# LAN Basics, MANs, WANs

❖Overview

Computer Networks (continued)

- CSMA/CD
- Types of LANs
- MANs
- WANs
- Network Interconnection Components
- The OSI Model

CSMA/CD

- Usually used in a bus topology
- Used in *Ethernet* LAN's
- Unlike the token ring, all nodes can send whenever they have data to transmit
- When a node wants to transmit information, it first "listens" to the network. If no one is transmitting over the network, the node begins transmission
- It is however possible for two nodes to transmit simultaneously thinking that the network is clear
- When two nodes transmit at the same time, a *collision* occurs
- The first station to detect the collision sends a jam signal into the network
- Both nodes back off, wait for a random period of time and then re-transmit
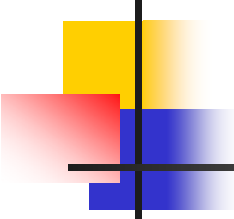
CSMA/CD
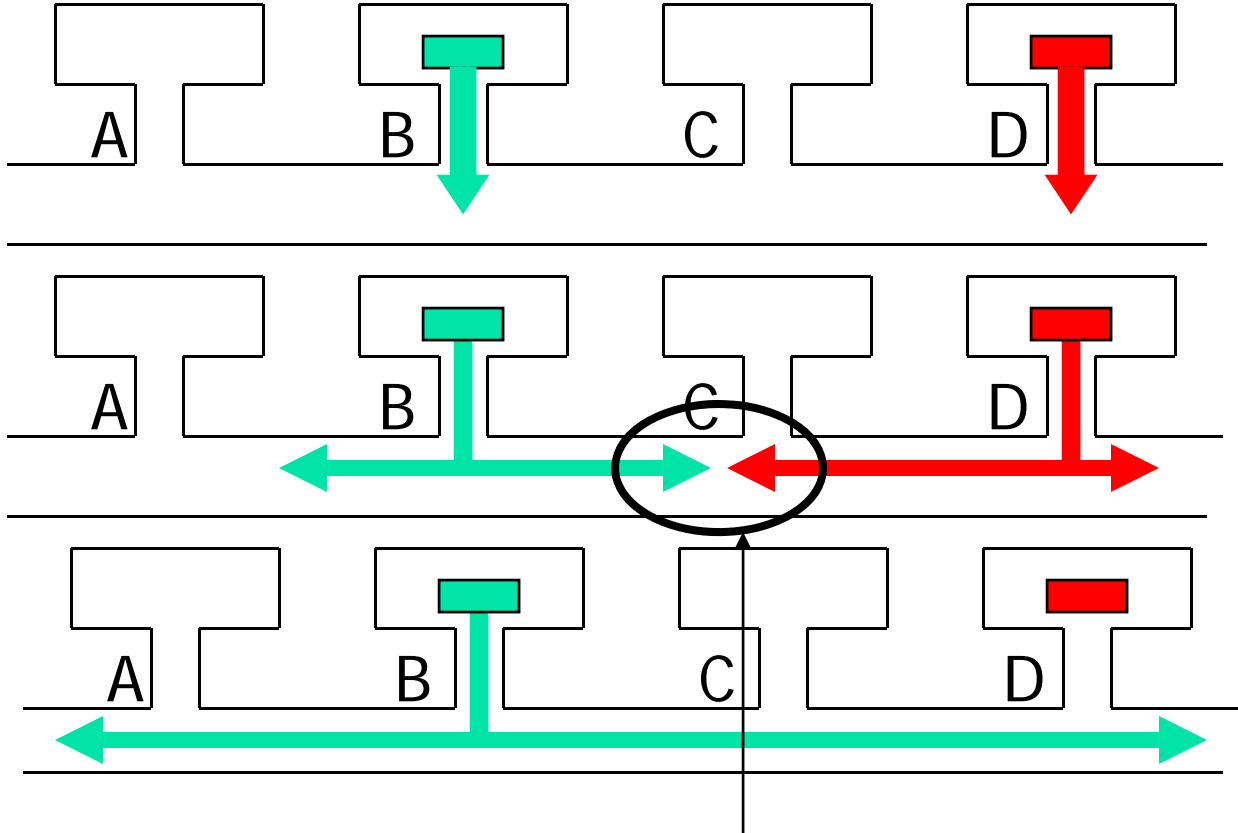
Types of LANs

- The three most popular types of LANs are:
  - Token ring network
  - FDDI (Fiber Distributed Data Interface) network
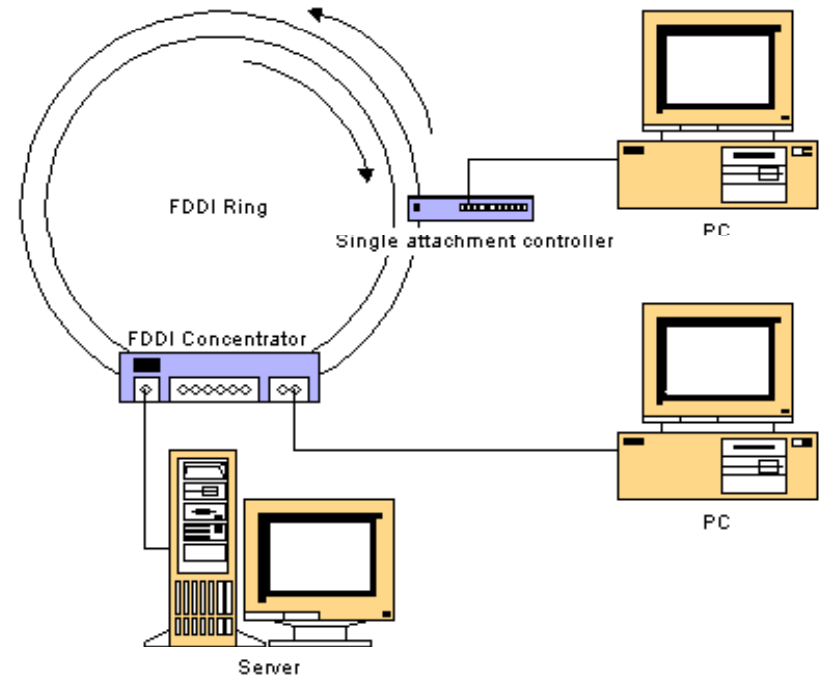 - Ethernet

Token Ring Network

- Originally developed by IBM in 1970's
- Still IBM's primary LAN technology
- In cases of heavy traffic, the token ring network has higher throughput than ethernet due to the deterministic (non-random) nature of the medium access
- Is used in applications in which delay when sending data must be predictable
- Is a robust network i.e. it is fault tolerant through fault management mechanisms
- Can support data rates of around 16 Mbps
- Typically uses twisted pair
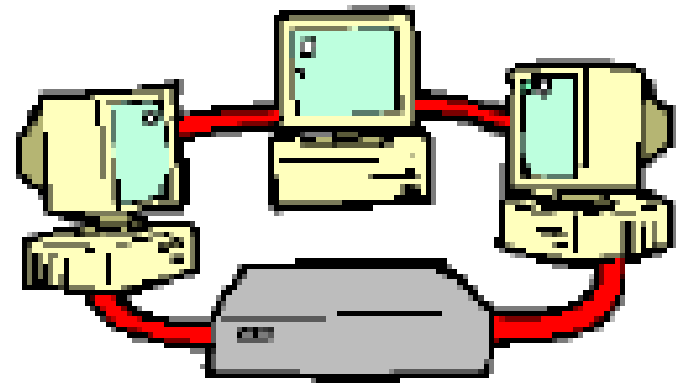
FDDI (Fiber Distributed Data Interface)

- *FDDI* is a standard developed by the American National Standards Institute (ANSI) for transmitting data on optical fibers
- Supports transmission rates of up to 200 Mbps
- Uses a dual ring
  - First ring used to carry data at 100 Mbps
  - Second ring used for primary backup in case first ring fails
  - If no backup is needed, second ring can also carry data, increasing the data rate up to 200 Mbps
- Supports up to 1000 nodes
- Has a range of up to 200 km

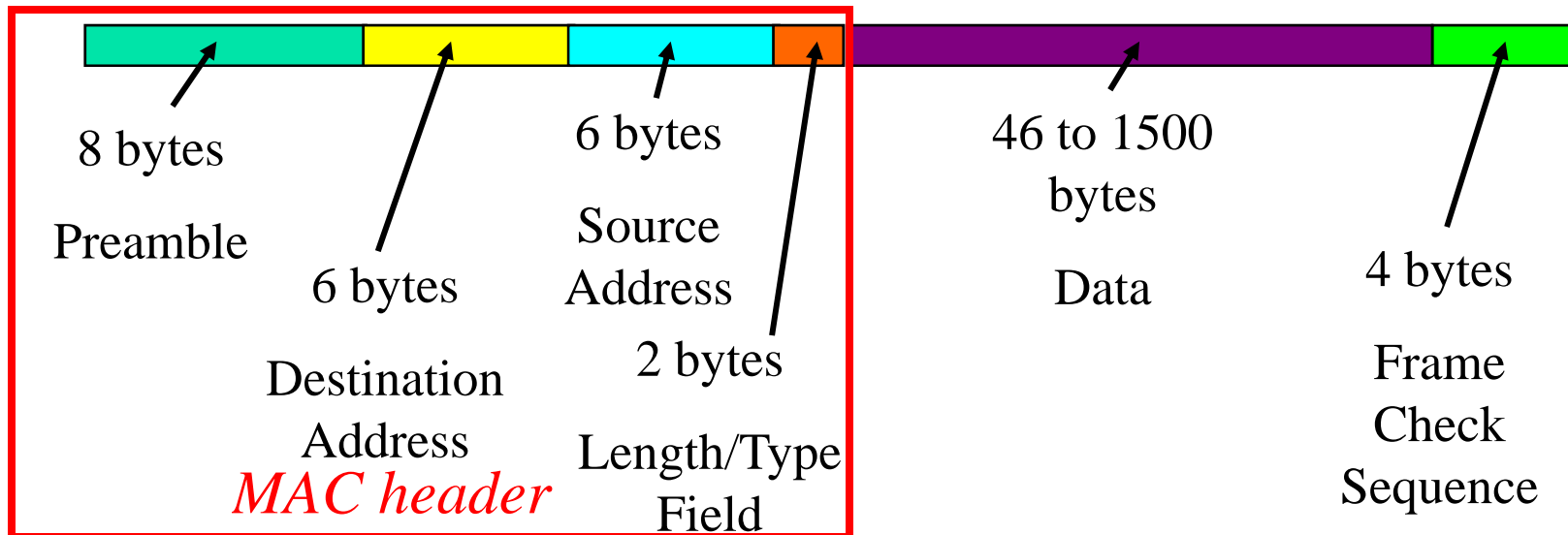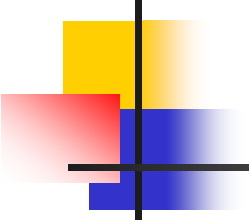Source:http://burks.brighton.ac.uk/burks/pcinfo/hardware/ethernet/fddi.htm

Ethernet

- First network to provide CSMA/CD
- Developed in 1976 by Xerox PARC (Palo Alto Research Center) in cooperation with DEC and Intel
- Is a fast and reliable network solution
- One of the most widely implemented LAN standards
- Can support data rates in the range of 10Mbps- 10 Gbps
- Used with a bus or star topology

The Ethernet Datagram (frame)

- Ethernet traffic is transported in units of a frame called the *Ethernet Datagram*

- The frame consists of a set of bits organized into several fields

8 bytes

Preamble

6 bytes

Destination
Address
MAC header

6 bytes

Source
Address

2 bytes

Length/Type
Field

46 to 1500
bytes

Data

4 bytes

Frame
Check
Sequence

- *Preamble:* Repeating Flag that ID's the sequence as an Ethernet datagram (10101010 7 times followed by 10101011) which is used in synchronizing and alerting the NIC

- *Destination Address:* Unique identifier found on the Network Interface Card that identifies the **recipient**

- *Source Address:* Unique identifier found on the Network Interface Card that identifies the **sender**

- *Length/Type Field:* Tells the recipient what kind of datagram is being received (IP, UDP, etc) and the length of the data

- *Data:* What sort of data is being sent:46 to 1500 bytes (text, JPEG, MP3, etc)

- *Frame Check Sequence:* Error detecting codes (If an error is detected, the frame is discarded)

Padding & Overhead

- The minimum length of data in an ethernet frame should be 46 bytes
- If the length of the message that you want to send is less than 46 bytes, then"padding" is added
- These are extra bits added to bring the total of the message length up to 46 bytes
- The bytes in a frame that do not constitute the actual message that we are interested in sending are called *overhead*
    - The Ethernet frame has 26 bytes of overhead (8+6+6+2+4)
    - If you had 100 bytes of data to send, you'd have to send 126 bytes of data
    - How much overhead is transmitted within the 126 bytes of data?
        - 26/126 = 21%

Ethernet NIC

- The Network Interface card allows computers to communicate with each other through the network

- Each NIC has a 48-bit unique hexadecimal address called the *MAC address*

- A computer or device on a network can be reached by its MAC address through the NIC card

- An example of a MAC address: A1B2C3D4E5F6

- The first 6 hex digits in the MAC address is the OUI (organizationally unique identifier), assigned by the IEEE to each manufacturer (e.g. Cisco, Intel etc). The rest of the MAC address can be assigned in any way by the manufacturer to the individual networking devices that it manufactures
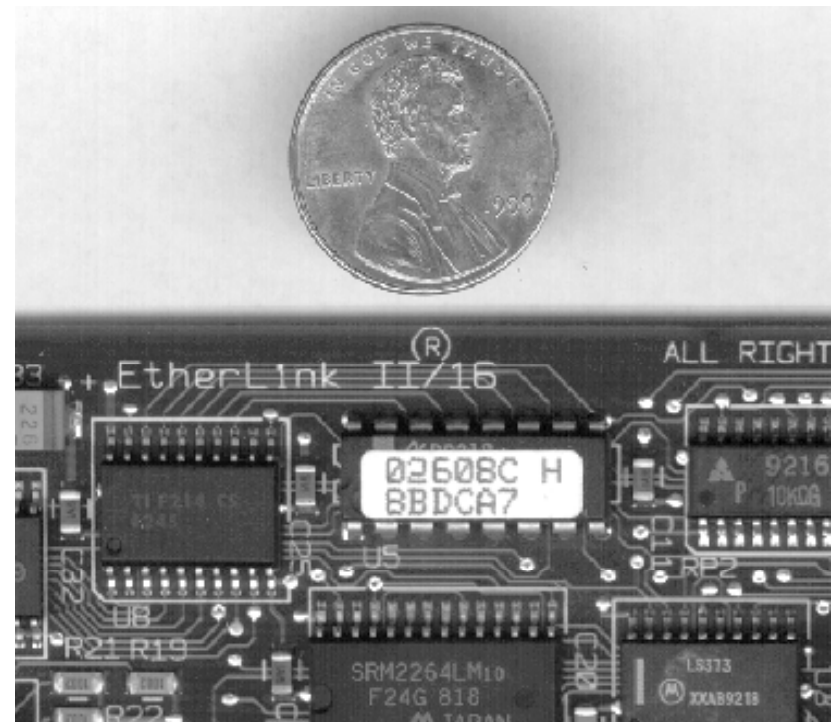
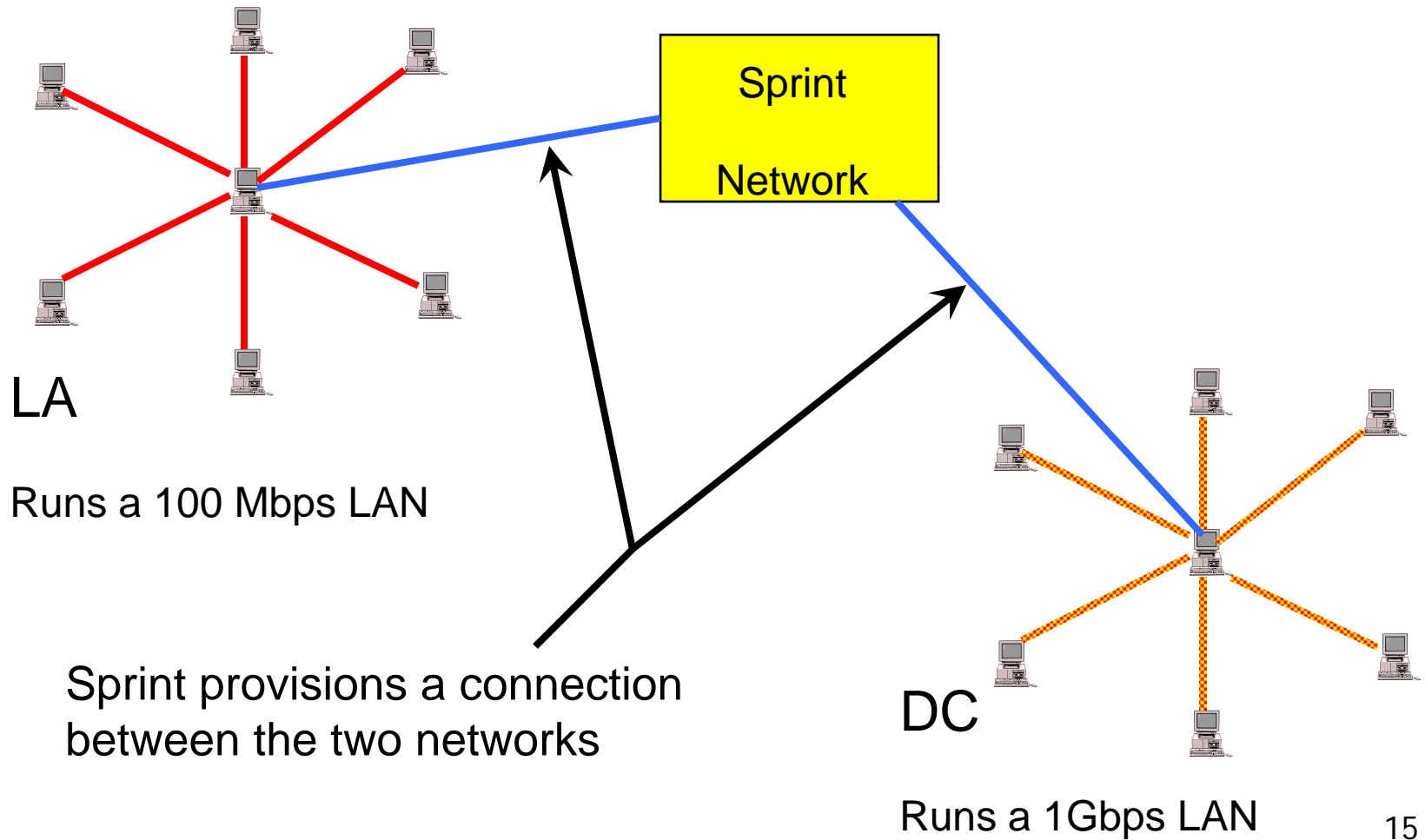# Metropolitan area network

- A *Metropolitan Area Network* (MAN) is a network that is utilized across multiple buildings

- Commonly used in school campuses or large companies with multiple buildings

- Is larger than a LAN, but smaller than a WAN

- Is also used to mean the interconnection of several LANs by bridging them together. This sort of network is also referred to as a *campus network*

Wide area network

- *A Wide Area Network* is a network spanning a large geographical area of around several hundred miles to across the globe
- May be privately owned or leased
- Also called "enterprise networks" if they are privately owned by a large company
- It can be leased through one or several carriers (ISPs-Internet Service Providers) such as AT&T, Sprint, Cable and Wireless
- Can be connected through cable, fiber or satellite
- Is typically slower and less reliable than a LAN
- Services include internet, frame relay, ATM (Asynchronous Transfer Mode)

Example of WAN application

LA

Runs a 100 Mbps LAN

Sprint

Network

Sprint provisions a connection between the two networks

DC

Runs a 1Gbps LAN

Network Interconnection Components

- Networks can be connected to each other through several components
  - Repeater
  - Bridge
  - Router
  - Gateway
- Before explaining the above components, we need to understand the OSI model

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The OSI Model

- The Open Systems Interconnection (OSI) model is a theoretical framework for understanding and explaining networking protocols

- Originally an effort by the ISO (International Standards Organization) to standardize network protocols

- TCP/IP became the dominant set of standards but the OSI model is widely used to help understand protocols

- The OSI model defines 7 layers of functional communications protocols.

The OSI Model

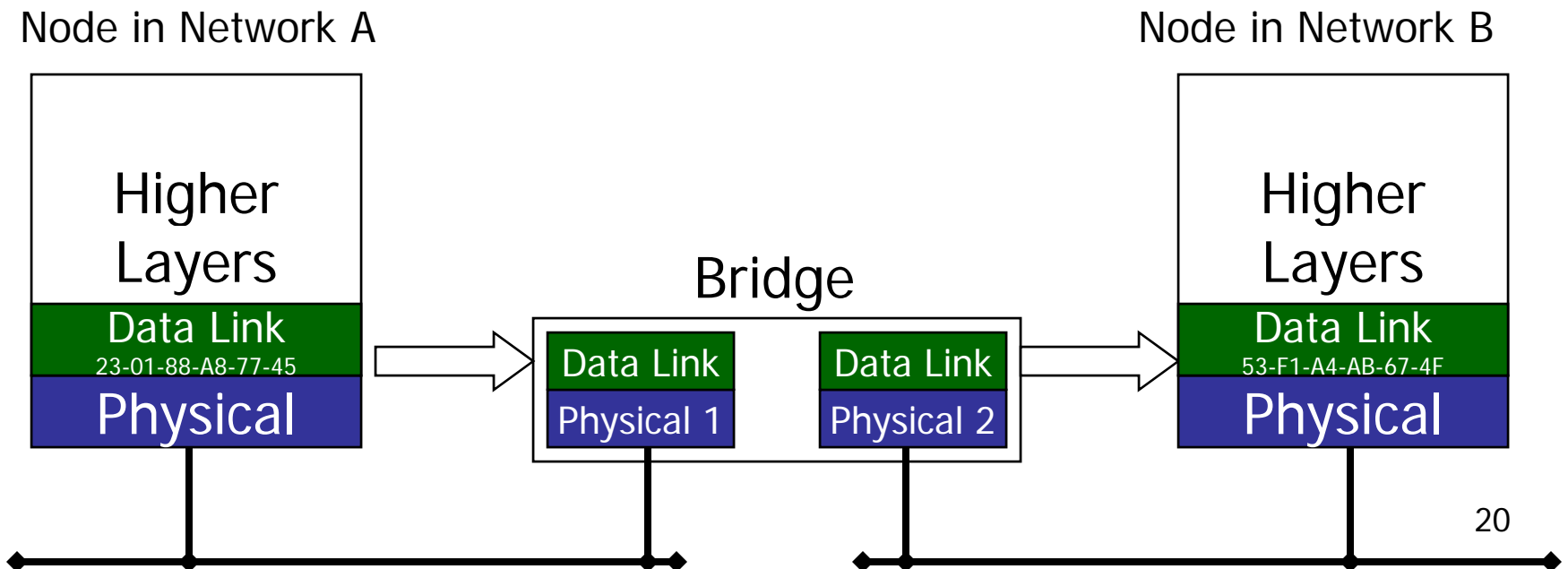| #	Layer	Description
7	Application Layer	*Provides a network interface for applications*
6	Presentation Layer	*Translates data to standard format*
5	Session Layer	*Establishes sessions between computers*
4	Transport Layer	*Provides error control and flow control*
3	Network Layer	*Supports logical addressing and routing*
2	Data Link Layer	*Interfaces with network adapter*
1	Physical Layer	*Converts information into transmitted pulses*

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Repeater

- Regenerates and propagates all electrical transmissions between 2 or more LAN segments
- Allows extension of a network beyond physical length limitations
- Layer 1 of the "OSI model"

Network A

Higher Layers
Physical

Repeater

Physical

Network B

Higher Layers
Physical
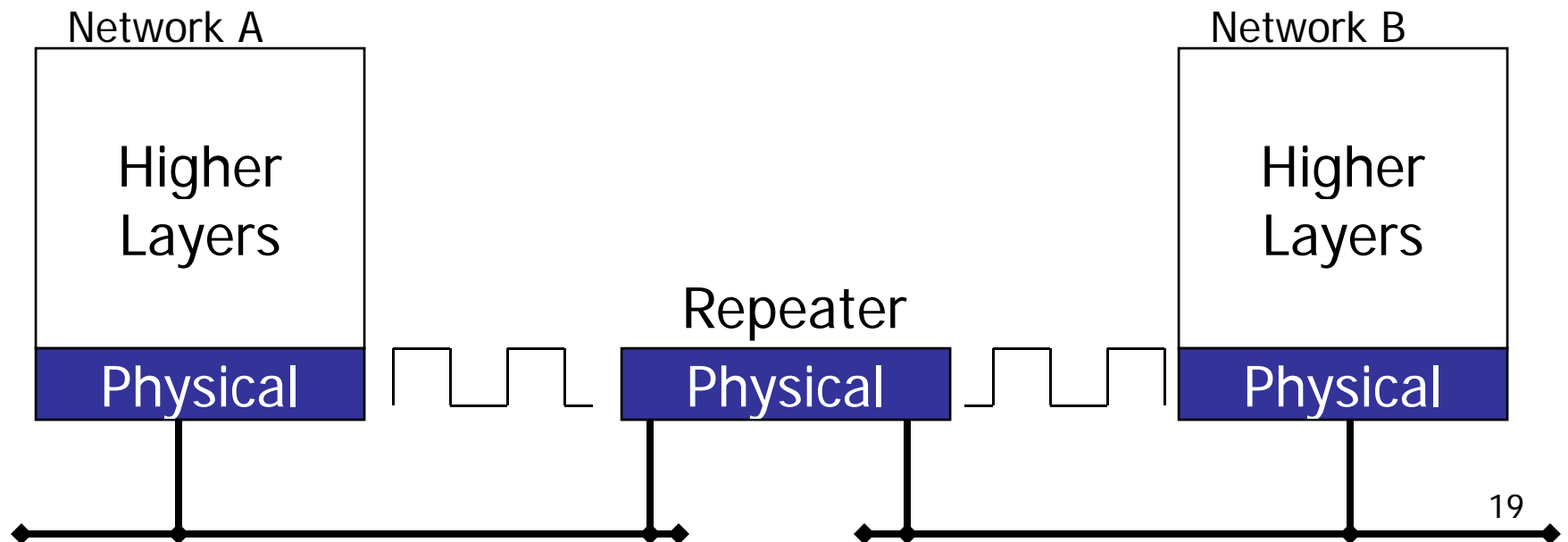
Bridge

- Connects 2 or more LAN segments and uses data link layer addresses (e.g.MAC addresses) to make data forwarding decisions
- Copies frames from one network to the other
- Layer 2 of the "OSI model"

Node in Network A

Node in Network B

Higher Layers

Data Link
23-01-88-A8-77-45

Physical

Bridge

Data Link

Physical 1

Data Link

Physical 2

Higher Layers

Data Link
53-F1-A4-AB-67-4F

Physical

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Router

- Connects 2 or more networks and uses network layer addresses (like IP address) to make data forwarding decisions
- Layer 3 of the "OSI model"

A node in Network A

A node in Network B

Higher Layers
Network 137.22.144.6
Data Link
Physical

Router

Network	Network
Data Link	Data Link
Physical 1	Physical 2

Higher Layers
Network 145.65.23.102
Data Link
Physical
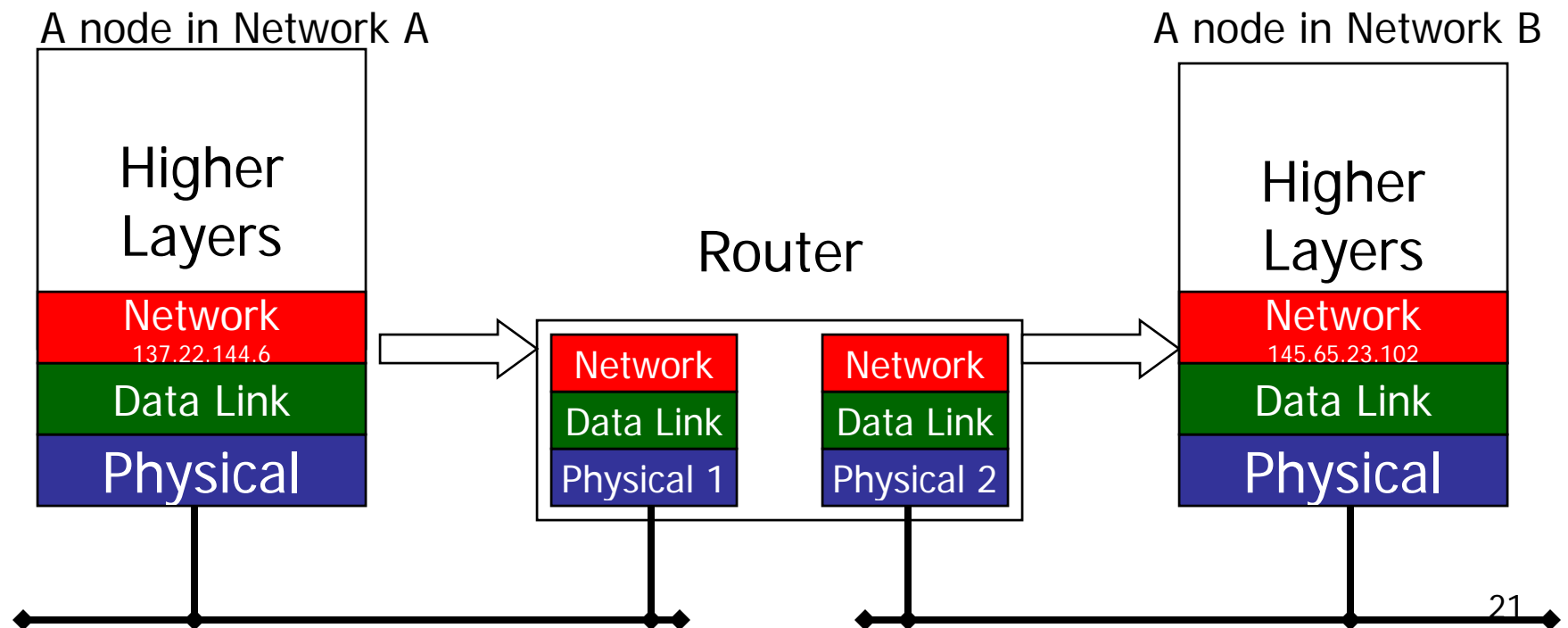
Gateway

- Connects 2 or more networks that can be of different types and provides protocol conversion so that end devices with dissimilar protocol architectures can interoperate

137.22.144.6

Netware

Gateway

TCP/IP   145.65.23.102