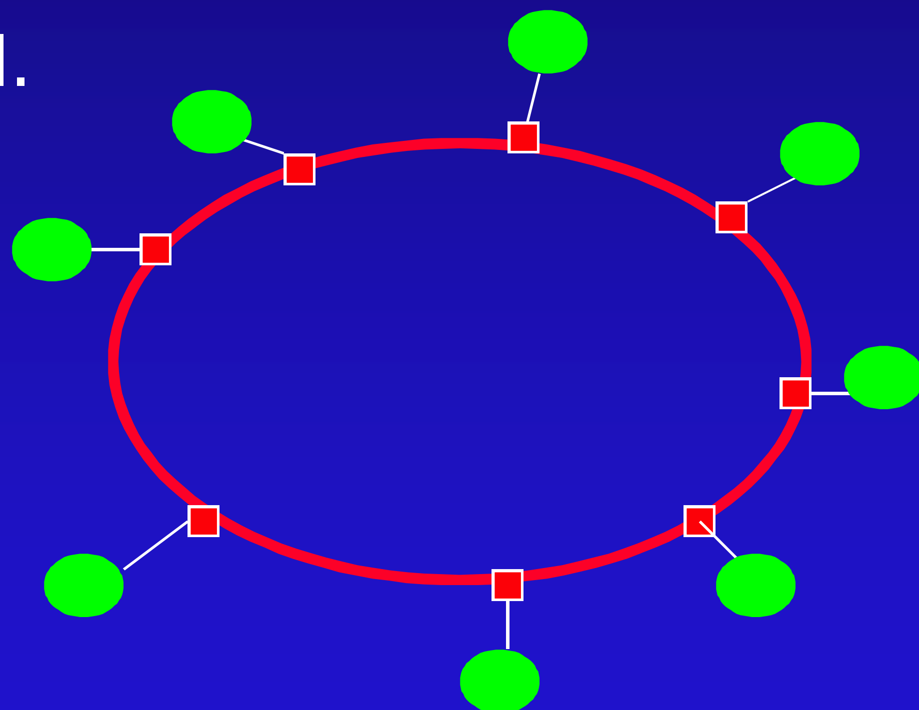
kbone Topologies

- **Star**
  - » Collapsed Backbone
  - » PBX system
  - » Switch-based networks



one Topologies (Cont.)

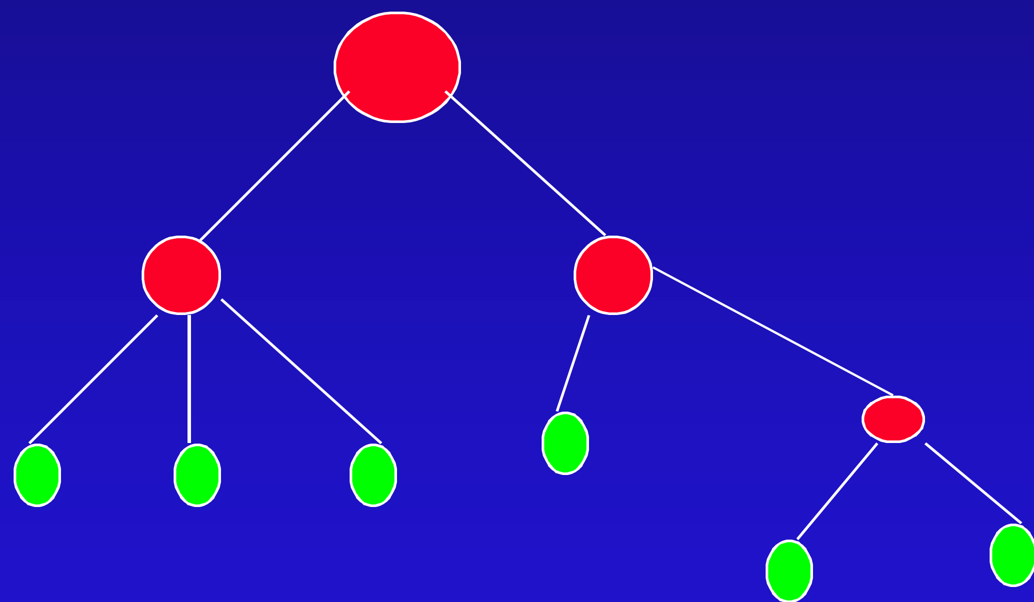
- **Ring.**
  - » Ex: FDDI.



one Topologies (Cont.)

- **Hierarchical/Inverse Tree.**

  Higher power at higher levels.

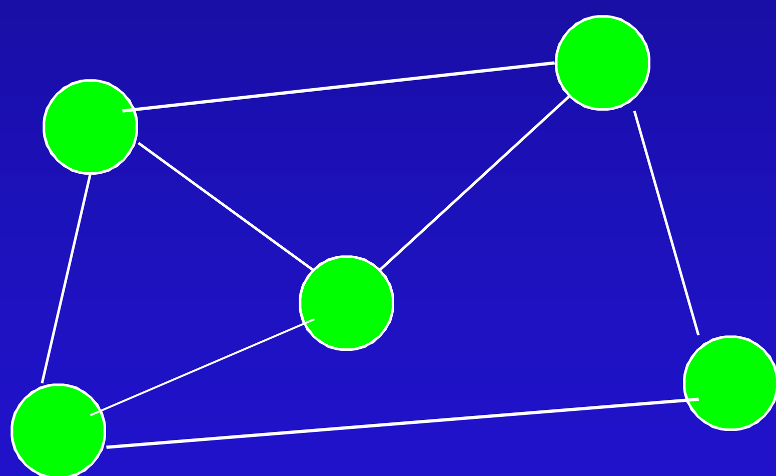


...one Topologies (Cont.)

- **Mesh.**

  Multiple data paths between peer stations.

  Topology relies on the use of **Routers**.



ckbone Benefits

- Makes complex distributed computing environment easier to manage.
- Allows Organizations to easily upgrade the system.
- Creates an integrated communication path capable of accommodating the enterpriseôs data transfer requirements safely and cost effectively.

Fiber Optics

- Many of the Backbone advantages are enabled by the implementation of fiber.
- Advantages of fiber:
  - Ability to combine data, voice & video signals over a single fiber pair.
  - Very large bandwidth: (allows large number of users, is cost effective and space-conservative).
  - Increased data security & reliability.

cation / Bandwidth

- High capacity Backbone is a must to support increasing need for bandwidth.

Application	Bandwidth
Digital audio	1.4 Mbps
Compressed video (JPEG)	2 - 10 Mbps
Document Reprographics	20 -100 Mbps
Compressed broadcast-quality TV	20 -100 Mbps
High-definition full motion video	1 - 2 Gbps
Chest X-Ray	4 - 40 Mbps
Remote query burst	1 Mbps

…exer-Based Backbones

- The first Backbones were Mux-based.
- Designed for and continued to be used predominantly in the mainframe environment.
- Suitable for situations when a mixture of LAN and host-to-terminal traffic needs to be supported via a common Backbone.
- A Mux is a device that simultaneously transmits several messages or signals across a single channel or data path.

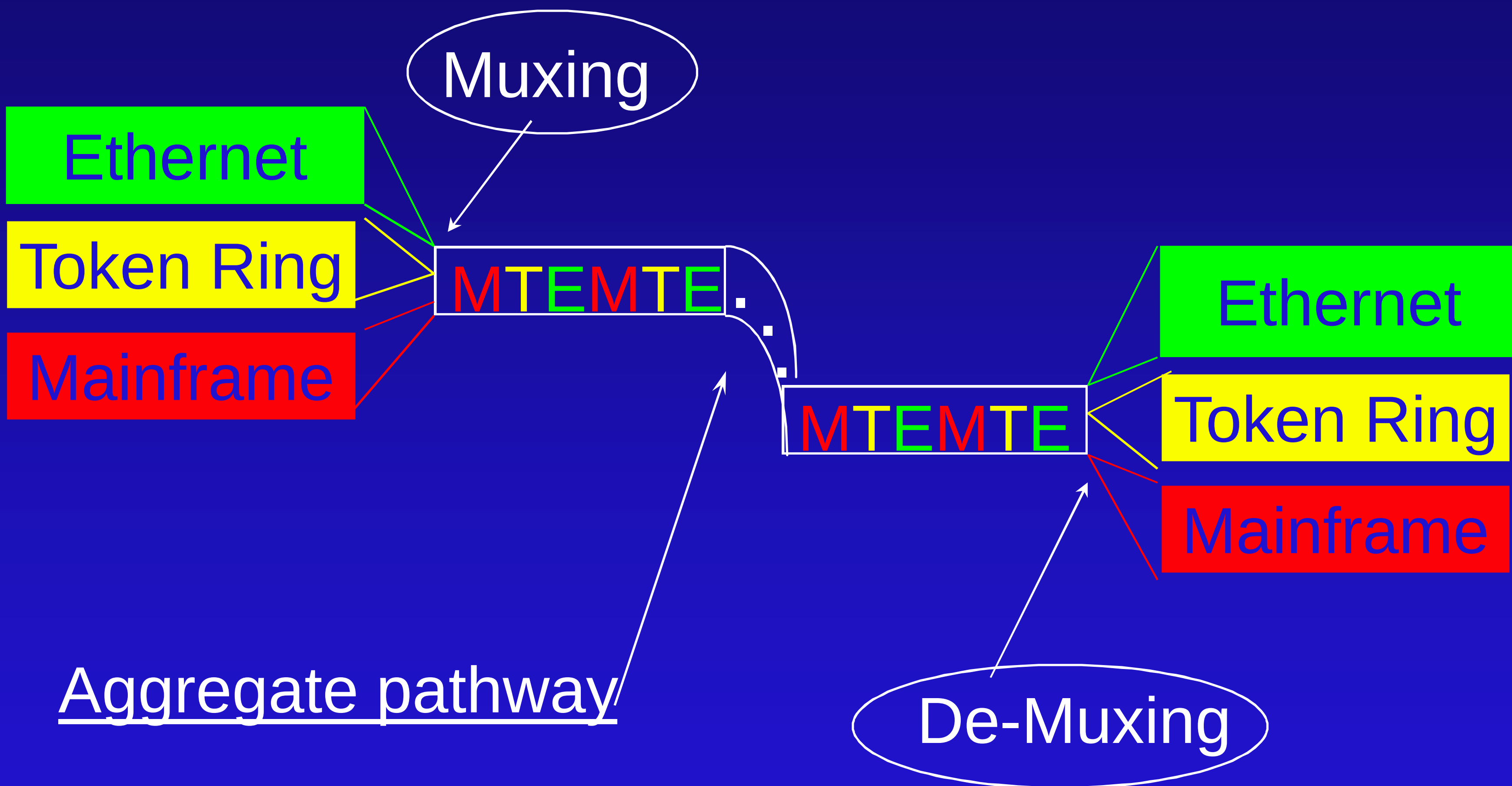
exer-Based Backbones

- Two primary types of Backbone Muxes in use today:
  - » Time Division Mux (TDM).
  - » Statistical or Stat Mux.

e Division Muxes

- A TDM combines signals onto a high speed link, and then sends those signals sequentially at fixed time intervals.
- Each user interface is allocated a time slot within which its data is transmitted.
- Data is usually sent one char at a time
- Combined signal rates > 100 Mbps.

ne Division Muxes



TDM Strengths

- + Dedicated bandwidth partitions
  => Guaranteed throughput & no loss.
- + Versatile & scaleable.
- + Low cost compared to Stat. TDM.
- + Proven Reliable data transport.

D

- Bandwidth of idle sources is lost.
- Minimal internetworking capability.

Statistical TDM

- Based on the premise that stations rarely need to transmit data constantly at full available speed.
- Attempts to move as much data as possible across the common channel.
- Combined bandwidth of all sources exceeds the available bandwidth.
- Allocates time slots on-demand, constantly evaluating traffic needing to be sent (based on priority).

Stat-Mux (Cont.)

- In case demand exceeds capacity, lower-priority traffic is off-loaded into a buffer and delayed for retransmission during a non-peak period

=>More complex front-end management.
Greater degree of intelligence.
Greater computer power.

t-Mux Strengths

- Supports more data than available bandwidth

  => better bandwidth utilization.

- Critical data can be given higher priority.

-Mux Weaknesses

-- Requires more management and more expensive to operate.

-- Low priority data can suffer excessive delays.

-- Data may get lost.
(No guaranteed bandwidth)

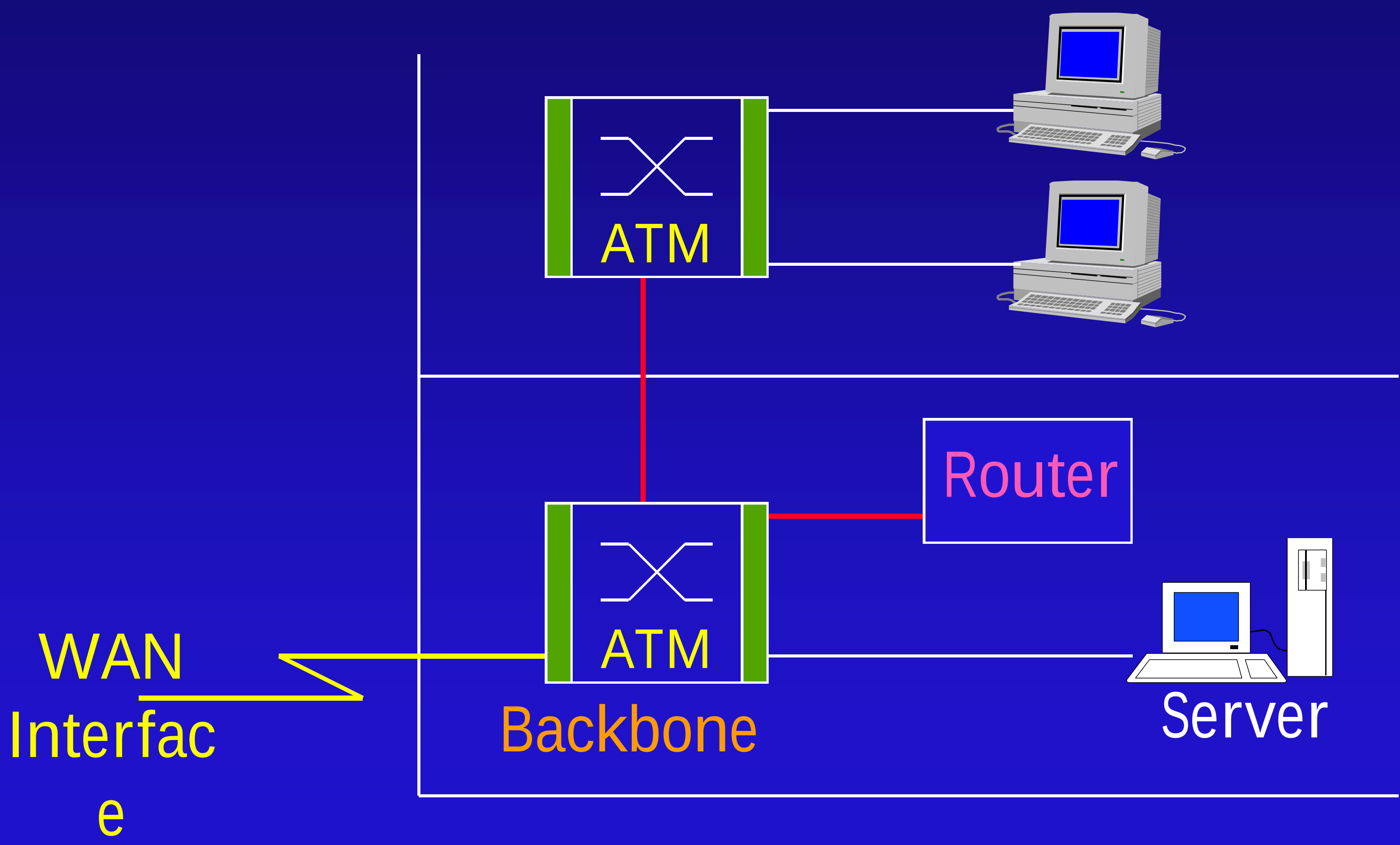
g Backbone Technologies

- Three of the most promising Backbone technologies are:
  - » Asynchronous Transfer Mode (ATM).
  - » Synchronous Optical Network (SONET).
  - » Fibre Channel.

ATM

- Todayﾒs collapsed Backbones are based on Router technology.
- Tomorrowﾒs collapsed Backbones will be based on switching technology.
- ATM is predicted to be at the core of the switching technology.
- ATM is hailed as the first solution that will erase the barriers between LANs and WANs.

ATM (Cont.)



ATM Benefits

- Combines best features of Muxes and LAN Backbones.
- ATM rides on top of a highly scaleable physical layer protocol such as Fiber channel and SONET.
- Short & fixed-length cells **=>** Relatively low cost hardware implementation.
- Can accommodate both real-time and non-real-time data.

M Benefits (Cont.)

- Provides high throughput.
- ATM is not protocol-dependent. Any packet format can be mapped into ATM cells and transported.
  - => It is an ideal data transfer system for changing LAN environments.

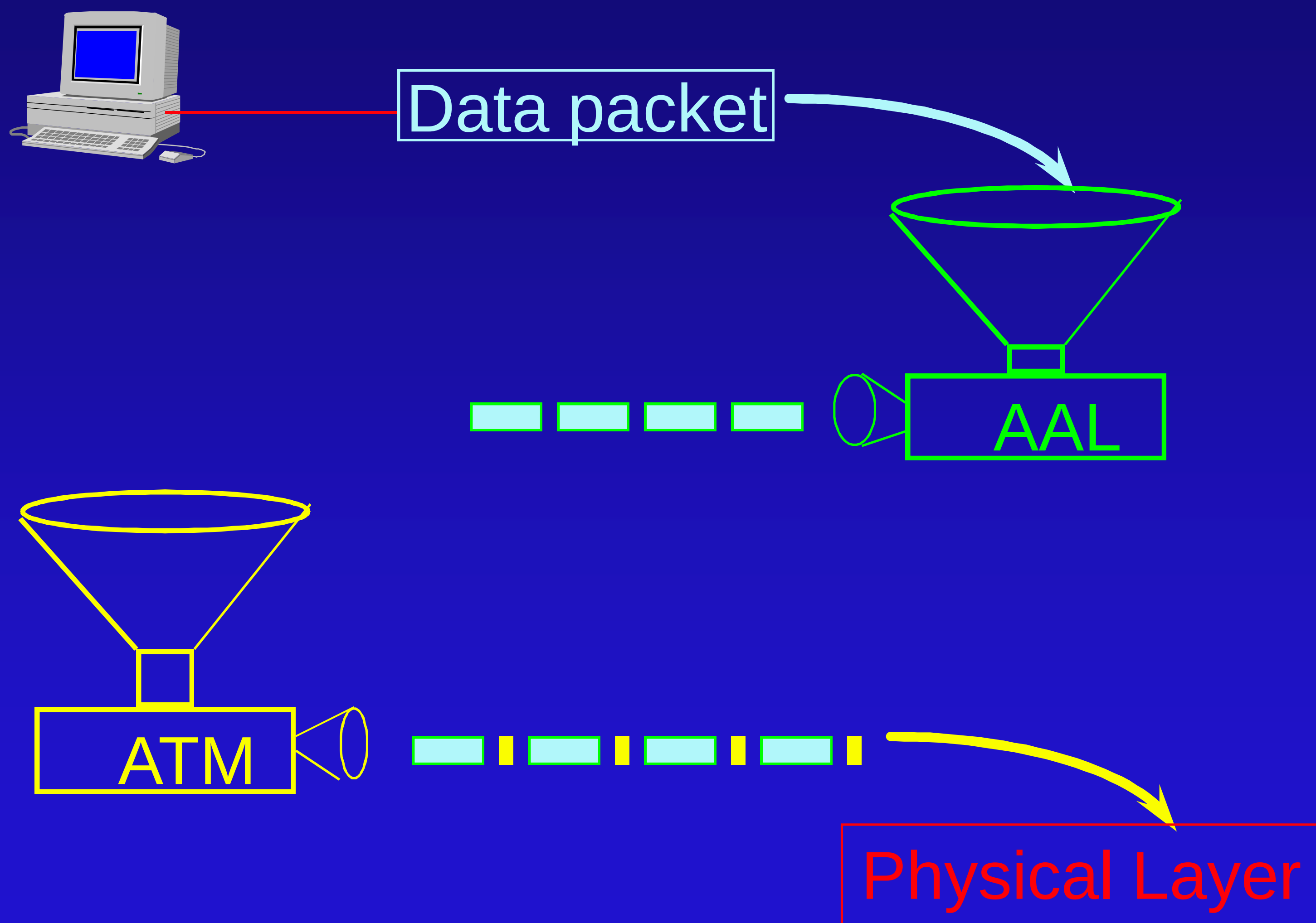
ow ATM Works?

- Data Units: Fixed-length cells of size 53 bytes each (5 Header + 48 payload).
- Operates at the equivalent of MAC sublayer. Operates above physical layer which could be SONET, Fibre channel,...
- Connection-oriented.
- Universal transfer mode for all B-ISDN services.
- Layered architecture.

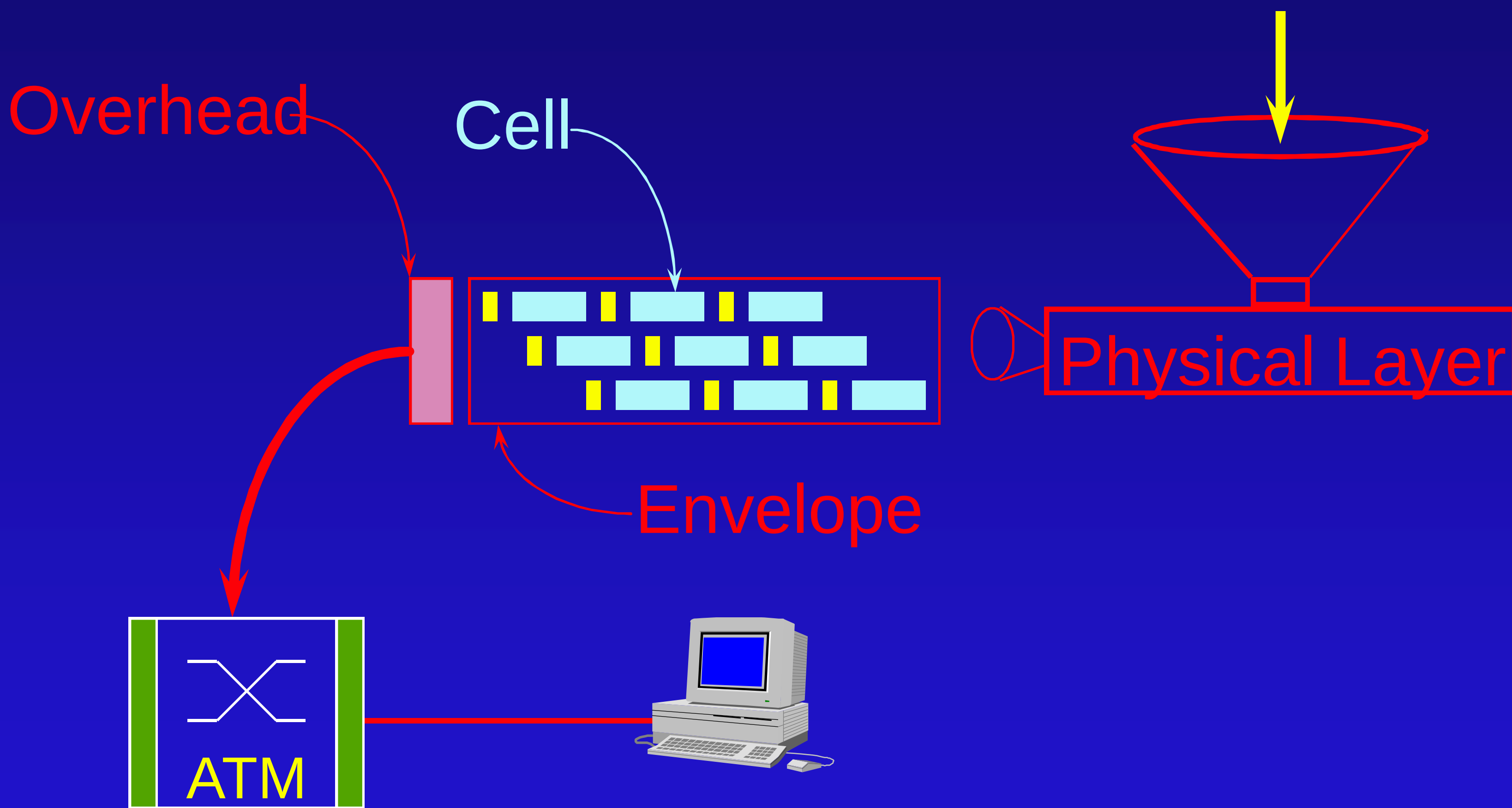
Layered Architecture

Layer	Functions
Higher Layers	User Services & applications
ATM Adaptation Layer	Fragmentation and de-fragmentation of frames
ATM Layer	Cell header insertion/removal Cell relaying & multiplexing Connection establishment
Physical Medium Dependent Layer	Transmission & receipt of bits Synchronization

ow ATM Works?



ATM Works (Cont.)?



Entire process is reversed

les of ATM Switches

- FORE Systems
  - » ASX-200BX (2.5 Gbps backplane)
  - » ASX-1000 (10 Gbps backplane)
- CISCO Systems
  - » NWAYS 8260 (5 Gbps backplane)
- Bay Networks
  - » Centillian-100: campus ATM switch (3.2 Gbps backplane)

s of ATM Switches (Cont.)

- IBM
  - NWAYS 8260 (5 Gbps backplane)
- MADGE Networks
  - Collage 740: Campus ATM switch (5 Gbps backplane)
- ALCATEL
  - 1100 LSS Series 550A

nous Optical Network

- SONET is ANSI & ITU Standard.
- First standard optical interface.
- Used in the public network and is being adopted as a private Backbone solution.
- American SONET Standard:
  - » Rates start at OC-1 : 51.84 Mbps
  - » Scaling up to OC-48 : 2.48 Gbps

SONET (Cont.)

- European SDH:
  - » Initial Rate: SDH-1 = OC-3: 155.52 Mbps
- SONET provides a transport payload envelope and framing format. Any type of data is transparently transmitted with low delays.
- SONET is currently defined for use with single mode fiber.

Fibre Channel

- ANSI X3T9.3 Standard.
- Developed as high speed interface for linking mainframes and their peripherals.
- Better suited as a private Backbone because
  - » less overhead
  - » lowest implementation
  - » multi-mode fiber

e Channel (Cont.)

- Is also highly expandable
  - » Initial Rate : 100 Mbps
  - » Scales up to : 1.6 Gbps
- Has a transport payload envelope

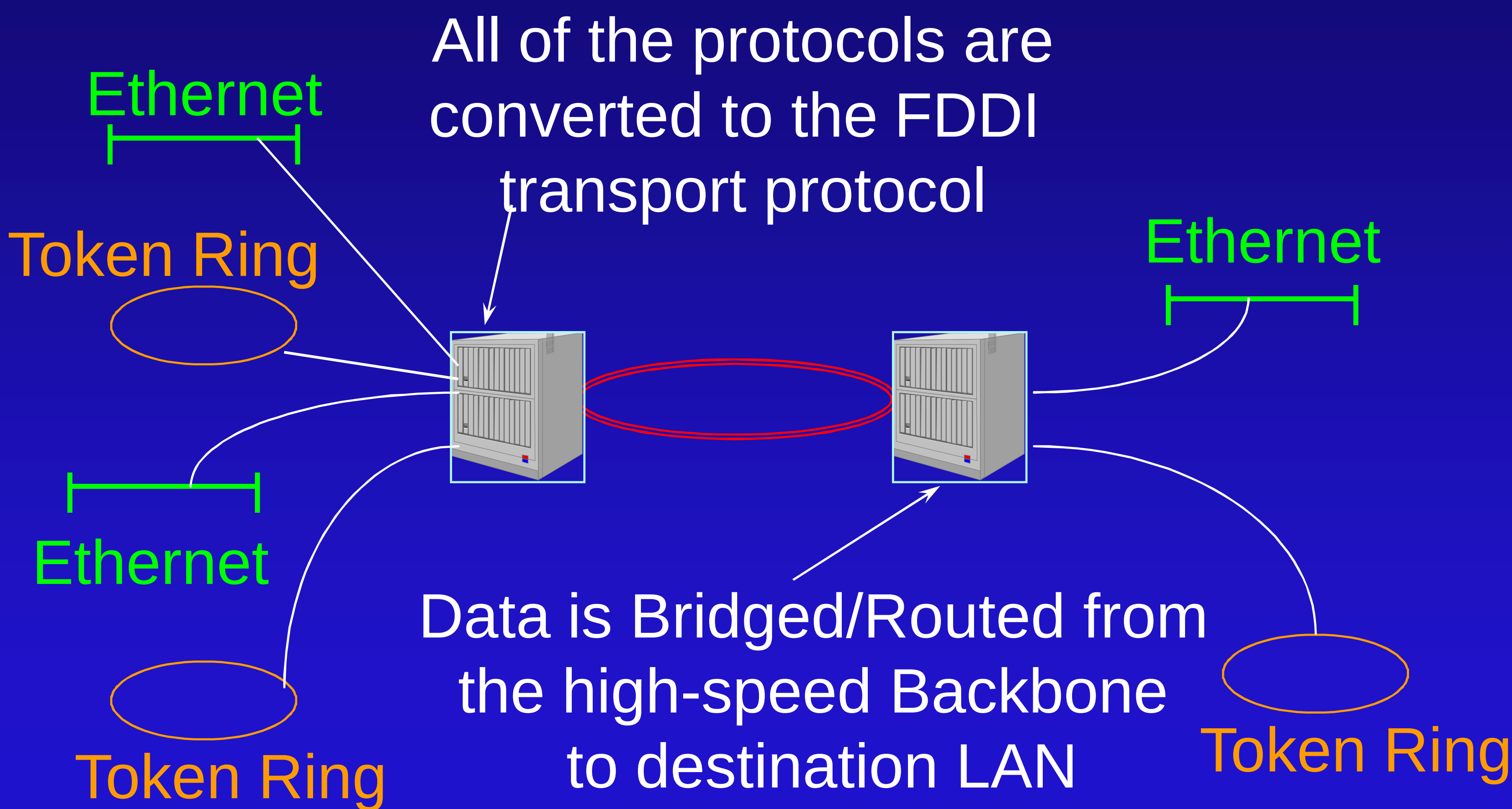
LAN Backbones

- Unlike Muxes which are capable of transmitting an array of data, host-to-host, voice and video signals, LAN Backbones are dedicated exclusively for LAN communication.
- Actually, any legacy LAN such as Ethernet or Token Ring can be called a backbone
- LANs constitute the primary datapaths.

Backbones (Cont.)

- In the broader context of Backbones, the key LAN standard that has far-reaching Backbone-based applications is the Fiber Distributed Data Interface (FDDI).
- FDDI is (still?) the dominant LAN Backbone in use. It provides standards-based connectivity for legacy LANs (Ethernet & Token Ring).

Backbones (Cont.)



Backbones (Cont.)

- FDDI complements existing LANs by providing a high-speed path upon which all LAN protocols can be transported.
- Typical FDDI applications:
  - » Backbone connectivity between LANs in a building or campus.
  - » LAN for high-end graphics & CAD/CAM workstations
  - » Connection device for host-to-host or Backbone-to-Backbone applications.

DDI Strengths

- FDDI is tailor-made and very effective as a high-speed LAN for workstation traffic and as a Backbone for LANs.

- Provides a framework for inter-networking between various LAN protocols.

I Strengths (Cont.)

- Compared to legacy LANs, FDDI provides greater data capacity and performance, transmitting at 100 Mbps.
- Can accommodate large networks of up to 500 Backbone nodes.

I Strengths (Cont.)

- Because of its dual-ring architecture, FDDI offers a high degree of network availability/reliability.
- Using Token passing, traffic is dealt with on a deterministic basis.
- Provides long distance communication (Ring perimeter can be 100 Km with a distance of up to 2Km between Stations)

DDI Weaknesses

- Can accommodate LAN traffic only. Not capable for transporting real-time signals (voice, host-to-terminal, etc.)

- Non scaleable (fixed at 100 Mbps).

- High implementation cost (Processor intensive).

ow FDDI Works?

- It is a token passing fiber ring with a data rate of 100 Mbps.
- Ring can be as large as 100 Km with a distance of 2 Km between stations.
- Most prevalent standard is multi-mode fiber. However, some manufacturers are producing multi-mode to single-mode FDDI adapter.

FDDI Works? (Cont.)

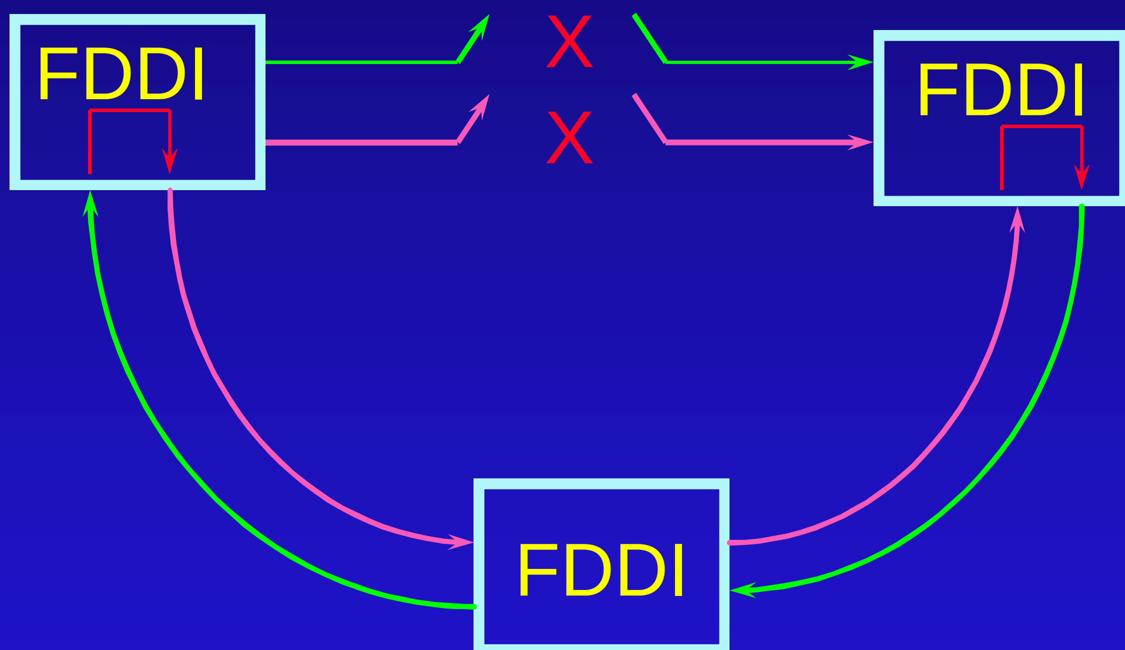
- Others proposed amendments to the standard to support FDDI on twisted pair (CDDI).
- Routers are used to convert competing LAN protocols to FDDI and back.

FDDI Works? (Cont.)

- Dual-counter rotating rings:
  - » Primary link for carrying data.
  - » Secondary link for failure recovery.

- In the event of a node or cable failure, the data on the primary link wraps on to the secondary link, making a U-turn, thus maintaining ring integrity.

FDDI Works? (Cont.)



FDDI Specification

- ANSI Standard.
- Ring as large as 100 Km with a distance of 2 Km between stations.
- 62.5 μ core / 125 μ cladding.
- 1300 nano-meter LED transmitter
- Two types of FDDI networking devices:
  - » Class A devices have dual attachment.
  - » Class B are typically workstations.

DI Specification

- **Class A Devices**
  - » To exploit counter-rotating rings. The failure wrapping feature is implemented through Class A devices.
  - » Can be any networking device, but are usually Bridges, Routers, Concentrators, Servers, or other devices comprising the network Backbone.

A Devices (Cont.)

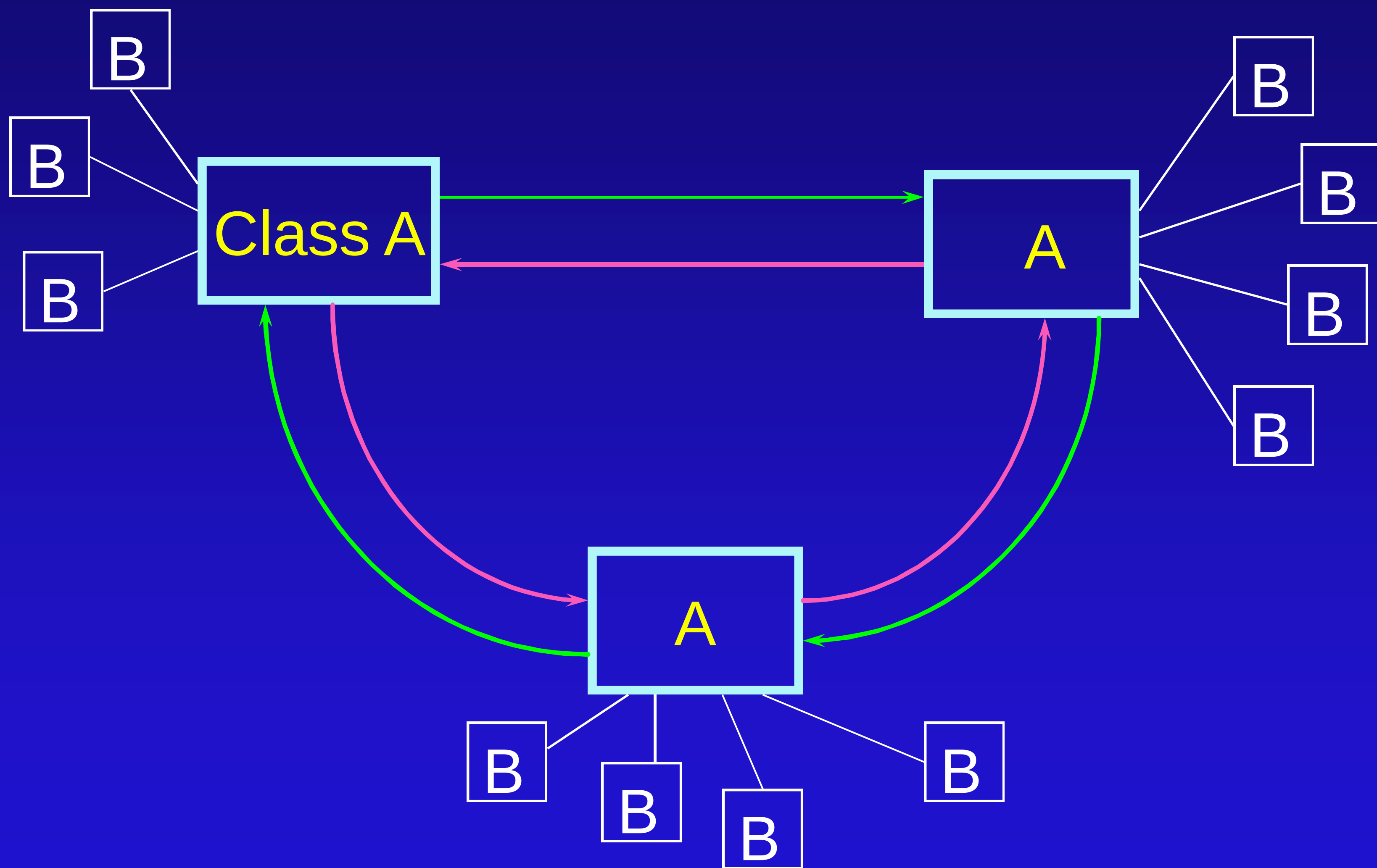
» Each dual-attached station constantly receives Handshaking information from its neighbors via the secondary link.

» If station stops receiving Handshaking information, it wraps data from the primary to the secondary ring so that the disabled node is avoided and ring integrity is maintained.

Specification (Cont.)

- **Class B Devices**
  - » They are single-attached stations.
  - » They are typically workstations, printers, and other nodes that are attached only indirectly to the primary link.
  - » They access the ring by plugging into a concentrator that is dual-attached to the ring.
- An FDDI network can operate with up to 500 dual-attached stations.

Specification (Cont.)



FDDI Frame

Preamble (Beginning)
Start of Frame
Frame Control
Destination @
Source @
Data
CRC
Frame Status (End)
End of Frame

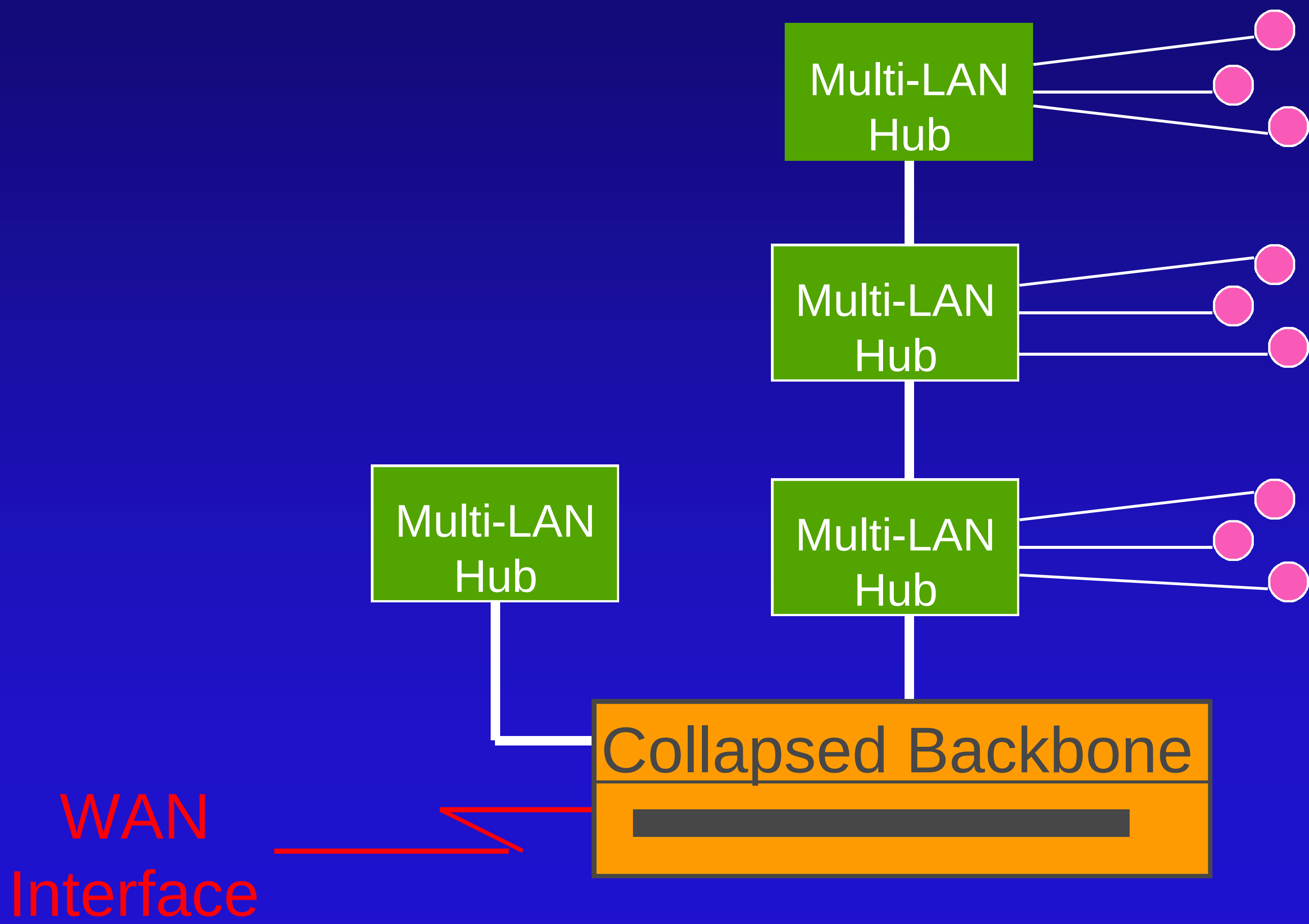
llapsed Backbone

- Based on todayôs high-speed Routers.
- Sometimes called Backbone Routers.
- This scheme collapses vast amounts of enterprise data onto the backplane of a high-throughput Router.
- LAN connections are starred back to the central collapsed backbone for high-speed internetworking.

sed Backbone (Cont.)

- The collapsed Backbone serves as the Gate-Keeper for the entire enterprise network and provides sophisticated protocol conversion and routing along an ultra high-speed Gigabit backplane.
- Multi-LAN Hubs are used to connect users on individual floors.

sed Backbone (Cont.)



ed Backbone Strengths

- Increased level of LAN Management, down to the segment level, since all LANs are directed back to the central Backbone for routing.
- Supports internetworking between enterprise LANs.
- Has Gigabit throughput, supporting dozens of LANs starred back to a highly managed location (no data bottlenecks).

Backbones Strengths (Cont.)

- Centrally located to reduce costs, increase manageability, and minimize reliability problems.
- Donôt translate LAN signals into an intermediate signal (as in FDDI).
- Keeps all network protocols in a central database, ensuring proper routing of all data packets
- Natural/smooth transition to right-sizing.

l Backbones Weaknesses

- Often require Hubs or physical Backbones to provide end-user connectivity.

- Are processor and software intensive, thus requiring more maintenance than a typical Hub (MTBF-Router = 20,000 hrs, MTBF-Intelligent-Hub > 100,000 hrs.)

- Donôt support Host-to-Terminal traffic.

uters Technology

- Routers provide a greater degree of intelligence than Bridges.
- Routers operate on the Network Layer to join different networks such as X.25-to-FDDI, X.25-to-Ethernet, etc.

uters vs. Bridges

- **Addressing**
  - > Routers are explicitly addressed.
  - > Bridges are not addressed. The stations are unaware of their existence.
- **Data**
  - > Routers access and use multiple sources of data to make appropriate routing decision.
  - > Bridges use only source and destination addresses.

rs vs. Bridges (Cont.)

- **Message**
  - > Routers can open messages & manipulate/ fragment a message contents. They can provide connection services between LANs that use different message lengths.
  - > Bridges have no access to message contts.
- **Feedback**
  - > Routers provide feedback on network conditions to end-users.
  - > Bridges cannot.

rs vs. Bridges (Cont.)

- **Forwarding**
  - > Routers forward a message to specific destination using the best route (intermediate nets are counted as hops)
  - > Bridges forward a message to an outgoing network.
- **Priority**
  - > Routers support different classes of service
  - > Bridges treat all packets identically.

rs vs. Bridges (Cont.)

- **Security**
  - » Both Bridges and Routers provide the ability to put ñsecurity wallsò around specific stations.
  - > Routers generally provide greater security than Bridges because:
    - + they are addressed directly
    - + they access more data.

rs vs. Bridges (Cont.)

- Overall, Routers provide
  - » Enhanced network segmentation and security.
  - » Improved reliability since alternative paths can be used.
  - » Improved bandwidth utilization.
  - » Ability to link many networks-going well beyond the seven-hop-limit of Bridges (not confronted with time delay constraints as Bridge-based systems).

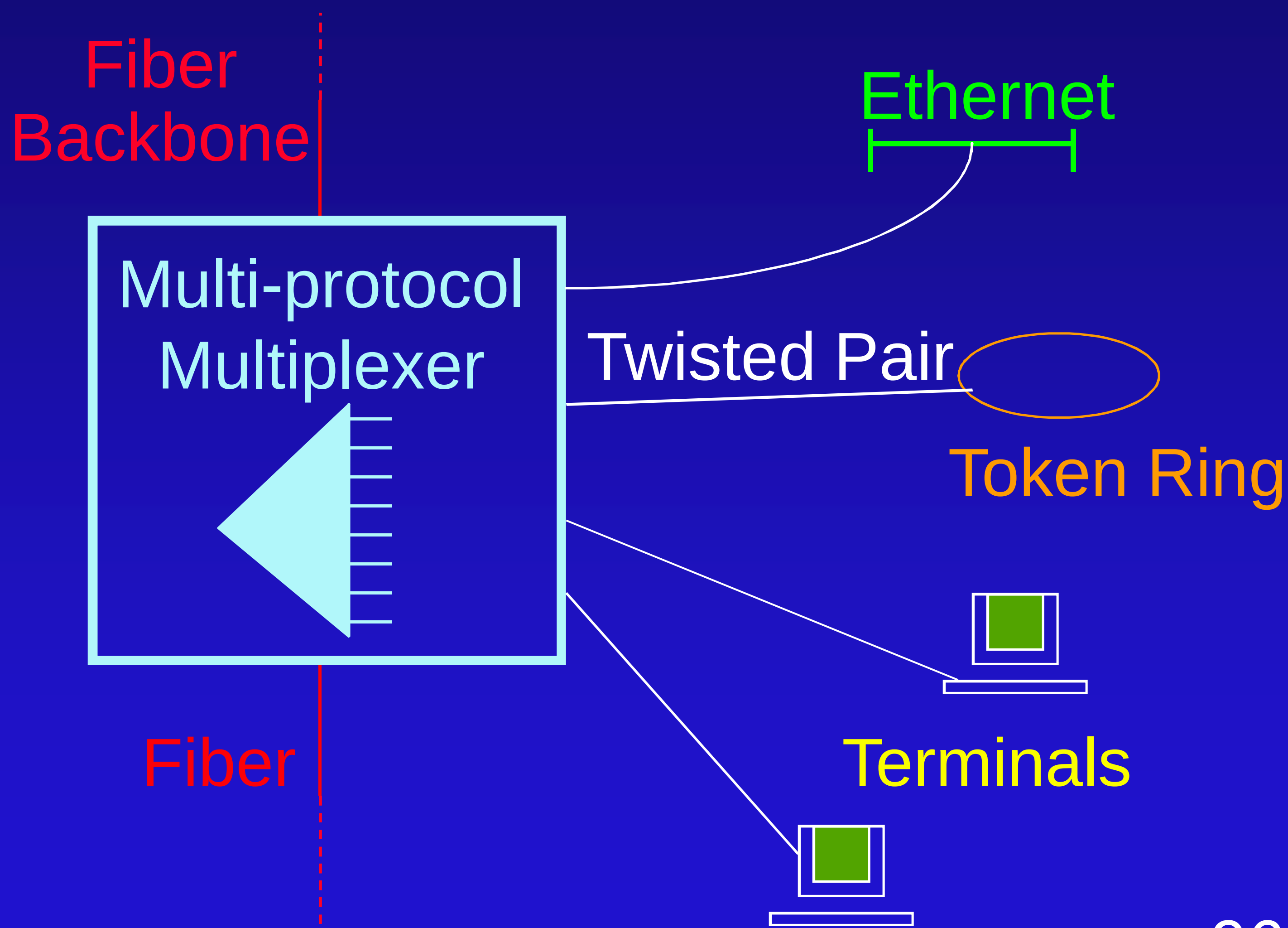
a

- All Backbone solutions are based on the use of fiber because fiber:
  - » Forms the bases for all future Backbone migrations.
  - » Enables network managers to extend the life of their cabling plants.
  - » Enables the network to easily migrate to better technology (network application software or network hardware).

sed Backbone Network

- Environment characteristics:
  - » Large mainframe use with an existing mainframe-based network management system (such as SNA/Netview).
  - » Several / multi-story buildings.
  - » Multiple signal types
  - » Duct space is at a premium.
  - » Clusters of workgroup LANs spread throughout the organization

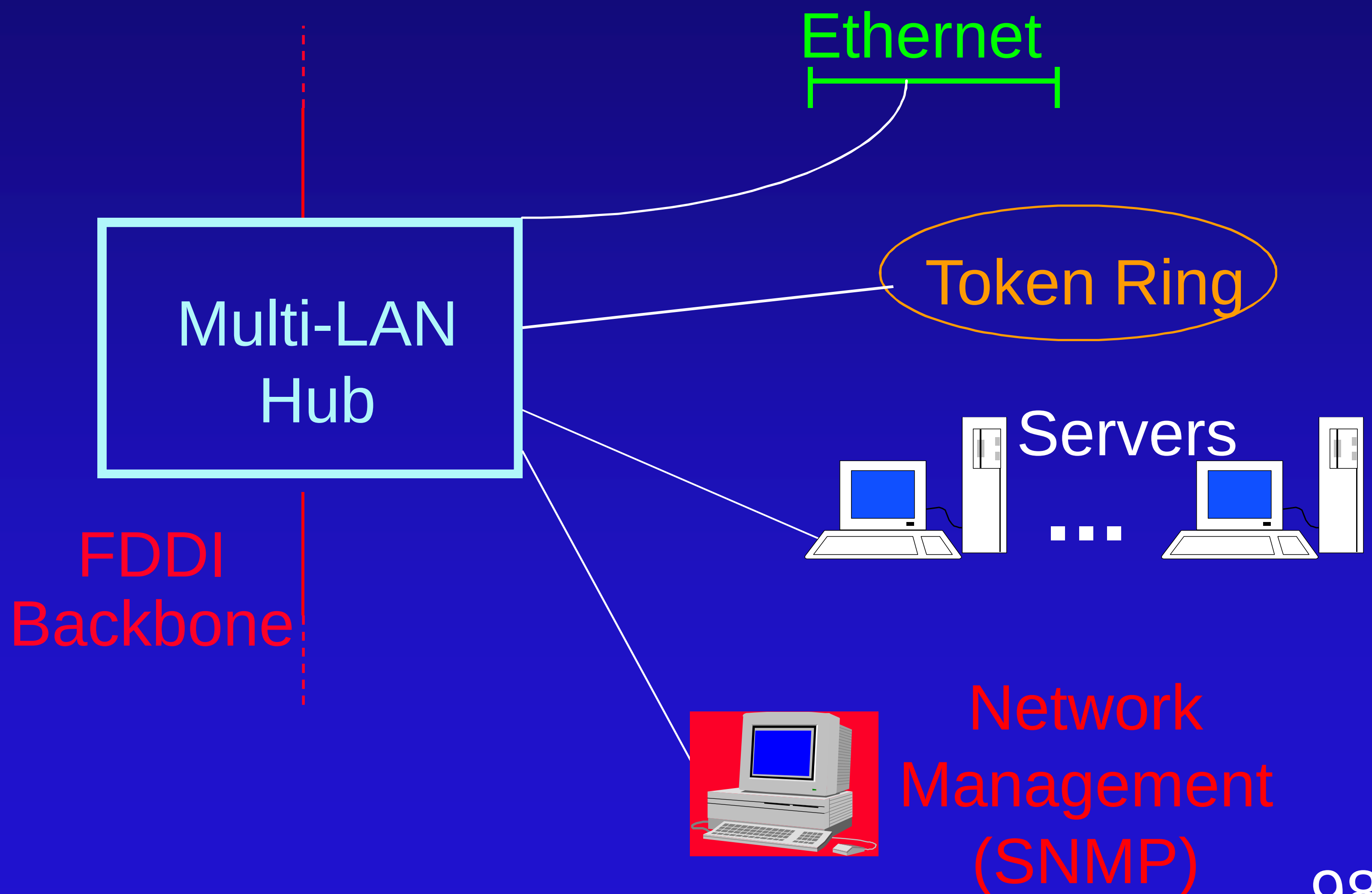
sed Backbone (Cont.)



nt-Server Backbone

- Environment characteristics:
  - » Several high-powered central servers for shared corporate resources/applications.
  - » A current Hub-based solution.
  - » Need to support multiple LANs (Ethernet, Token Ring, FDDI).
  - » A high degree of local traffic and therefore the need to create subnetworks and separate workgroups.

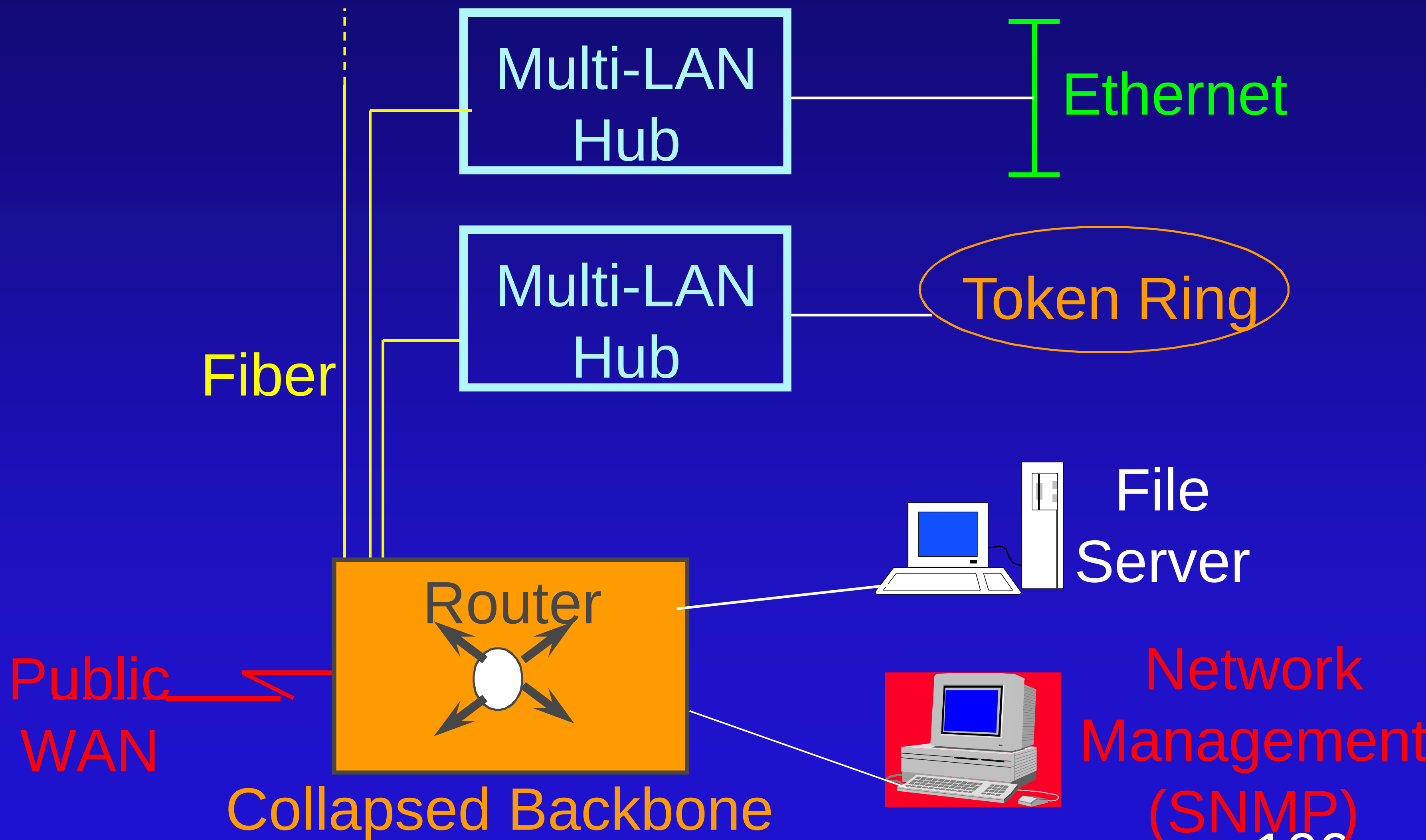
erver Backbone (Cont.)



ed Backbone Network

- Environment characteristics:
  - » Several legacy LANs and a high degree of traffic.
  - » Varying network resources to be shared.
  - » Need for centralized management.

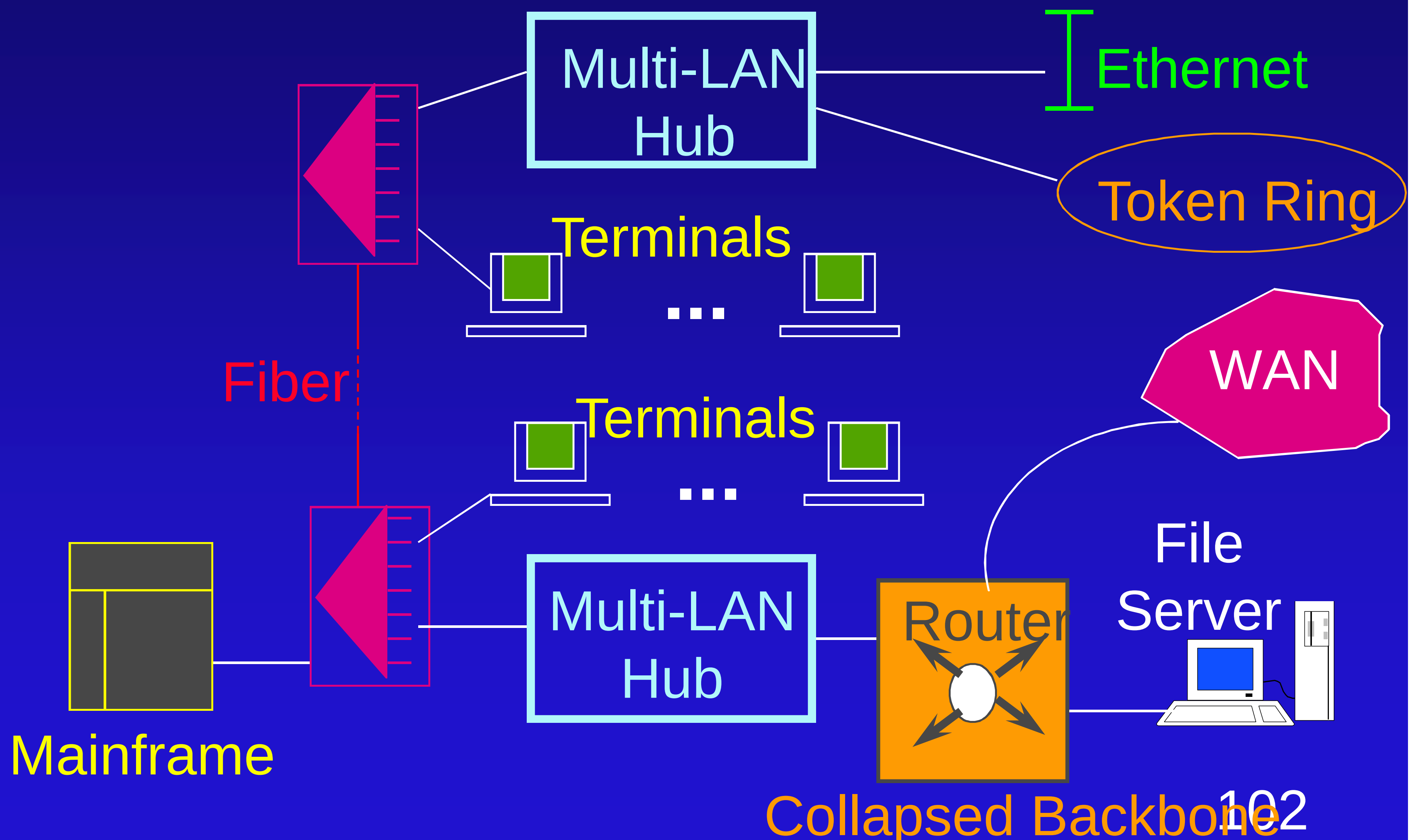
sed Backbone (Cont.)



d Backbone Network

- Environment characteristics:
  - » Need to support Mainframe (host-to-terminal) users, LAN traffic, and WAN access.
  - » A large number of users, multiple locations, and various remote sites.
  - » Growing LANs and increasing traffic.

d Backbone (Cont.)



Development Life Cycle

- Effective Networking & its Importance.
- **NDLC** Definition.
- **NDLC** Phases:
  - » Analysis.
  - » Design.
  - » Simulation and Prototyping.
  - » Implementation.
  - » Monitoring and Management.

Why ?!!

- Most networking systems do not follow sound engineering techniques in architecting the network.
- Networks built in an ad-hoc fashion are not well structured.
- Many performance bottlenecks.
- No or little future expandability.

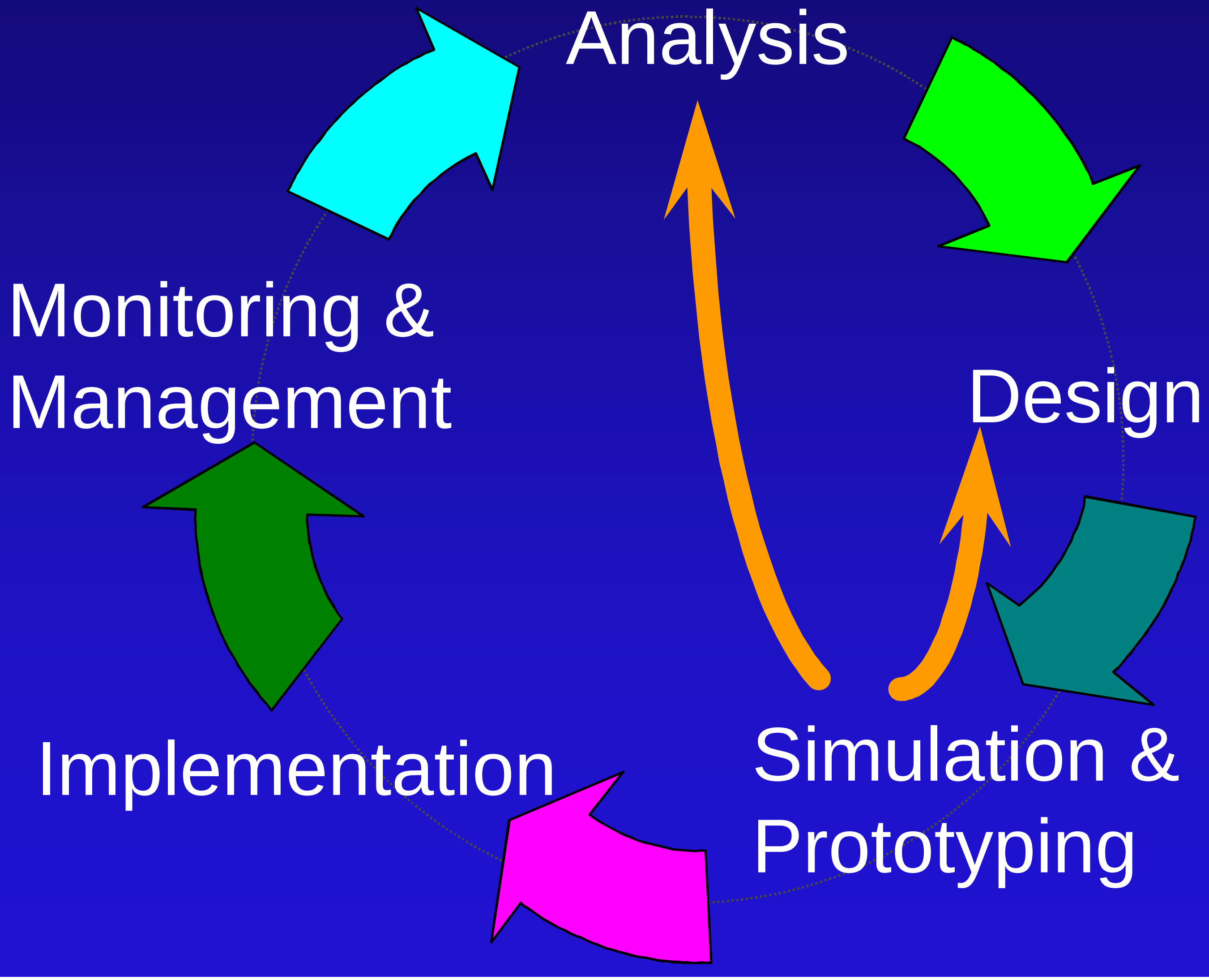
NDLC Defined

A design methodology to create and maintain an efficient enterprise networked system that meets desired objectives.

NDLC Phases

- Analysis.
- Design.
- Prototyping and simulation.
- Implementation.
- Monitoring and management.

NDLC


Analysis
Design
Simulation & Prototyping
Implementation
Monitoring & Management

Analysis

- Before making any decisions on network architecture, topology, speed, or cost, an appropriate investigation must be performed by responsible analyst(s) together with:
  - » Users.
  - » Application providers.
  - » Networking devices suppliers.
  - » Financing entity (Decision makers)!

aring a Site Survey

- A site survey must be done before proposing & committing to new design.

- A site survey should include all existing interconnections as well as physical and logical network layout.

...e Survey (Cont.)

- To prepare a site survey, document all aspects of the installation:
  - » Existting grounding
  - » Underlying cable structure, distances from closets, and quality
  - » Data link topologies in use (Ethernet, etc.)
  - » Network hardware (Hubs, servers, routers, bridges, switches, NICs, etc.)

e Survey (Cont.)

» Interconnections (Cross-connect fields, pushdown blocks, termination hardware, patch panels, modular jacks, transceiversé)

» Workstations

» Design (single-ended or multi-homed) and location (wiring closet or network center) of servers.

le Considerations

- 70 - 80% of network installation problems involve the physical cabling plant and/or power grounding problems.

- Impedance, attenuation, and near-end cross-talk limit the acceptable distance data can travel and still be recovered at receiver-end.

Considerations (Cont.)

- To determine cable needs, proceed as follows:

1. Determine cable type and category and use it to determine network speed and distance.

Wiring Options

Media	LAN	Dist.	Application
UTP-cat 3	E, TR	100 m	Horizontal
UTP-cat 5	E, TR, FDDI 155 Mbps ATM	100 m	Horizontal
STP	TR, FDDI, 155 Mbps ATM	100 m	Horizontal / Riser (TR)

ng Options (Cont.)

Media	LAN	Dist.	Application
M-M Fiber	E, TR, FDDI, 155 Mbps ATM 622 Mbps ATM	2 km	Horizontal / Riser (TR)
S-M Fiber	FDDI, 155 Mbps ATM 622 Mbps ATM	2 km	Horizontal / Riser (TR) / Campus

Considerations (Cont.)

2. Make detailed component list, including:

- Media (UTP, STP, Fiber, Coax)
- Termination Hardware (RJ-45,BNCé)
- Miscellaneous hardware (terminators, couplers)
- Support hardware (patch pannels, Fiber distributed centers, racks, pushdown blocks)
- Tools & electronic test equipment
- Patch cables, wiring closets.

Considerations (Cont.)

3. Recommended hardware to support distances.

> Must upgrade existing cables if they will not support a planned hardware upgrade.

> If UTP is considered, make sure that RFI & EMI noise will not be a problem.

4. Implement structured cabling when planning for switched networks.

...sport Method & Media Considerations

- If one plans to use ATM:
  - » Use structured wiring for all LANS, including FDDI.
  - » Pull cable to support both current and future needs:
    - Cat 5 UTP will support 155 Mbps ATM (should be used when new copper is pulled to desktop)
    - Currently installed multi-mode fiber can be used to run 155 Mbps ATM in campus-wide network.
    - Single-mode fiber will be necessary to run 622 Mbps ATM in most campus-wide networks.

sport Method & Media Considerations (Cont.)

» For premises LAN infrastucture purshases, recommend Routers whose vendors will support ATM interfaces and Hubs whose vendors plan to integrate ATM into Hubs.

» FDDI note:

- ï Wiring an FDDI network as a physical ring can make transition to future switched technologies more difficult.
- ï When implementing FDDI backbones, wire them as physical star.

e

- Identify and understand the following:
  - » Address architecture (NIC or privately assigned).
  - » Routing and Bridging protocols.
    - ï IP-IGRP, RIP, OSPF, IGP
    - ï IPX-RIP, NLSP
    - ï AppleTalk,RTMP
    - ï Banyan VINES
    - ï DECnet
    - ï Transport Bridge
    - ï etc.

ork Architecture (Cont.)

- » WAN Protocols (Frame Relay, X.25, PPP, SMDS, ATM, Dial-Up service, é).
- » WAN implementation used (T1, E1, é).
- » Workstation configuration (IP vs PC-LAN prtocols).
- » Security concerns.

… Management Concerns

- Management data gathered near its source.
- Data reduced within the Hubs.
- Reduced data forward it to a central management console.

ysis : Collectibles (1)

- Information Flow
  - Servers and Clients
  - Data Transfer
- Traffic loads and patterns
  - Applications
    - Textual
    - Graphical
    - Voice and Video
  - User productivity
  - Peak Hours
- Integration of Legacy systems

s : Collectibles (Cont.)

- Breakdown of users
  - » Locations
  - » Distances
  - » Used Application
- Geographical Breakdown
  - » Main sites
  - » Branches
  - » Remote sites
- Availability of Public Services
  - » Telephone Lines

Design

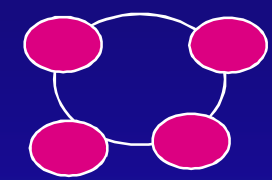
- Analysis delivers collected information and establishes a set of desired objectives for the required design.
- Collected information serves as design input.
- Set of objectives serves as design goals / constraints.
- Network designer have to decide on several issues including **topology, architecture, flexibility** and other cost and vendor related issues.

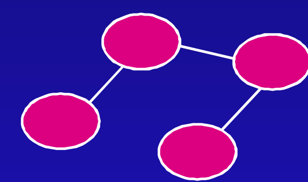
Design Schemes and Topologies

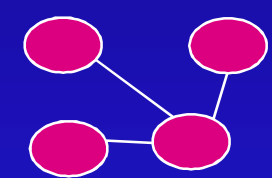
- Structured Schemes
  - » Distributed.
  - » Collapsed Backbone.
  - » Hierarchical
  - » Mixed
- Topological Design
  - » Ethernet, Token Ring, FDDI, ATM.

stributed Design

- Distributed
  - » Physically disjoint segments
  - » Advantage
    - ï No single point of failure
  - » Disadvantages
    - ï Less efficient use of server resources
    - ï Decentralized administration
    - ï Routers (Slow) connect segments

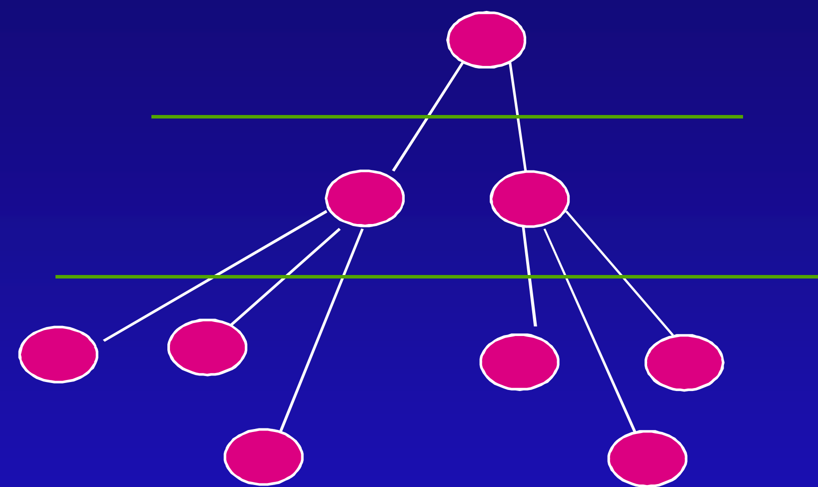






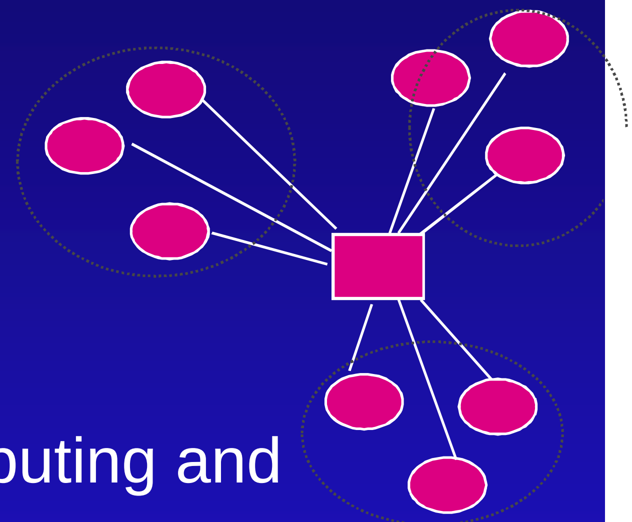
erarchical Design

- Hierarchical
  - » Based on clustering
  - » Advantage
    - ï Simple
    - ï Structured
  - » Disadvantages
    - ï Requires higher capacity links and devices the higher the clustering level is.



ollapsed Design

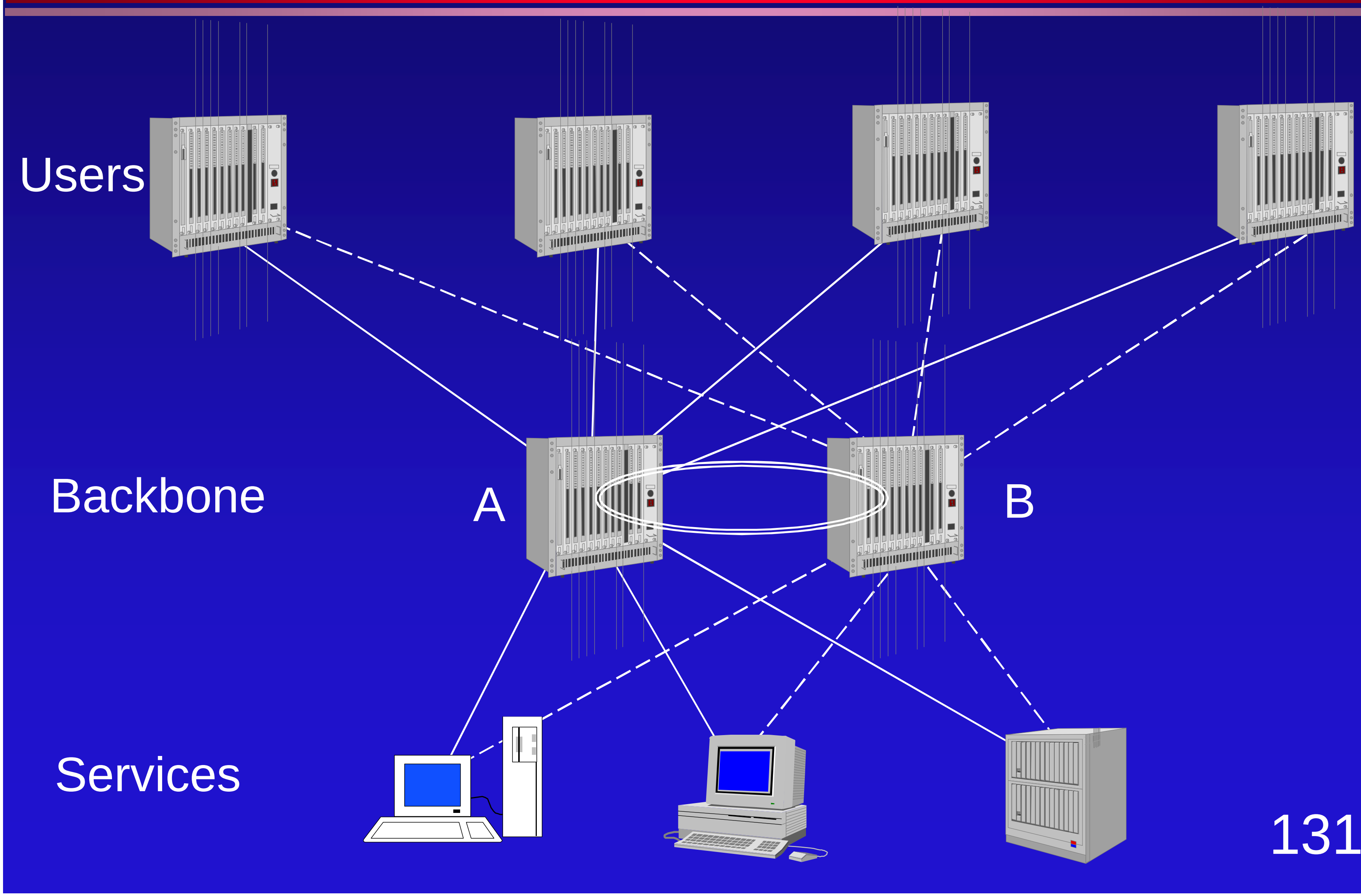
- Collapsed
  - » Segmented architecture.
  - » Centralized routing or bridging.
  - » Advantages
    - ï Good Balance of distributed computing and centralized control.
    - ï Single point of administration.
  - » Disadvantages
    - ï Single point of failure
    - ï Reliability needs to be built in.



ating Fault Tolerance into Design

- Major techniques:
  - » Extra hardware
    - ï Dual homing (FDDI).
  - » Stand by software monitors
    - ï Spanning tree.
    - ï Redundant paths (switching).
  - » Proactive management (As a basic Design practice)
    - ï Trend analysis.
    - ï Management by exception (Traps).

ple : Dual Homing



r (RFP)

1. Analysis and Design steps completed.
2. Prepare preliminary overall project schedule.
3. Determine information required from vendor.
4. Determine potential vendors-request for literature.
5. Compile and distribute RFP to vendors.

Sample RFP

1. Management Abstract

1.1. Company profile

A brief description of the company issuing the RFP Number of corporate locations, approximate yearly sales, growth rate, brief statement on current state of computerization/networking.

1.2. Statement of the problem

Briefly describe the source of the initiation of the problem definition process and what did the problem definition team conclude.

mple RFP (Cont.)

1.3. Overall system characteristics

It is important to include overall system characteristics at the beginning of the RFP as some of the requested features are beyond the capabilities of some vendors.

1.4. Project Phase Prioritization

If some modules are more critical than others, such prioritization should be conveyed to all vendors, since some vendors may be able to supply only some of the modules.

1.5. Proposed Project Schedule Summary

It is important to supply vendors with a tentative implementation timetable for the project.

Project Schedule Summary

Event	Proposed Completion Date
RFP Sent to vendors	3/29/97
Proposals due from vendors	4/29/97
Selection & notification of vendors	5/14/97
Presentations/demos by vendors	5/21/97 - 6/7/97
Make or buy decision	6/14/97
Pilot test	8/14/97
Projected system implementation date	1/1/98

mple RFP (Cont.)

1.6. Information Requested from Vendor

1.6.1. System development experience

1.6.2. Hardware, software, networking experience

1.6.3. References

1.6.4. Pricing

1.6.5. Support

1.6.6. Training and documentation

1.6.7. Vendor background

mple RFP (Cont.)

2. System Design

2.1. Summary Review

2.2. Details of Geographic Locations

2.3. System Requirements of Each Software Module

Simulation

- Static and dynamic aspects of Network modeled by computer code.
- Execution of simulation model produces various performance metrics:
  - » Response Time
  - » Link utilization
  - » Cost
  - » etc.

mulation (Cont.)

- Predicts performance of various networking scenarios in a what-if network analysis fashion.
- Numerous user-friendly computer network simulation packages are available.

Prototyping

- Prototyping is useful in situations where applied networking techniques are:
  - » Newly introduced.
  - » Customized for a special environment.
  - » To be repeated in so many sites.

Final RFP

1. Prepare a detailed, comprehensive budget.
2. Prepare detailed implementation timetable
3. Prepare project tasks details.
4. Prepare formal presentation.
5. Sell to management.

mplementation

- Most important issues to consider in this phase are
  - » A well defined implementation plan.
  - » Structured wiring.
  - » Implementing a physical star for the fiber backbone.

plementation Plan

- Assign a project manager with single points of contact at the implementing and supervising/owning organizations.
- Project manager must set up and adhere to a well defined implementation plan with
  - » Specific tasks.
  - » Task owners.
  - » Durations.
  - » Milestones.

ructured Wiring

- Use FO whenever:
  - » Distance exceeds 100 meters.
  - » Cross from one building to another.
  - » In vertical risers or noisy environments
    - ï EMI resistance.
- Use Category 5 UTP for desktop distribution and horizontal wiring if topology supports this media.
- Advantage: Guaranteed performance and extended warranty!

hysical FO Star

- Advantages
  - » Ease of administration
    - ï Additions/insertions.
    - ï Removals.
    - ï Tracing and troubleshooting.
  - » Future investment protection
    - ï New technologies can be easily adopted.
    - ï Only end connectors may need replacement.
  - » Reliability.
- Disadvantage: Longer cable lengths!

o 1)

- A proactive means of network management.
- Provides management by exception and reports ongoing network activities.
- Based on sophisticated software packages running on powerful workstations.
- Provides a user friendly interface to achieve complex console, scripting and text based tasks.

Monitoring and Management (Cont.)

- Network management serves the following main purposes:
  - » Problem (Fault) management and trouble ticketing.
  - » Performance management and trend analysis.
  - » Configuration/Change management.
  - » Security Management.
- Based on the Defacto SNMP standard as defined in RFC 1157.

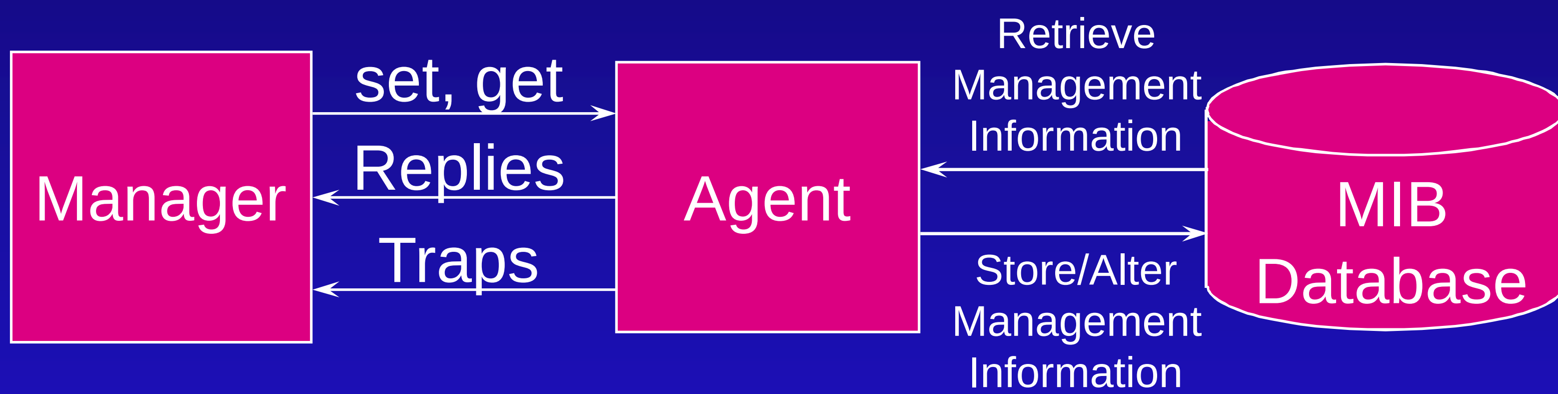
Simple Network Management Protocol

- SNMP is the protocol used to retrieve network information from nodes.
- Major concepts:
  - » Management Station
  - » Management Agent
  - » Management Information Base (MIB).
  - » Network Management Protocol.
- Key capabilities:
  - » Get, set, and Trap.

SNMP (Cont.)

- Get:
  - » Enables the management station to retrieve the values of objects at the agent.
- Set:
  - » Enables the management station to set the values of objects at the agent.
- Trap:
  - » Enables the agent to notify the management station of significant events.

Agent-Manager Model



Usage

- Baselining and Thresholds.