NETWORKING CONCEPTS

Compare the layers of the OSI and TCP/IP models

Building a Network with the OSI Model

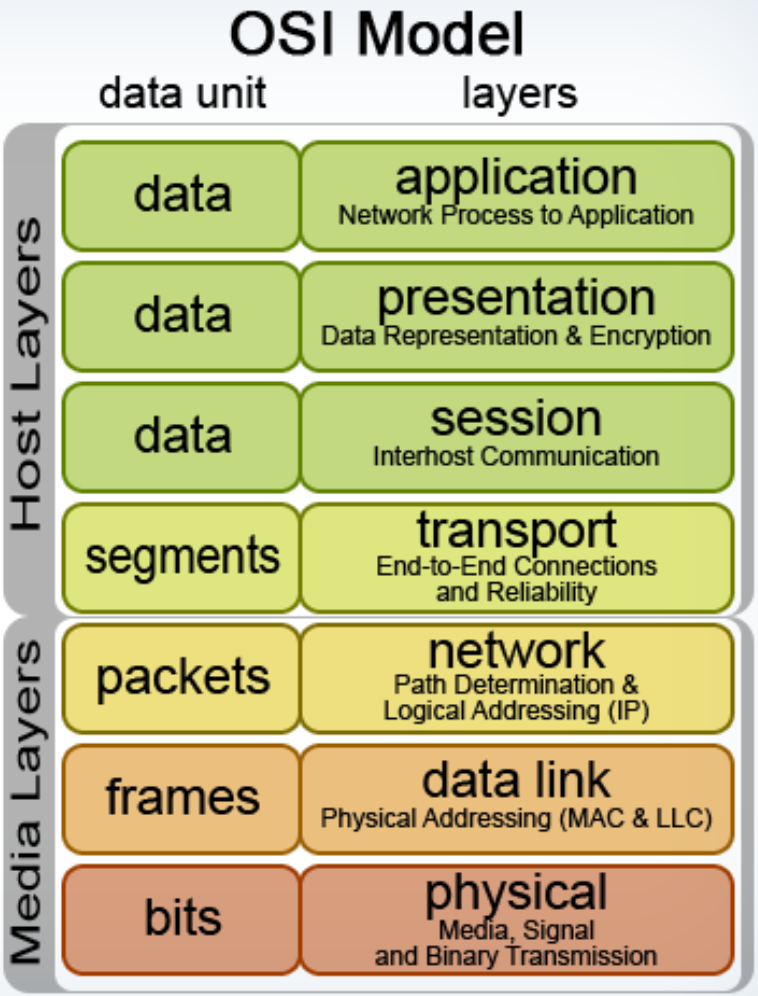
OBJECTIVES

- Describes the OSI seven-layers Models
- Describes the TCP/IP layers

The OSI seven-layer model

- What functions define all networks?
- ISO (International Organization for Standardization) proposed the OSI seven-layer model

- The Open Systems Interconnection (OSI) model was created by the ISOto help standardize communication between computer systems.
- It divides communications into seven different layers, which each include multiple hardware standards, protocols, or other types of services.



Layer 1- Physical Layer

- The phsyical layer, the lowest layer of the OSI model
- It is concerned with the transmission and reception of the unstructured raw bit stream over a physical medium
- Refers to the physical media itself: wires, electromagnetic energy, etc
- Also refers to the standards for cables and connectors

Communication with in the OSI Layers

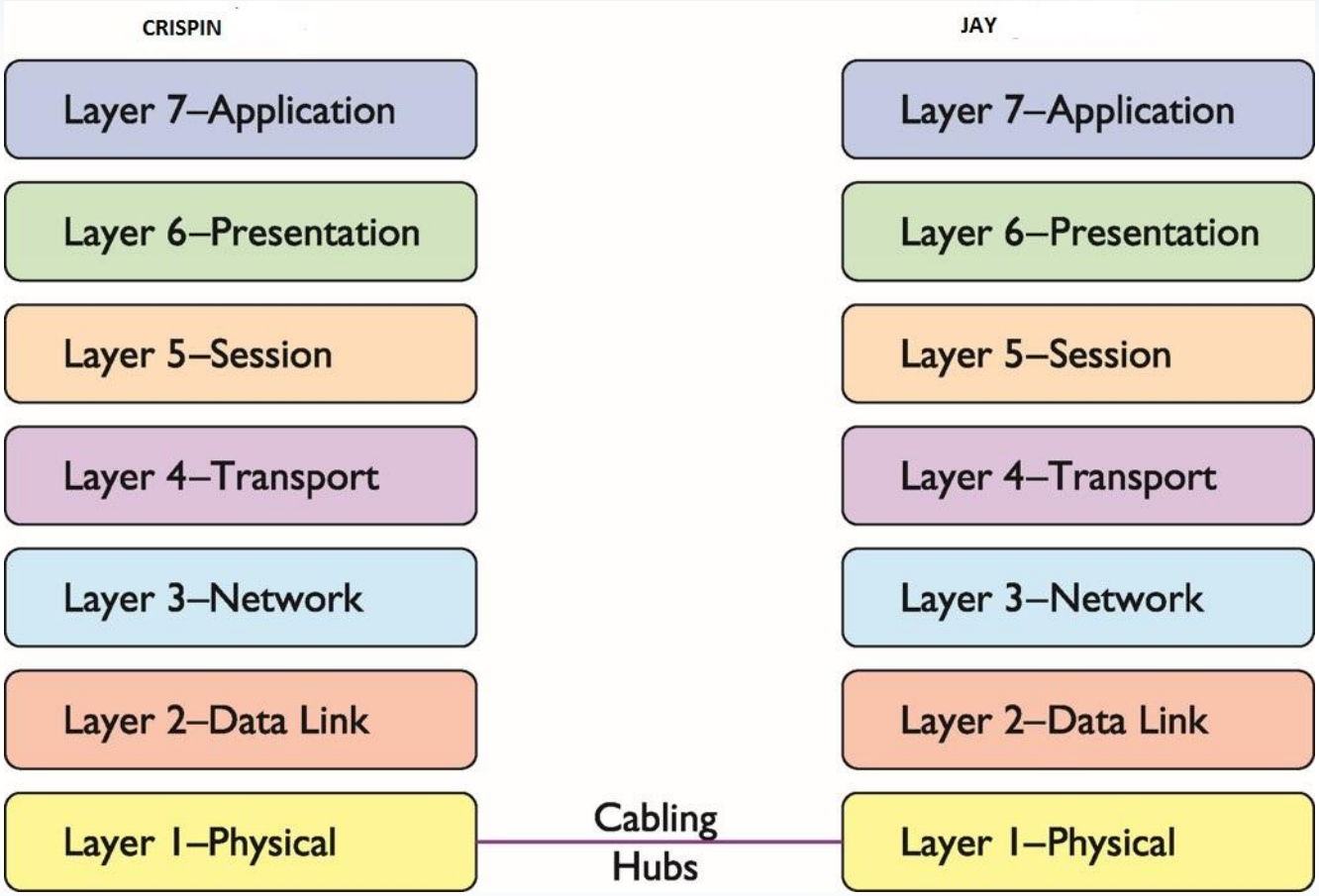


Figure 1.1 The network so far, with the Physical layer hardware

Layer 2- Data Link Layer

- Identify hosts: MAC Address
- Enables error-free transfer of data frames from one node to another over the physical layer.
- Controls the flow of data between hosts on the network

Network Cabling System

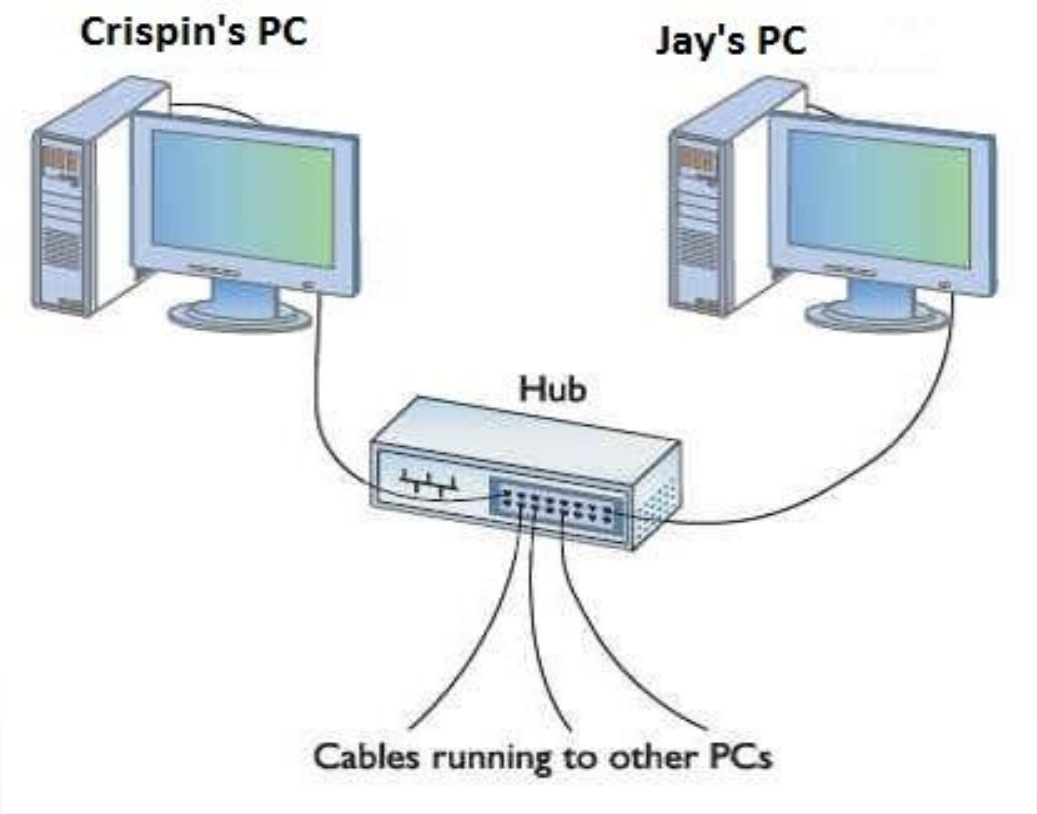


Figure 2.10 **Network Inside Student Network**

Layer 3- Network Layer

- The network layer controls the operation of the subnet.
- Deciding which physical path the data should take based on network conditions, priority of service, and other factors.

Layer 4- Transport Layer

- Deciding which physical path the data should take based on network conditions, priority of service, and other factors.
- It relieves the higher layer protocols from any concern with the transfer of data between them and their peers.

Layer 5- Session Layer

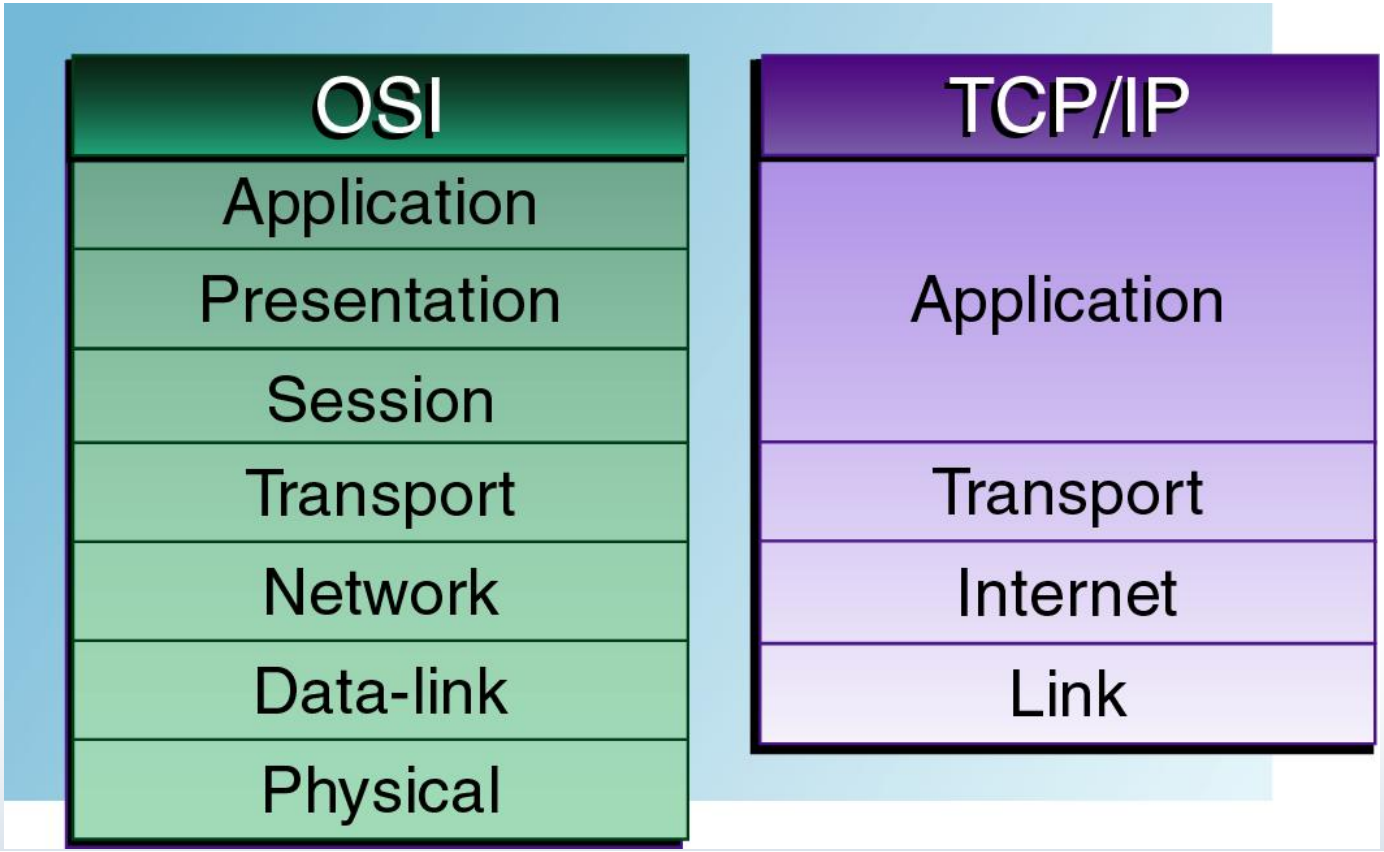
- The session layer allows session establishment between processes running on different stations.
- Allows two application processes on different machines to establish use and terminate a connection, called a session.

Layer 6- Presentation Layer

- Allows two application processes on different machines to establish use and terminate a connection, called a session.
- It can be viewed as the translator for the network.

Layer 7- Application Layer

- The application layer serves as the window for users and application processes to access network services.
- The application layer serves as the window for users and application processes to access network services.


OSI
Application
Presentation
Session
Transport
Network
Data-link
Physical
TCP/IP
Application
Transport
Internet
Link

- Link. Includes Serial Line Internet Protocol (SLIP) and Point-to-Point Protocol (PPP)
- Internet. Includes Internet Protocol (IP), Internet Control Message Protocol (ICMP), and Internet Group Membership Protocol (IGMP), plus some dynamic routing protocols
- Transport. Includes Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)
- Application. Includes Hypertext Transfer Protocol (HTTP) and File Transfer Protocol (FTP)

Application Layer

- Defines TCP/IP application protocols and how host programs interface with transport layer services to use the network.

- **Protocols:**
  - HTTP, Telnet, FTP, TFTP, SNMP, DNS, SMTP, X Windows, other application protocols

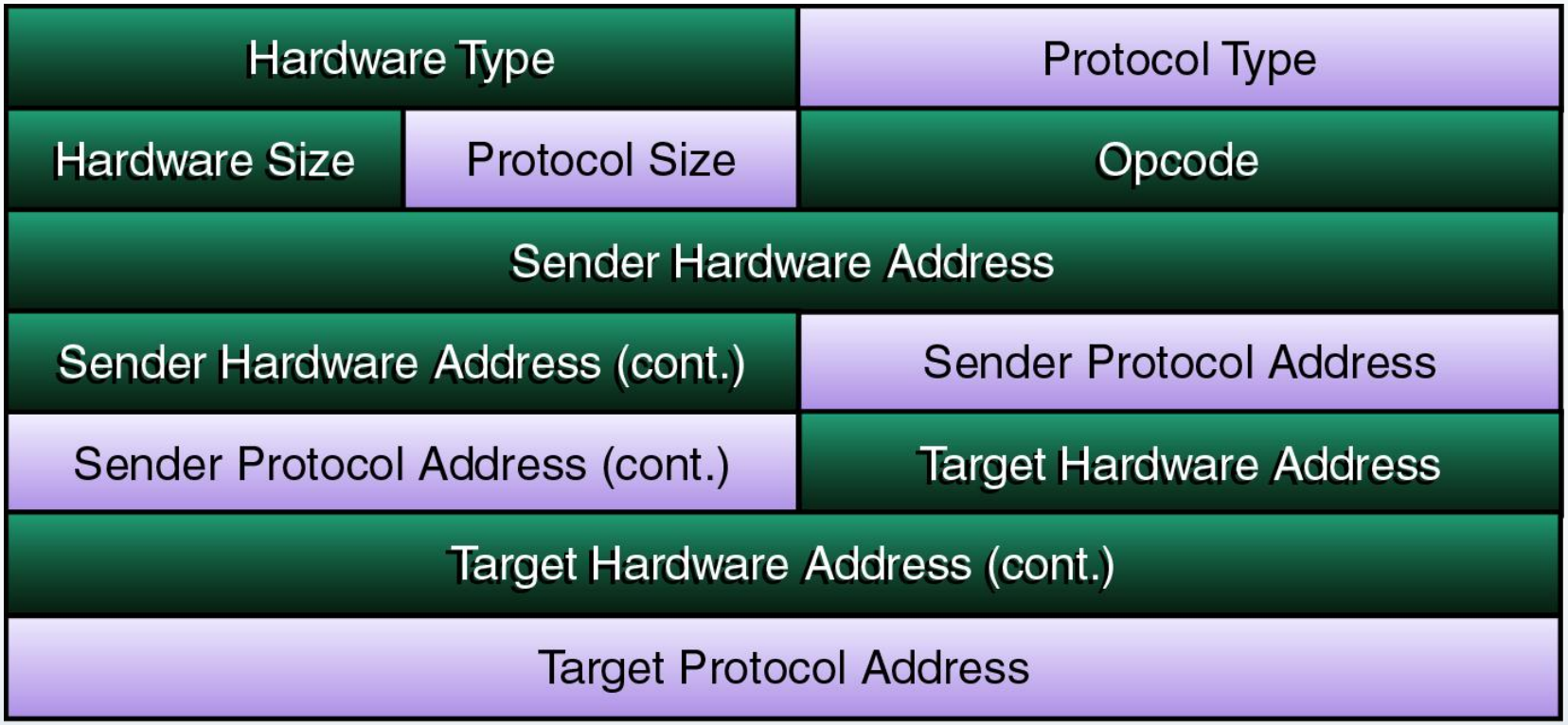
- SLIP
- PPP

- ARP is the acronym for Address Resolution Protocol.
- ARP is defined in RFC 826, “Ethernet Address Resolution Protocol.”
- It can be considered a link layer protocol or an internet layer protocol.
- ARP resolves IP addresses into hardware addresses.

1. IP packages transport layer information into a datagram by inserting the IP address of the destination system into the Destination IP Address field of the IP header.
2. IP compares the network identifier in the destination IP address to its own network identifier and determines whether to send the datagram directly to the destination host or to a router on the local network.
3. IP generates an ARP Request packet containing its own hardware address and IP address in the Sender Hardware Address and Sender Protocol Address fields.

5. The systems on the LAN receive the ARP Request message and read the contents of the Target Protocol Address field.
6. If the system receiving the ARP Request message recognizes its own IP address in the Target Protocol Address field, it generates an ARP Reply message.
7. The system transmits the ARP Reply message as a unicast message back to the computer that generated the request, using the hardware address in the Target Hardware Address field.
8. The system that originally generated the ARP Request message receives the ARP Reply and uses the newly supplied value in the Sender Hardware Address field to encapsulate the datagram in a data-link layer frame and transmit it to the desired destination as a unicast message.

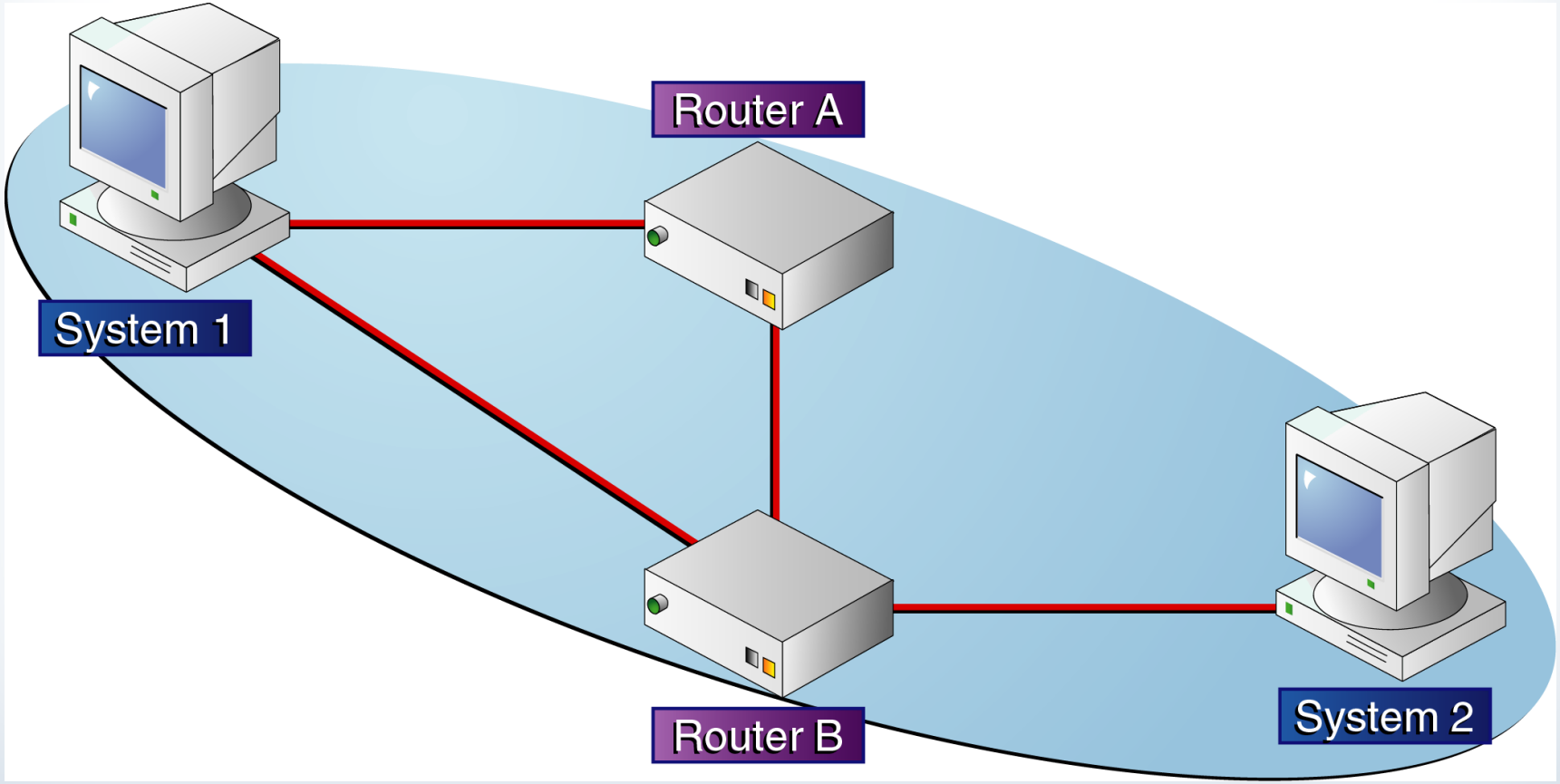
The ARP Message Format



- ICMP is the acronym for Internet Control Message Protocol.
- ICMP is defined in RFC 792.
- It is used to perform network administration tasks such as
  - Delivering error messages
  - Carrying query and response messages
- ICMP messages are carried in IP datagrams.

The ICMP Message Format

- Destination Unreachable
- Source Quench
- Redirect
- Time Exceeded


Router A
System 1
Router B
System 2

- Echo Request and Echo Reply
- Router Solicitation and Router Advertisement

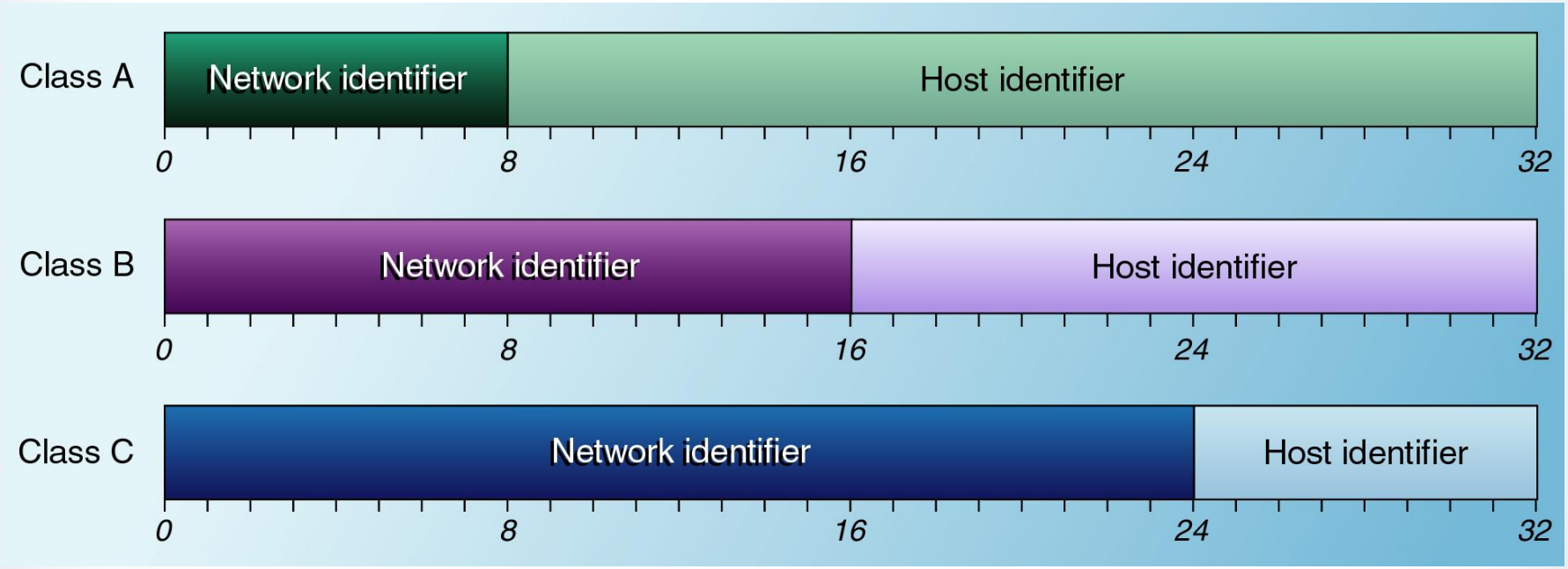
- TCP
- UDP

- Internet Mail Access Protocol 4 (IMAP4)
- Network Time Protocol (NTP)
- Domain Name System (DNS)
- Dynamic Host Configuration Protocol (DHCP)
- Simple Network Management Protocol (SNMP)
- Telnet
- Hypertext Transfer Protocol (HTTP)
- Secure Hypertext Transfer Protocol (S-HTTP or HTTPS)
- File Transfer Protocol (FTP)
- Trivial File Transfer Protocol (TFTP)
- Simple Mail Transport Protocol (SMTP)
- Post Office Protocol 3 (POP3)

- 32-bit value that contains a network identifier and a host identifier
- Expressed in dotted decimal notation
- Assigned to network interface adapters, not computers

- Every network interface adapter on a network must have
  - The same network identifier as the others on the network
  - A unique host identifier
- The Internet Assigned Numbers Authority (IANA) assigns network identifiers, but you typically obtain network addresses from an Internet service provider (ISP).
- Network administrators assign host identifiers.

IP Address Classes



Class	First Bits	First Byte Values
A	0	1–127
B	10	128–191
C	110	192–223

Class	Network ID Bits	Host ID Bits	Number of Networks	Number of Hosts
A	8	24	126	16,777,214
B	16	16	16,384	65,534
C	24	8	2,097,152	254

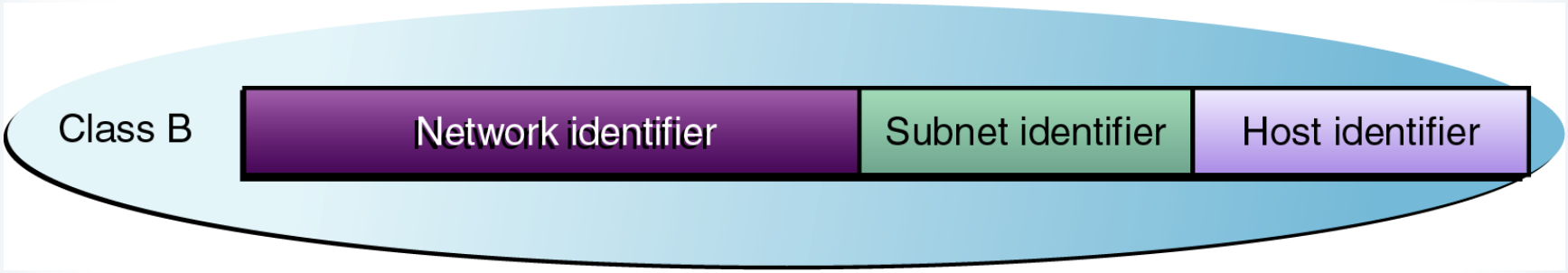
- All the bits in the network identifier cannot be set to zeros.
- All the bits in the network identifier cannot be set to ones.
- All the bits in the host identifier cannot be set to zeros.
- All the bits in the host identifier cannot be set to ones.

- A subnet mask is a 32-bit binary number that indicates which bits of an IP address identify the network and which bits identify the host.
- The 1 bits are the network identifier bits and the 0 bits are the host identifier bits.
- A subnet mask is typically expressed in dotted decimal notation.

Class	Subnet Mask
A	255.0.0.0
B	255.255.0.0
C	255.255.255.0

- Borrow bits from the host identifier and use them as a subnet identifier.
- Increment the subnet and host identifiers separately.
- Convert the binary values to decimals.

Subnetting a Class B Address



Class	Network Addresses
A	10.0.0.0 through 10.255.255.255
B	172.16.0.0 through 172.31.255.255
C	192.168.0.0 through 192.168.255.255

- Expands IP address space from 32 to 128 bits
- Designed to prevent the depletion of IP addresses
- Uses XX:XX:XX:XX:XX:XX:XX:XX notation

- TCP/IP protocols
  - The TCP/IP protocols were developed to support systems that use any computing platform or operating system.
  - The TCP/IP protocol stack consists of four layers: link, internet, transport, and application.
  - IP uses the ARP protocol to resolve IP addresses into the hardware addresses needed for data-link layer protocol communications.
  - The ICMP protocol performs numerous functions at the internet layer, including reporting errors and querying systems for information.
  - Application layer protocols enable specific programs and services running on TCP/IP computers to exchange messages.

- IP addressing
  - IP addresses are 32 bits long and consist of a network identifier and a host identifier, expressed as four decimal numbers separated by periods.
  - Every network interface adapter on a TCP/IP network must have a unique IP address.
  - The IANA assigns IP network addresses in three classes, and network administrators assign the host addresses to each individual system.
  - The subnet mask specifies which bits of an IP address identify the network and which bits identify the host.
  - Modifying the subnet mask for an address in a particular class lets you "borrow" some of the host bits to create a subnet identifier.

Transport Layer

- Provides communication session management between host computers. Defines the level of service and status of the connection used when transporting data.

- **Protocols:**
  - TCP, UDP, RTP

Internet Layer

- Packages data into IP datagrams, which contain source and destination address information.
- That is used to forward the datagrams between hosts and across networks.
- Performs routing of IP datagrams.

- **Protocols:**
  - IP, ICMP, ARP, RARP

Network Access Layer

- Specifies details of how data is physically sent through the network, including how bits are electrically signaled by hardware devices that interface directly with a network medium, such as coaxial cable, optical fiber, or twisted-pair copper wire.
- Also called the Link Layer
- **Protocols:**
  - Ethernet, Token Ring, FDDI, X.25, Frame Relay, RS-232, v.35

THANK YOU