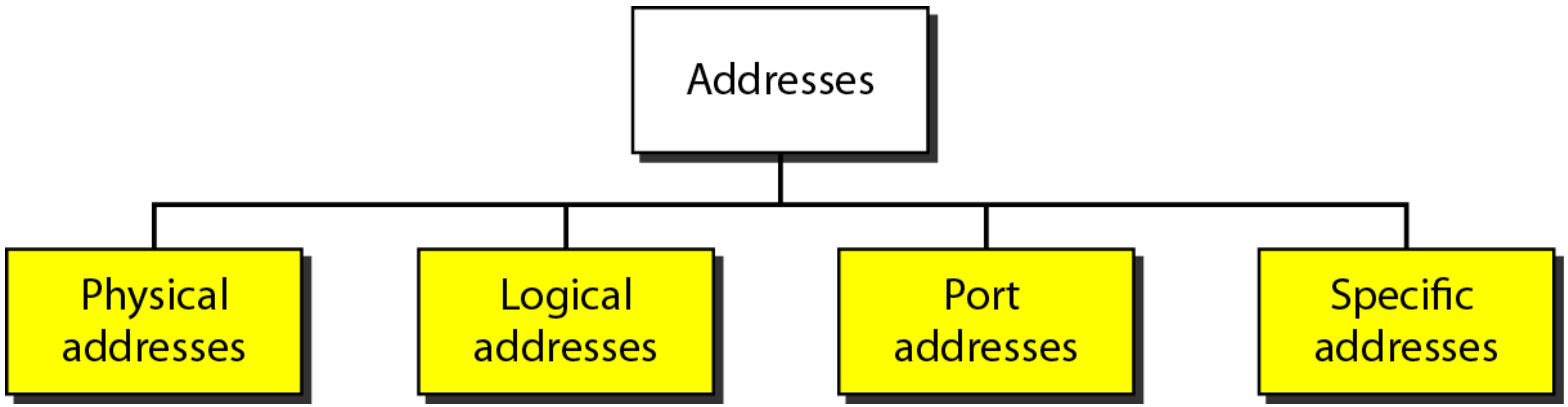
IT2004- Introduction to Data Communication & Network

Device Addressing & protocols

P.G.R Nayomi Gamlath
MSc(Pdn) , BSc (Rajarata)
ATI -Kurunegala

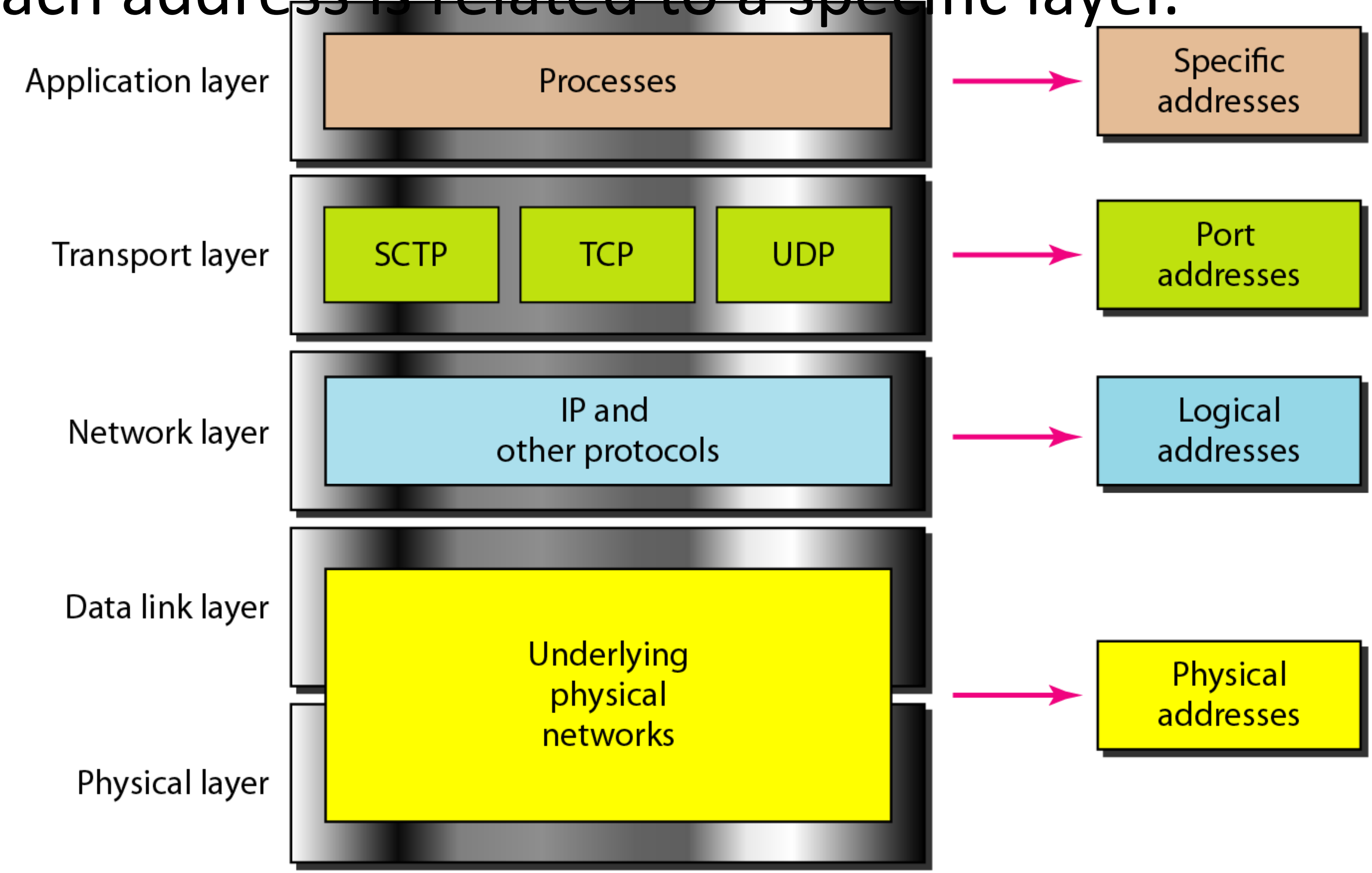
Addressing

- Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical(IP), port, and specific.



Relationship of layers and addresses in TCP/IP

- Each address is related to a specific layer.



Physical Address

- Also known as the link address
- Is the address of a node as defined by its LAN or WAN.
- Is included in frame used by data link layer
- Is the lowest level address
- Eg. Ethernet uses 48 bit physical address that imprinted on the NIC .

Physical Addressing

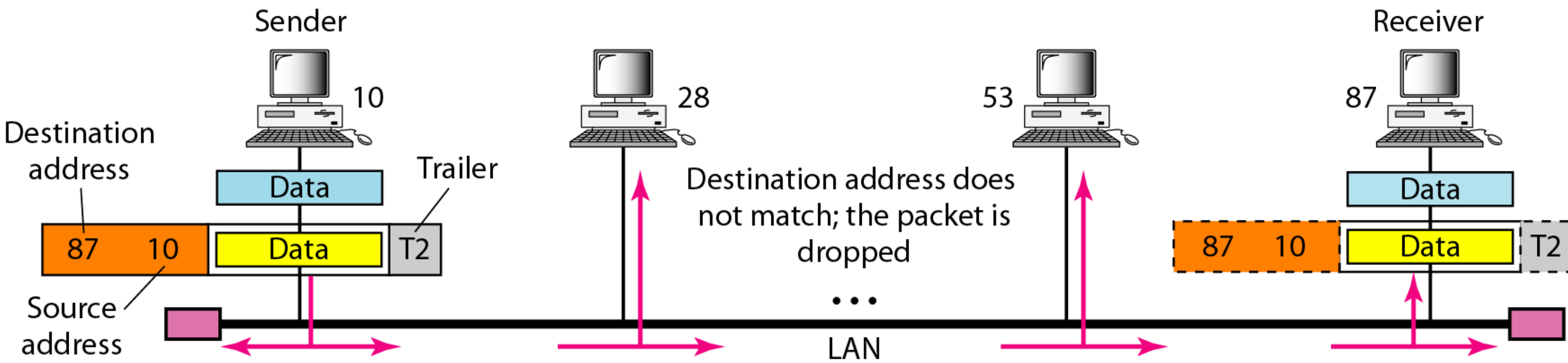


Figure 2 *Physical addresses*

- *In Figure 2 a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (bus topology LAN). As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver.*

Physical Addressing(1)

- In Figure 2 a node with physical address 10 sends a frame to a node with physical address 87.
- The two nodes are connected by a link (bus topology LAN). At the data link layer, this frame contains physical (link) addresses in the header.
- These are the only addresses needed. The rest of the header contains other information needed at this level.
- The trailer usually contains extra bits needed for error detection.

Physical Addressing(2)

- As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver.
- The data link layer at the sender receives data from an upper layer.
- It encapsulates the data in a frame, adding a header and a trailer.
- The header, among other pieces of information, carries the receiver and the sender physical (link) addresses.

Physical Addressing(3)

- We have shown a bus topology for an isolated LAN. In a bus topology, the frame is propagated in both directions (left and right).
- The frame propagated to the left dies when it reaches the end of the cable if the cable end is terminated appropriately. The frame propagated to the right is sent to every station on the network.
- Each station with a physical addresses other than 87 drops the frame because the destination address in the frame does not match its own physical address.

Physical Addressing(4)

- The intended destination computer, however, finds a match between the destination address in the frame and its own physical address.
- The frame is checked, the header and trailer are dropped, and the data part is de capsulated and delivered to the upper layer.
- Most local-area networks use a 48-bit (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon

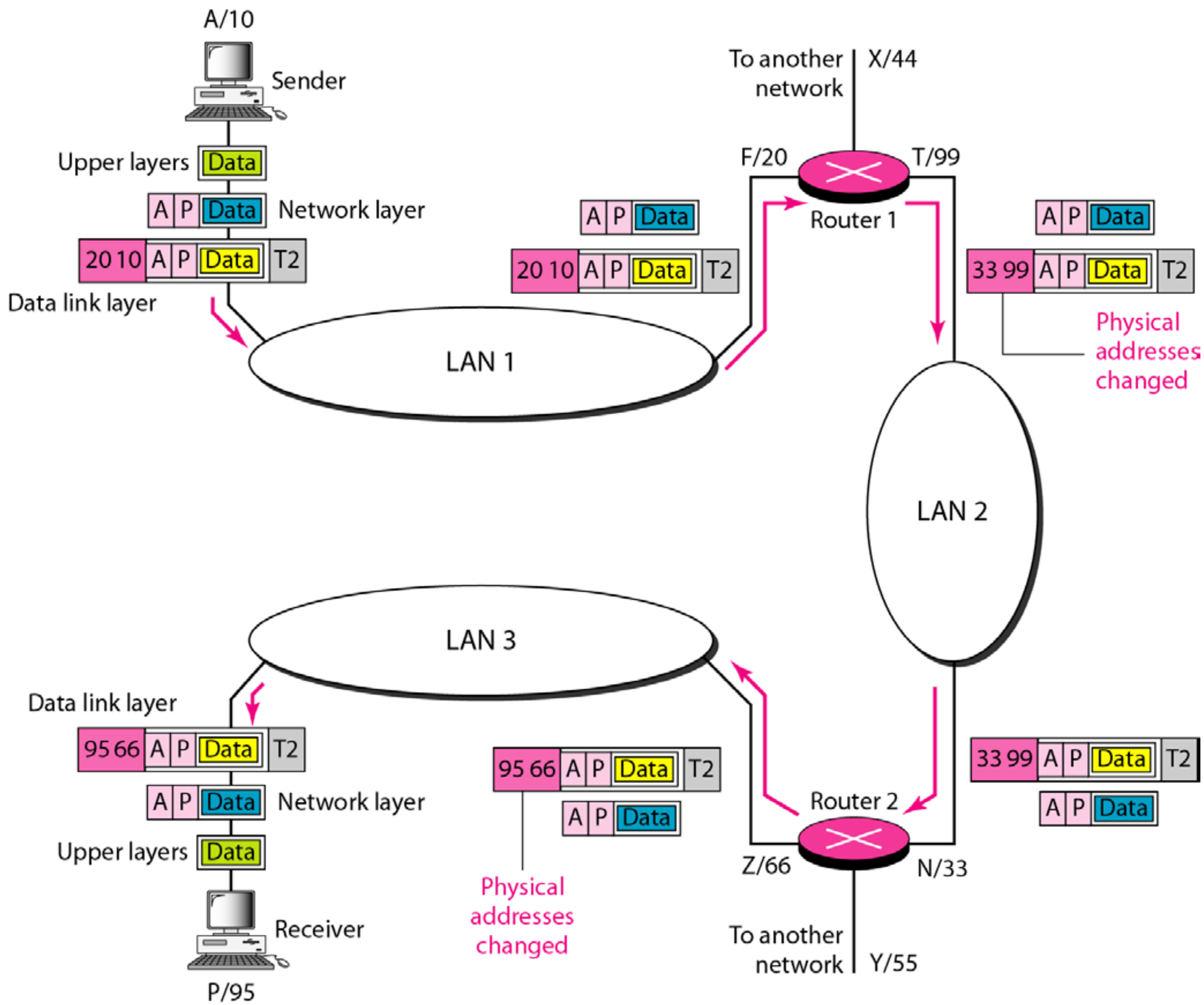
07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address

Logical address(IP)

- Logical addresses are necessary for universal communications that are independent of underlying physical networks.
- Physical addresses are not adequate in an internetwork environment where different networks can have different address formats.
- A universal addressing system is needed in which each host can be identified uniquely, regardless of the underlying physical network.
- The logical addresses are designed for this purpose. A logical address in the Internet is currently a 32-bit address that can uniquely define a host connected to the Internet.
- No two publicly addressed and visible hosts on the Internet can have the same IP address.

Figure 3 *IP addresses*



Logical & Physical addressing

- Figure 3 shows a part of an internet with two routers connecting three LANs.
- Each device (computer or router) has a pair of addresses (logical and physical) for each connection.
- In this case, each computer is connected to only one link and therefore has only one pair of addresses.
- Each router, however, is connected to three networks (only two are shown in the figure).
- So each router has three pairs of addresses, one for each connection.

Logical & Physical addressing

- The computer with logical address A and physical address 10 needs to send a packet to the computer with logical address P and physical address 95.
- Note: We use letters to show the logical addresses and numbers for physical addresses.
- The sender encapsulates its data in a packet at the network layer and adds two logical addresses (A and P). Note that in most protocols, the logical source address comes before the logical destination address (contrary to the order of physical addresses).
- The network layer, however, needs to find the physical address of the next hop before the packet can be delivered.

Logical & Physical addressing

- The network layer consults its routing table and finds the logical address of the next hop (router I) to be F.
- The ARP finds the physical address of router 1 that corresponds to the logical address of 20.
- Now the network layer passes this address to the data link layer, which in turn, encapsulates the packet with physical destination address 20 and physical source address 10.

Logical & Physical addressing

- The frame is received by every device on LAN 1, but is discarded by all except router 1, which finds that the destination physical address in the frame matches with its own physical address.
- The router decapsulates the packet from the frame to read the logical destination address P. Since the logical destination address does not match the router's logical address, the router knows that the packet needs to be forwarded.

Logical & Physical addressing

- The router consults its routing table and ARP to find the physical destination address of the next hop (router 2), creates a new frame, encapsulates the packet, and sends it to router 2.
- Note the physical addresses in the frame. The source physical address changes from 10 to 99.
- The destination physical address changes from 20 (router 1 physical address) to 33 (router 2 physical address).
- The logical source and destination addresses must remain the same; otherwise the packet will be lost.

Logical & Physical addressing

- At router 2 we have a similar scenario. The physical addresses are changed, and a new frame is sent to the destination computer.
- When the frame reaches the destination, the packet is decapsulated. The destination logical address P matches the logical address of the computer.
- The data are decapsulated from the packet and delivered to the upper layer.
- Note that although physical addresses will change from hop to hop, logical addresses remain the same from the source to destination.

Port Address

- The IP address and the physical address are necessary for a quantity of data to travel from a source to the destination host.
- However, arrival at the destination host is not the final objective of data communications on the Internet.
- A system that sends nothing but data from one computer to another is not complete.
- Today, computers are devices that can run multiple processes at the same time.

Port Address

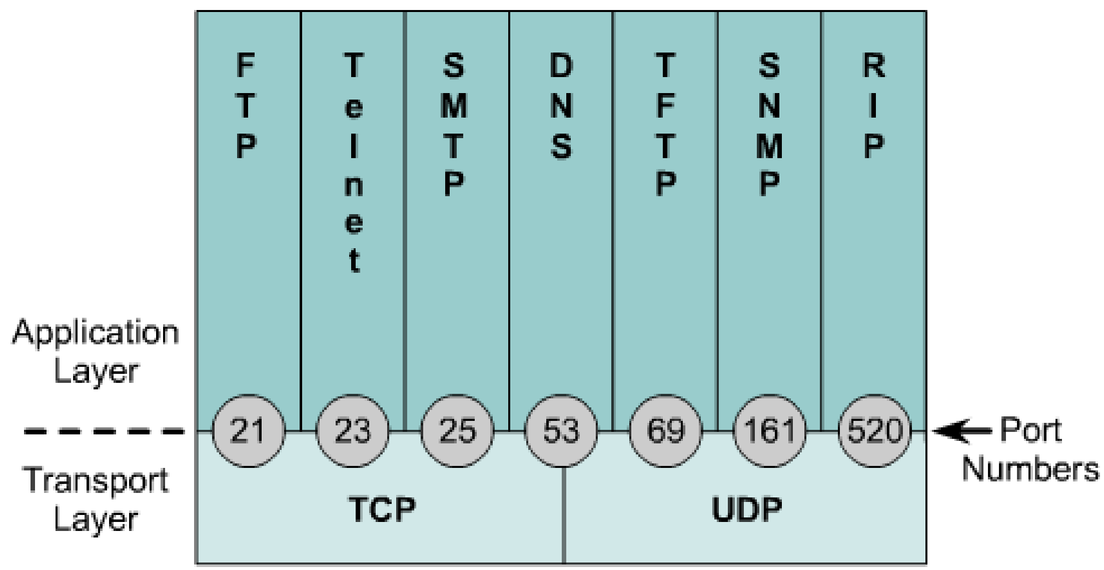
- The end objective of Internet communication is a process communicating with another process. For example, computer A can communicate with computer C by using TELNET. At the same time, computer A communicates with computer B by using the File Transfer Protocol (FTP).
- For these processes to receive data simultaneously, we need a method to label the different processes.

Port Address

- In other words, they need addresses. In the TCP/IP architecture, the label assigned to a process is called a port address.
- A port address in TCP/IP is 16 bits in length.

Well Known Port Numbers

- The following port numbers should be memorized:
- **Port 80** is used for **HTTP** or **WWW** protocols. (Essentially access to the internet.)
- In addition,



Logical, Physical & port addressing

Note

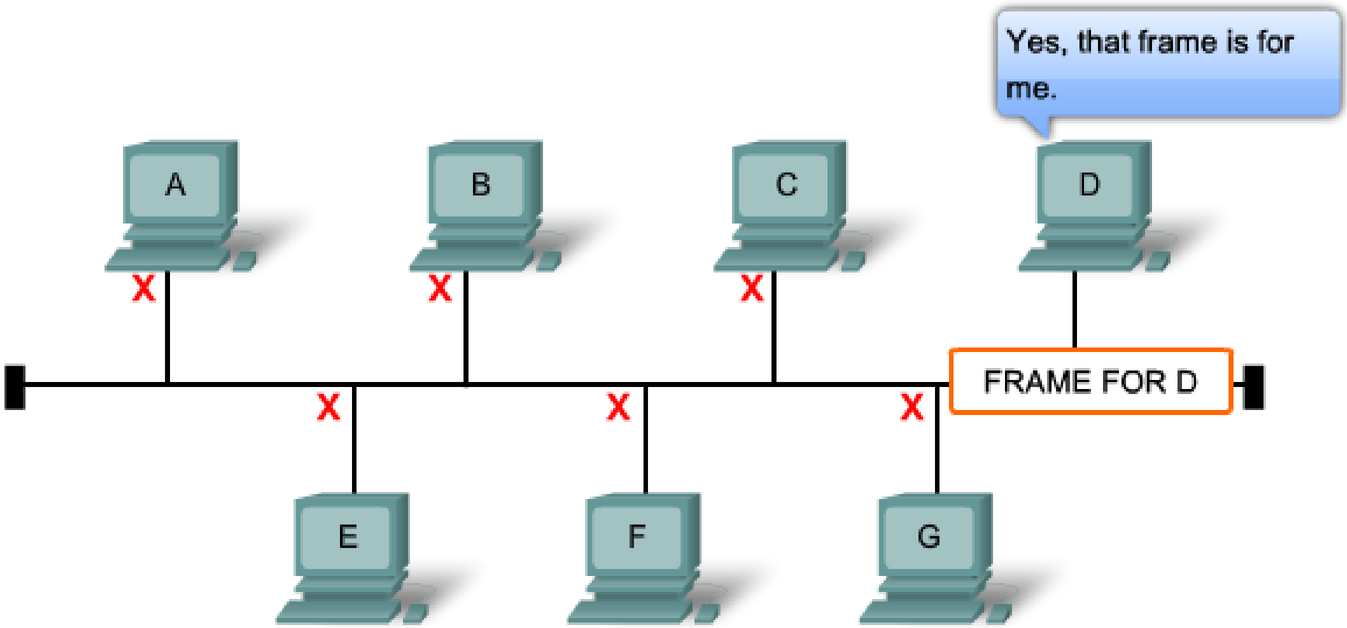
The physical addresses change from hop to hop,
but the logical and port addresses usually remain the same.

MAC Address(Physical Address)

- is a unique identifier assigned to most network adapters or network interface cards (NICs) by the manufacturer for identification, and used in the Media Access Control protocol sub-layer.
- If assigned by the manufacturer, a MAC address usually encodes the manufacturer's registered identification number.
- It may also be known as an **Ethernet Hardware Address** (EHA), **hardware address**, **adapter address**, or **physical address**.

MAC address- Addressing in Ethernet

The MAC Address—Addressing in Ethernet



Shared Media (Multiple Access)

All Ethernet nodes share the media.
To receive the data sent to it, each node needs a unique address.

MAC address structure

- The MAC address value is a direct result of IEEE-enforced rules for vendors to ensure globally unique addresses for each Ethernet device.
- The rules established by IEEE require any vendor that sells Ethernet devices to register with IEEE.
- The IEEE assigns the vendor a 3-byte code, called the Organizationally Unique Identifier (OUI).
- IEEE requires a vendor to follow two simple rules:
  - All MAC addresses assigned to a NIC or other Ethernet device must use that vendor's assigned OUI as the first 3 bytes.
  - All MAC addresses with the same OUI must be assigned a unique value (vendor code or serial number) in the last 3 bytes.

MAC address structure

- The MAC address is often referred to as a burned-in address (BIA) because it is burned into ROM (Read-Only Memory) on the NIC. This means that the address is encoded into the ROM chip permanently - it cannot be changed by software.
- However, when the computer starts up, the NIC copies the address into RAM. When examining frames, it is the address in RAM that is used as the source address to compare with the destination address.

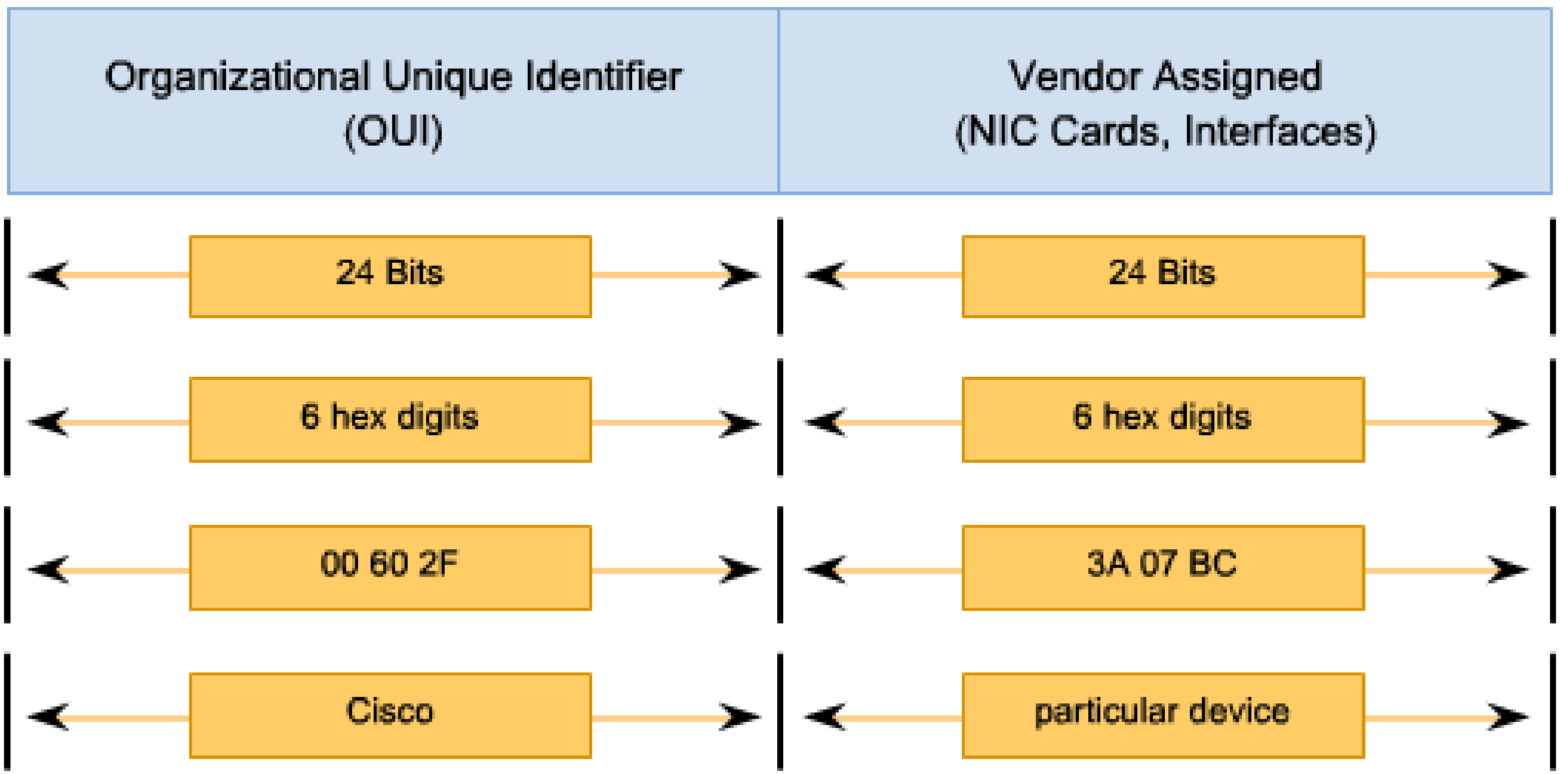
Network Devices

- When the source device is forwarding the message to an Ethernet network, the header information within the destination MAC address is attached.
- The source device sends the data through the network.
- Each NIC in the network views the information to see if the MAC address matches its physical address.
- If there is no match, the device discards the frame.
- When the frame reaches the destination where the MAC of the NIC matches the destination MAC of the frame, the NIC passes the frame up the OSI layers, where the decapsulation process take place.

Network Devices

- All devices connected to an Ethernet LAN have MAC-addressed interfaces.
- Different hardware and software manufacturers might represent the MAC address in different hexadecimal formats.
- The address formats might be similar to 00-05-9A-3C-78-00, 00:05:9A:3C:78:00, or 0005.9A3C.7800.
- MAC addresses are assigned to workstations, servers, printers, switches, and routers - any device that must originate and/or receive data on the network.

The Ethernet MAC Address Structure



Different representations of MAC Addresses

00-60-2F-3A-07-BC
00:60:2F:3A:07:BC
0060.2F3A.07BC

Hexadecimal Numbering

Decimal and Binary equivalents of 0 to F Hexadecimal

Decimal	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Selected Decimal, Binary and Hexadecimal equivalents

Decimal	Binary	Hexadecimal
0	0000 0000	00
1	0000 0001	01
2	0000 0010	02
3	0000 0011	03
4	0000 0100	04
5	0000 0101	05
6	0000 0110	06
7	0000 0111	07
8	0000 1000	08
10	0000 1010	0A
15	0000 1111	0F
16	0001 0000	10
32	0010 0000	20
64	0100 0000	40
128	1000 0000	80
192	1100 0000	C0
202	1100 1010	CA
240	1111 0000	F0
255	1111 1111	FF

Viewing the MAC

- A tool to examine the MAC address of our computer is the ipconfig /all or ifconfig.
  - In the graphic, notice the MAC address of this computer. If you have access, you may wish to try this on your own computer.
- You may want to research the OUI of the MAC address to determine the manufacturer of your NIC.

Viewing the MAC

Viewing the MAC Address

```
C:\>ipconfig /all
Ethernet adapter Network Connection:
        Connection-specific DNS Suffix: example.com
        Description . . . . . . . . . . . : Intel(R) PRO/Wireless 3945ABG Network
Connection
        Physical Address. . . . . . . . . : 00-18-DE-C7-F3-FB
        Dhcp Enabled. . . . . . . . . . . : Yes
        Autoconfiguration Enabled . . . . : Yes
        IP Address. . . . . . . . . . . . : 10.2.3.4
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        Default Gateway . . . . . . . . . : 10.2.3.254
        DHCP Server . . . . . . . . . . . : 10.2.3.69
        DNS Servers . . . . . . . . . . . : 192.168.226.120
        Lease Obtained. . . . . . . . . . : Thursday, May 03, 2007 3:47:51 PM
        Lease Expires . . . . . . . . . . : Friday, May 04, 2007 6:57:11 AM
C:\>
```

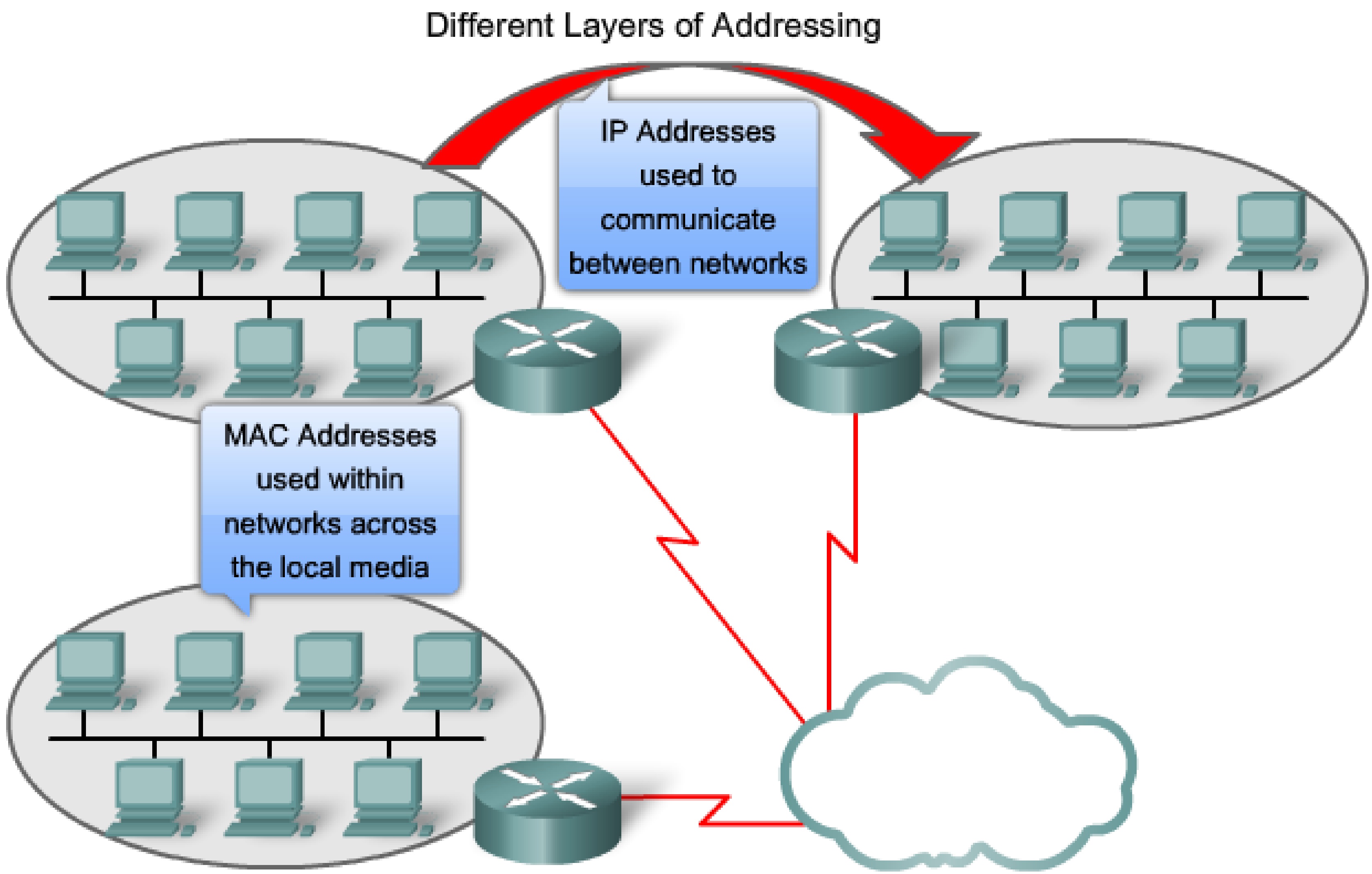
Layer of Addressing

Data Link Layer

- OSI Data Link layer (Layer 2) physical addressing, implemented as an Ethernet MAC address, is used to transport the frame across the local media. Although providing unique host addresses, physical addresses are non-hierarchical. They are associated with a particular device regardless of its location or to which network it is connected.
- These Layer 2 addresses have no meaning outside the local network media. A packet may have to traverse a number of different Data Link technologies in local and wide area networks before it reaches its destination. A source device therefore has no knowledge of the technology used in intermediate and destination networks or of their Layer 2 addressing and frame structures.

Layer of Addressing

- Network layer (Layer 3) addresses, such as IPv4 addresses, provide the ubiquitous, logical addressing that is understood at both source and destination. To arrive at its eventual destination, a packet carries the destination Layer 3 address from its source. However, as it is framed by the different Data Link layer protocols along the way, the Layer 2 address it receives each time applies only to that local portion of the journey and its media.
- In short:
- The Network layer address enables the packet to be forwarded toward its destination.
- The Data Link layer address enables the packet to be carried by the local media across each segment.


Different Layers of Addressing
IP Addresses used to communicate between networks
MAC Addresses used within networks across the local media

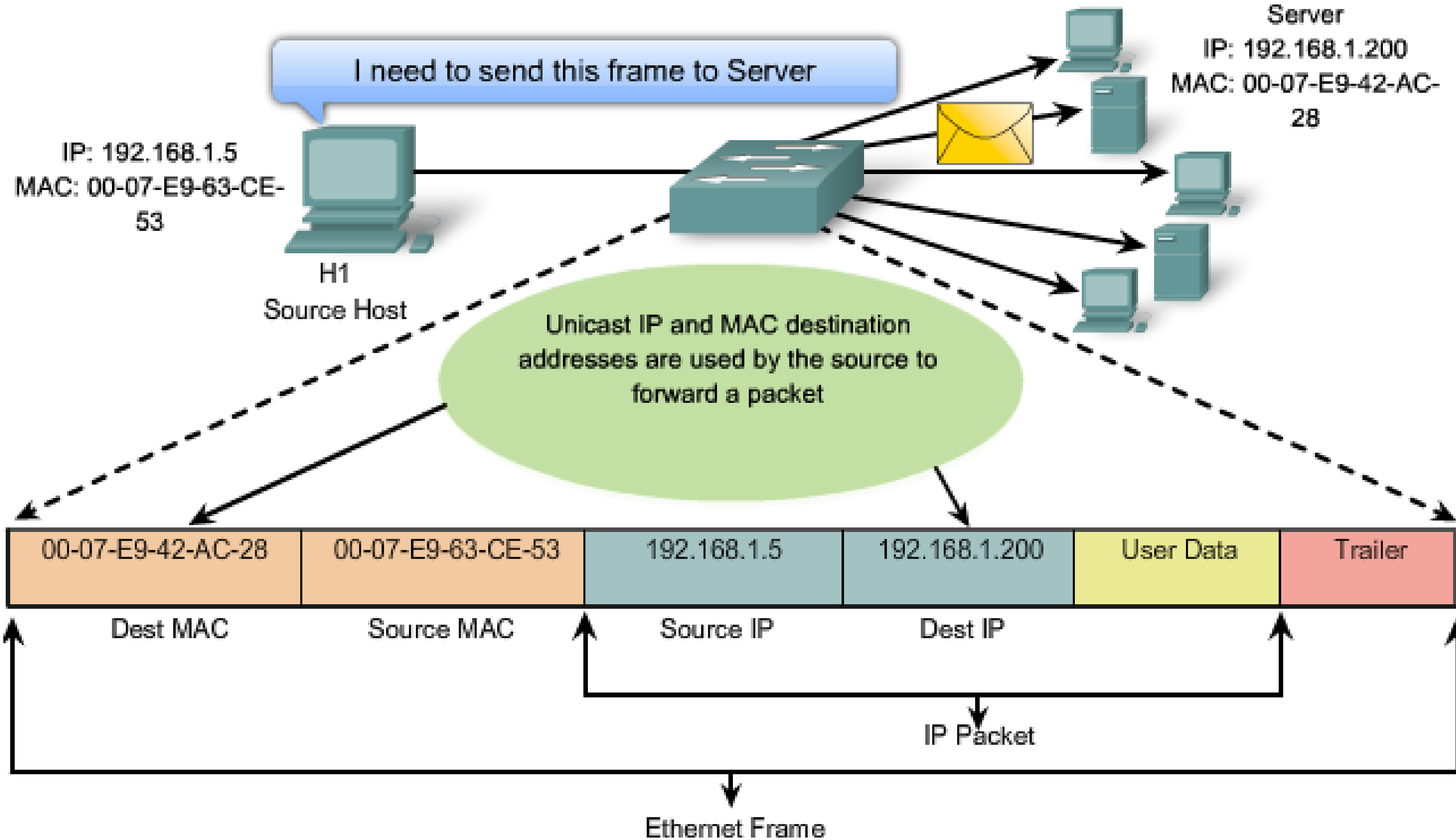
Ethernet Unicast, Multicast, & Broadcast

- In Ethernet, different MAC addresses are used for Layer 2 unicast, multicast, and broadcast communications.

Unicast

- A unicast MAC address is the unique address used when a frame is sent from a single transmitting device to single destination device.
- In the example shown in the figure, a host with IP address 192.168.1.5 (source) requests a web page from the server at IP address 192.168.1.200. For a unicast packet to be sent and received, a destination IP address must be in the IP packet header. A corresponding destination MAC address must also be present in the Ethernet frame header. The IP address and MAC address combine to deliver data to one specific destination host.

Unicast

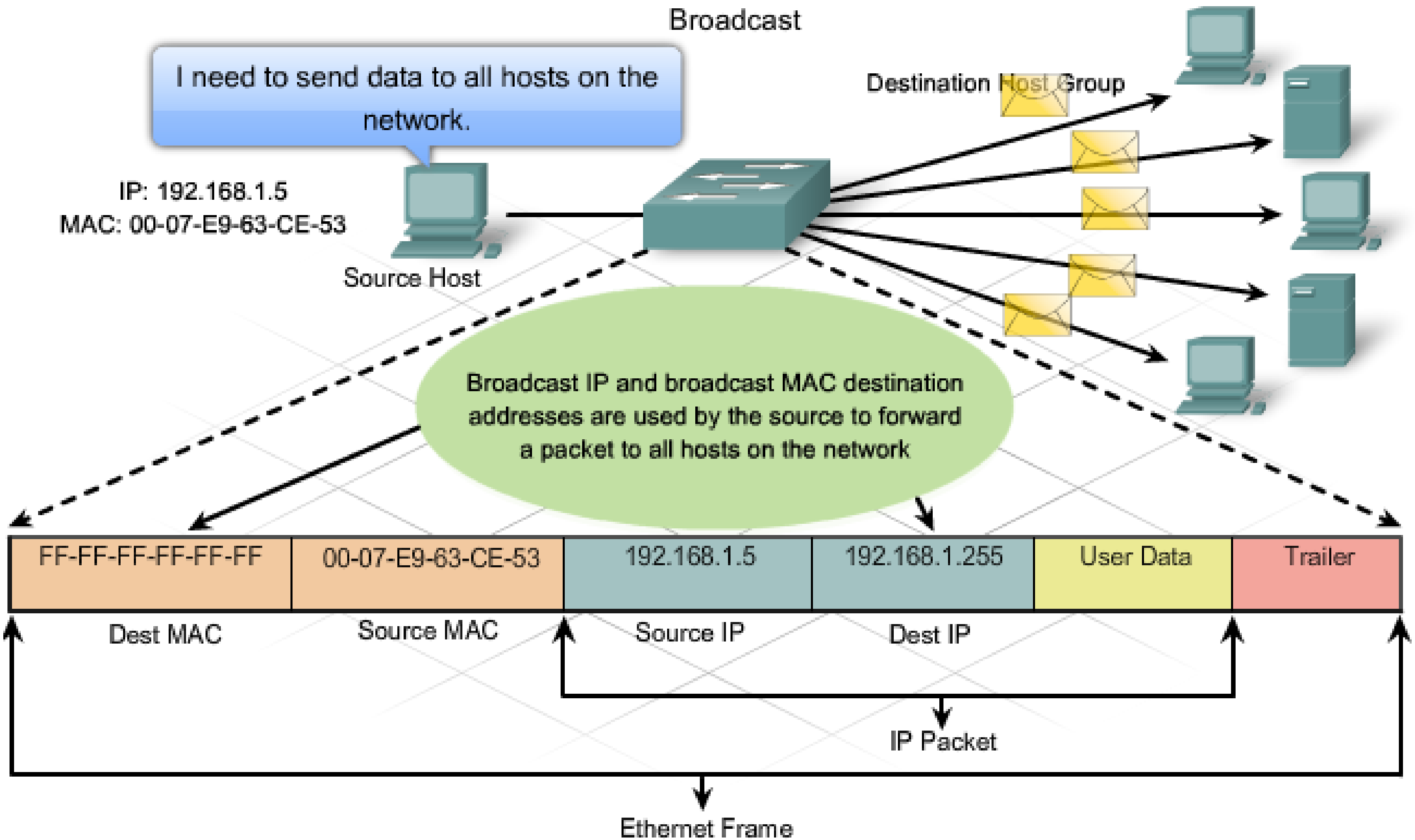

I need to send this frame to Server
IP: 192.168.1.5
MAC: 00-07-E9-63-CE-53
H1
Source Host
Server
IP: 192.168.1.200
MAC: 00-07-E9-42-AC-28
Unicast IP and MAC destination addresses are used by the source to forward a packet
00-07-E9-42-AC-28
00-07-E9-63-CE-53
192.168.1.5
192.168.1.200
User Data
Trailer
Dest MAC
Source MAC
Source IP
Dest IP
IP Packet
Ethernet Frame

Broadcast

- With a broadcast, the packet contains a destination IP address that has all ones (1s) in the host portion. This numbering in the address means that all hosts on that local network (broadcast domain) will receive and process the packet. Many network protocols, such as Dynamic Host Configuration Protocol (DHCP) and Address Resolution Protocol (ARP), use broadcasts. How ARP uses broadcasts to map Layer 2 to Layer 3 addresses is discussed later in this chapter.

- As shown in the figure, a broadcast IP address for a network needs a corresponding broadcast MAC address in the Ethernet frame. On Ethernet networks, the broadcast MAC address is 48 ones displayed as Hexadecimal FF-FF-FF-FF-FF-FF.

Broadcast


Broadcast
I need to send data to all hosts on the network.
Destination Host Group
IP: 192.168.1.5
MAC: 00-07-E9-63-CE-53
Source Host
Broadcast IP and broadcast MAC destination addresses are used by the source to forward a packet to all hosts on the network
FF-FF-FF-FF-FF-FF
00-07-E9-63-CE-53
192.168.1.5
192.168.1.255
User Data
Trailer
Dest MAC
Source MAC
Source IP
Dest IP
IP Packet
Ethernet Frame

Multicast

- multicast addresses allow a source device to send a packet to a group of devices. Devices that belong to a multicast group are assigned a multicast group IP address. The range of multicast addresses is from 224.0.0.0 to 239.255.255.255. Because multicast addresses represent a group of addresses (sometimes called a host group), they can only be used as the destination of a packet. The source will always have a unicast address.

- Examples of where multicast addresses would be used are in remote gaming, where many players are connected remotely but playing the same game, and distance learning through video conferencing, where many students are connected to the same class.

Multicast

- As with the unicast and broadcast addresses, the multicast IP address requires a corresponding multicast MAC address to actually deliver frames on a local network. The multicast MAC address is a special value that begins with 01-00-5E in hexadecimal. The value ends by converting the lower 23 bits of the IP multicast group address into the remaining 6 hexadecimal characters of the Ethernet address. The remaining bit in the MAC address is always a "0".

Multicast

- An example, as shown in the graphic, is hexadecimal 01-00-5E-00-00-01. Each hexadecimal character is 4 binary bits.