OSI Network Layer

Network Fundamentals – Chapter 5

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Objectives

- Identify the role of the Network Layer, as it describes communication from one end device to another end device
- Examine the most common Network Layer protocol, Internet Protocol (IP), and its features for providing connectionless and best-effort service
- Understand the principles used to guide the division or grouping of devices into networks
- Understand the hierarchical addressing of devices and how this allows communication between networks
- Understand the fundamentals of routes, next hop addresses and packet forwarding to a destination network

IP v4 protocol characteristics

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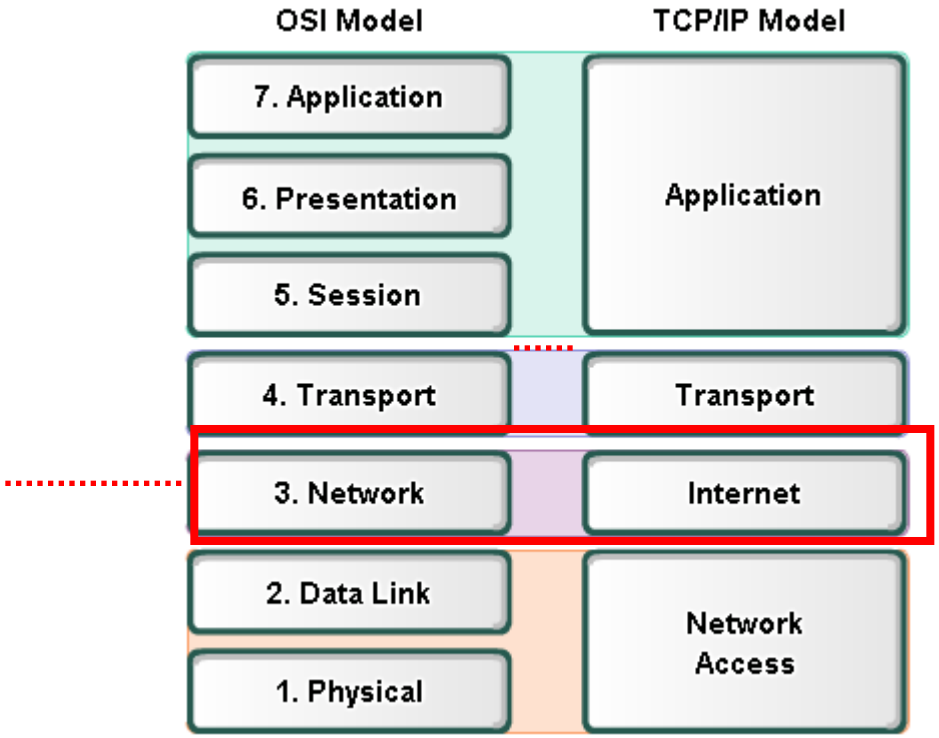
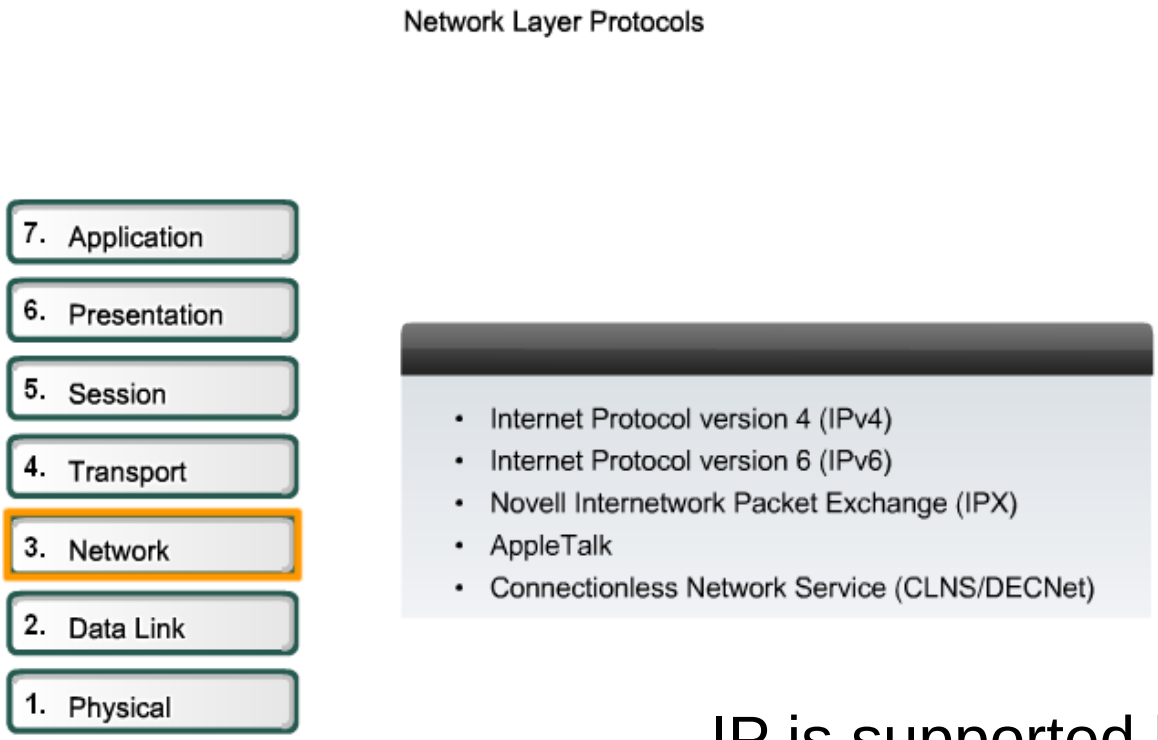
Network Layer

IPv4



Network layer protocols.

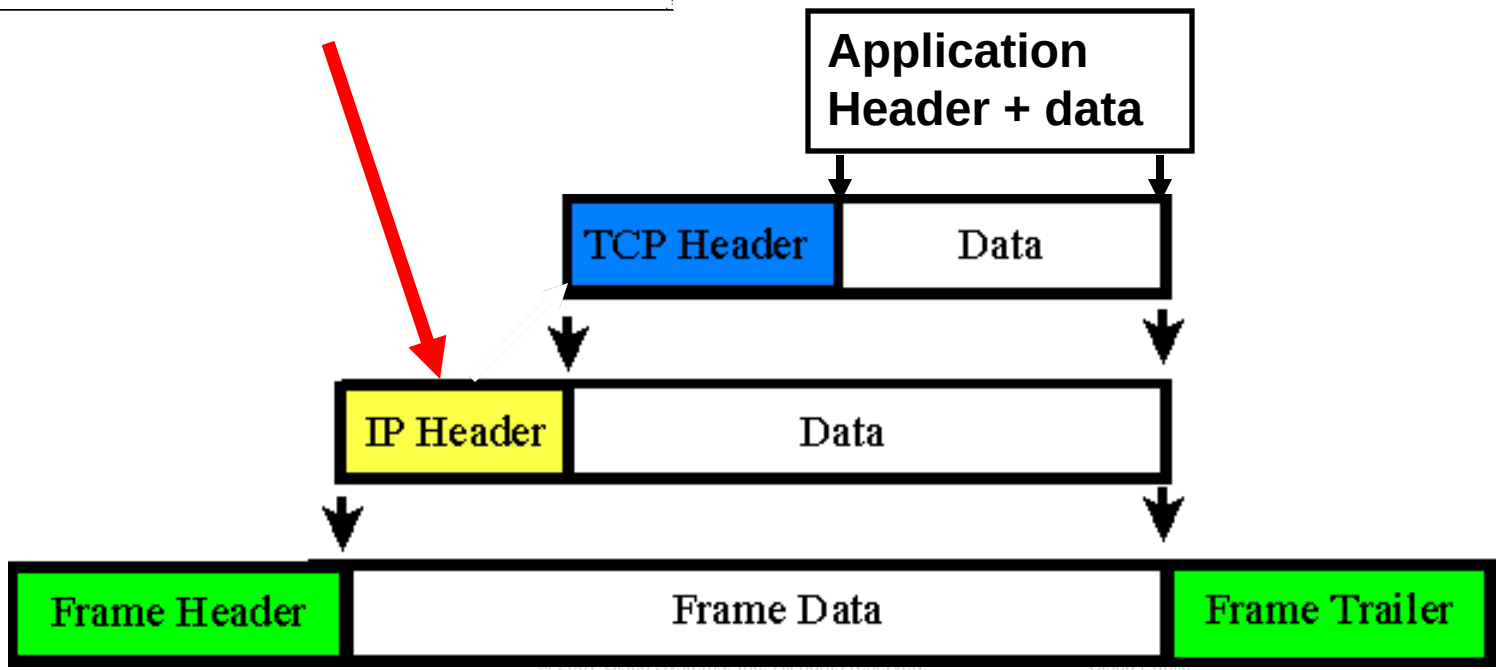


IP is supported by another protocols at layer3

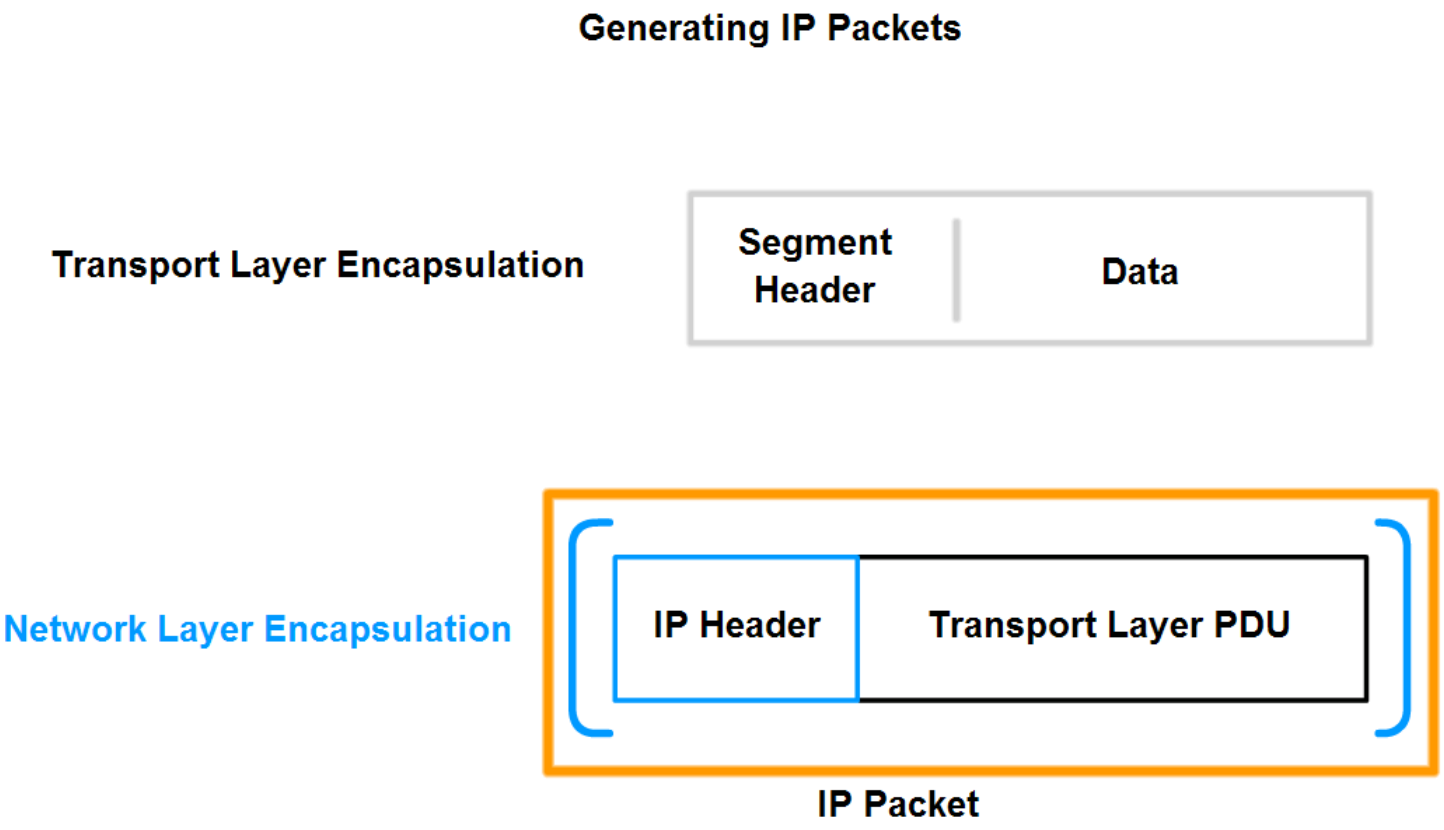
- ICMP
- ARP

IP Header

0		15	16	31
4-bit Version	4-bit Header Length	8-bit Type Of Service (TOS)	16-bit Total Length (in bytes)	
16-bit Identification			3-bit Flags	13-bit Fragment Offset
8 bit Time To Live TTL		8-bit Protocol	16-bit Header Checksum	
32-bit Source IP Address				
32-bit Destination IP Address				
Options (if any)				
Data				

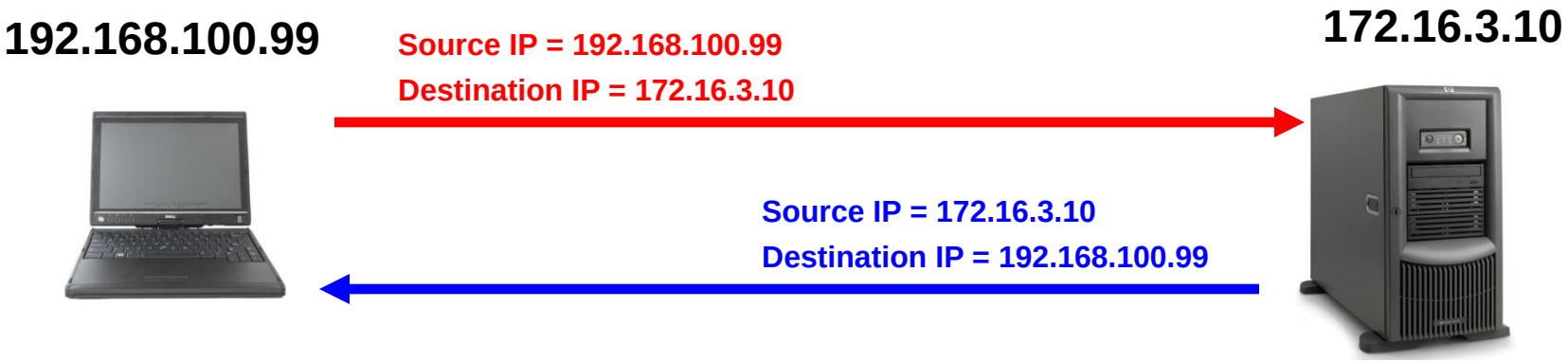


IPv4 packet- Packaging the Transport layer PDU

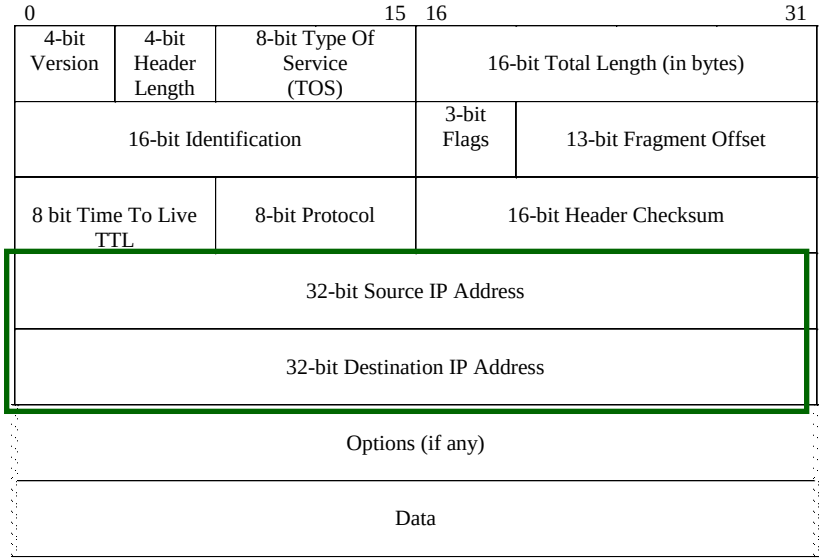


In TCP/IP based networks, the Network layer PDU is the IP packet.

Addressing at layer 3

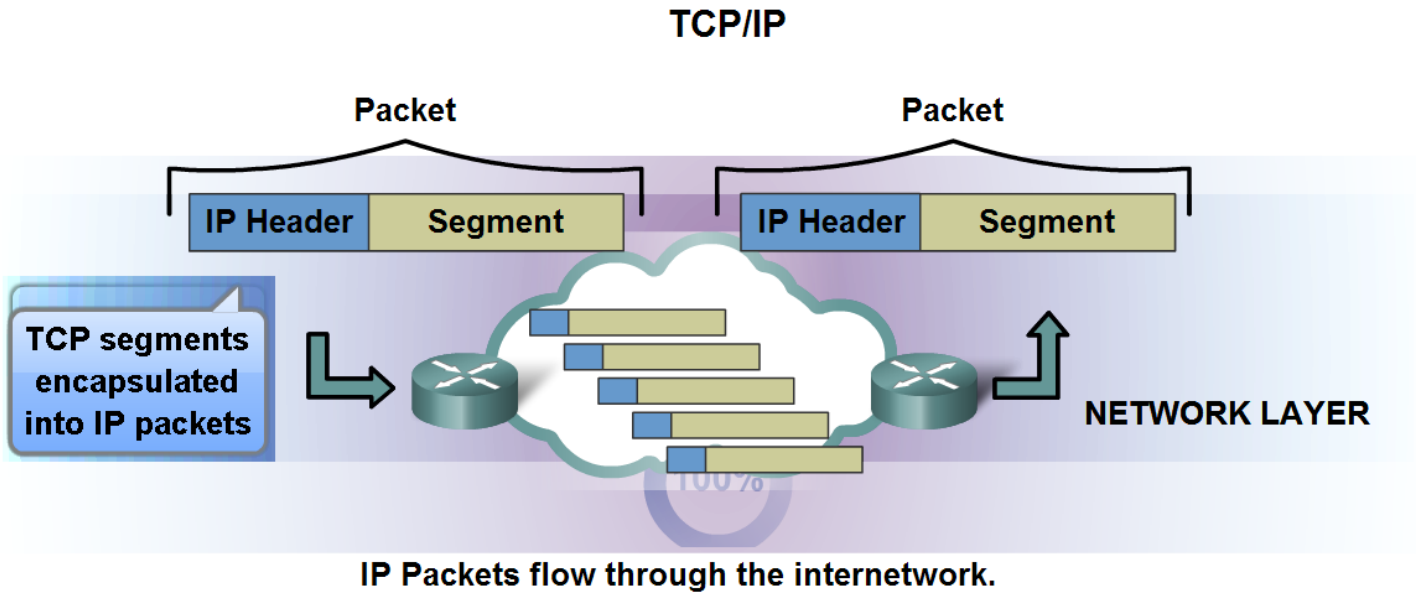


- Source IP Address
- Destination IP Address



The IP v4 protocol

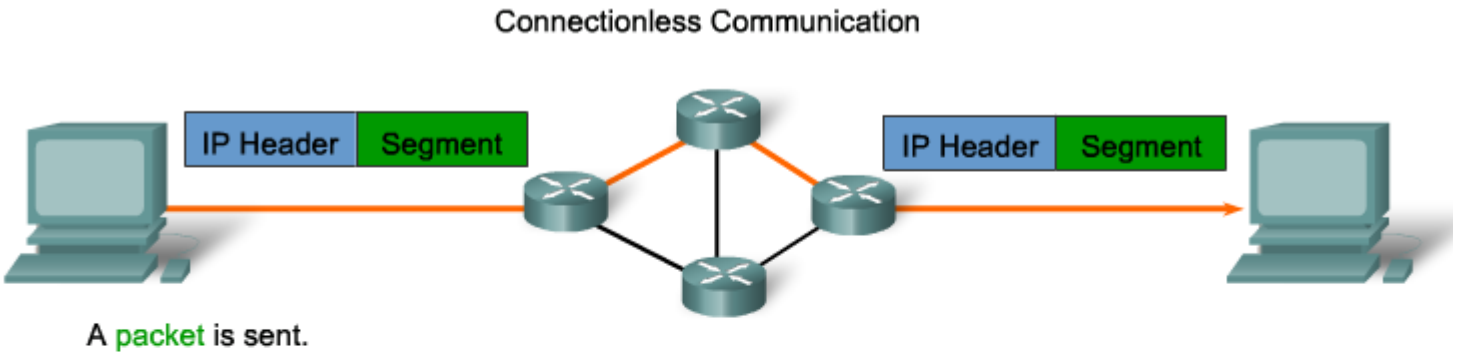
- Identify the basic characteristics and the role of the IPv4 protocol



IP Packets flow through the internetwork.

- Connectionless - No connection is established before sending data packets.
- Best Effort (unreliable) - No overhead is used to guarantee packet delivery.
- Media Independent - Operates independently of the medium carrying the data.

IP v4 protocol - connectionless



The sender doesn't know:

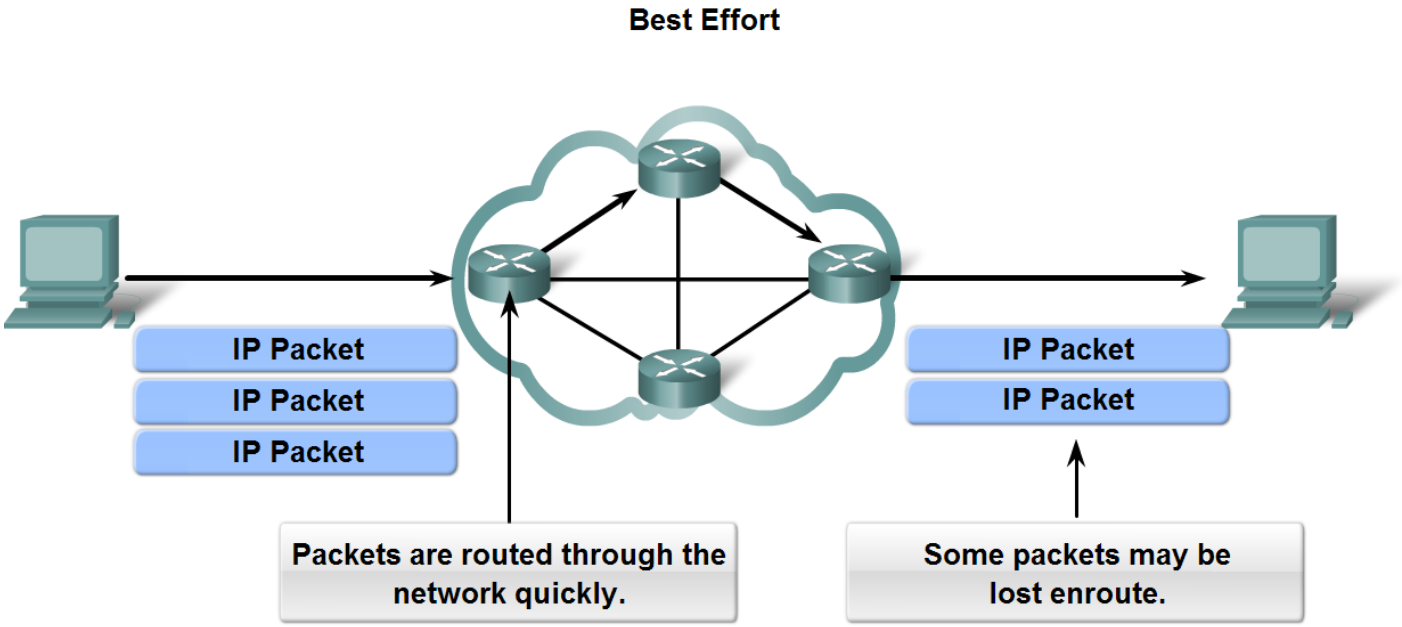
- if the receiver is present
- if the packet arrived
- if the receiver can read the packet

The receiver doesn't know:

- when it is coming

IP v4 protocol- best effort

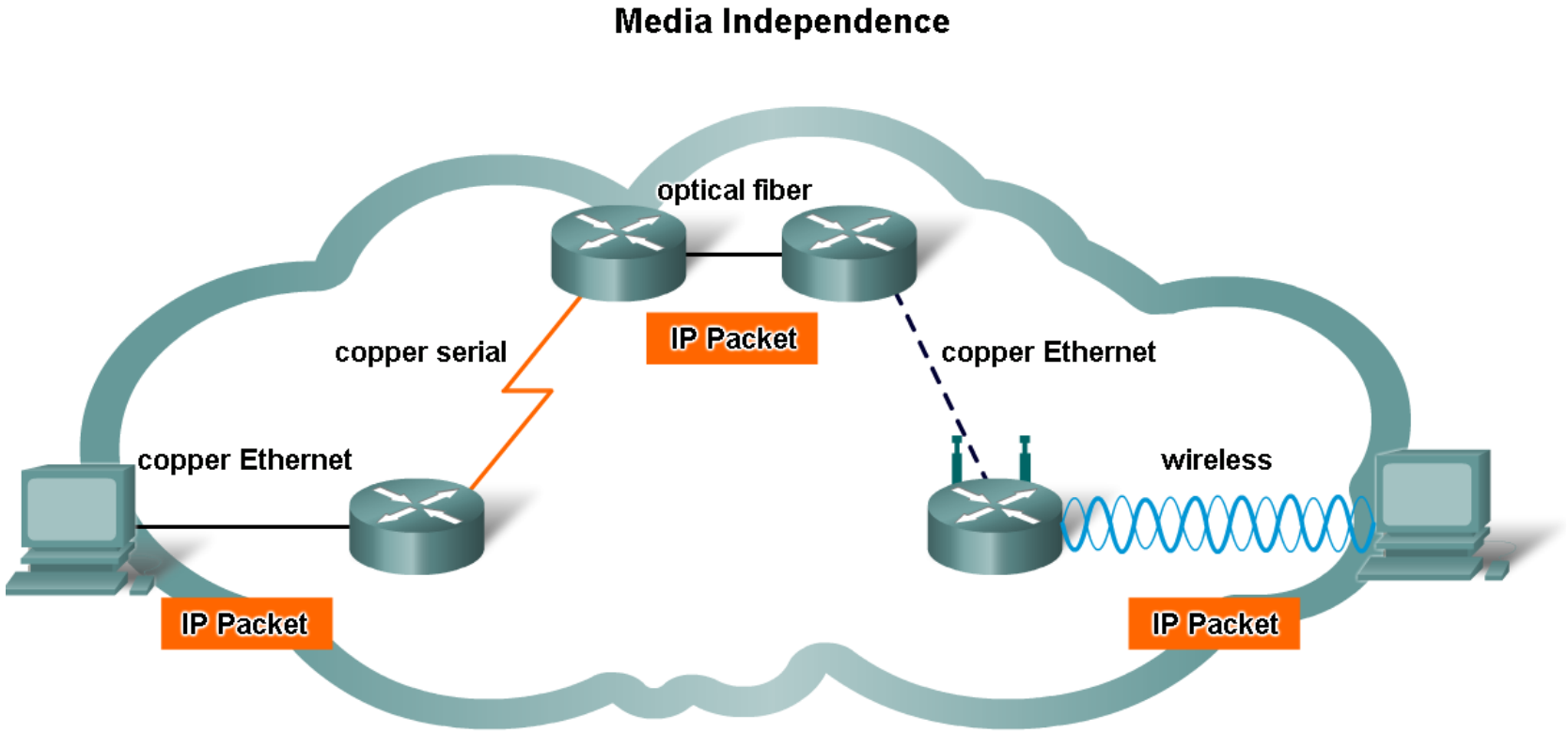
- Unreliable means simply that IP does not have the capability to manage, and recover from, undelivered or corrupt packets.



As an unreliable Network layer protocol, IP does not guarantee that all sent packets will be received.

Other protocols manage the process of tracking packets and ensuring their delivery.

The IP protocol – media independent



IP packets can travel over different media.

The IP protocol – media independent

- one major characteristic of the media that the Network layer considers: the maximum size of PDU that each medium can transport. This characteristic is referred to as the Maximum Transmission Unit (MTU).
- router may have to fragment a packet when forwarding it from one medium to another medium that has a smaller MTU.

IP Header content

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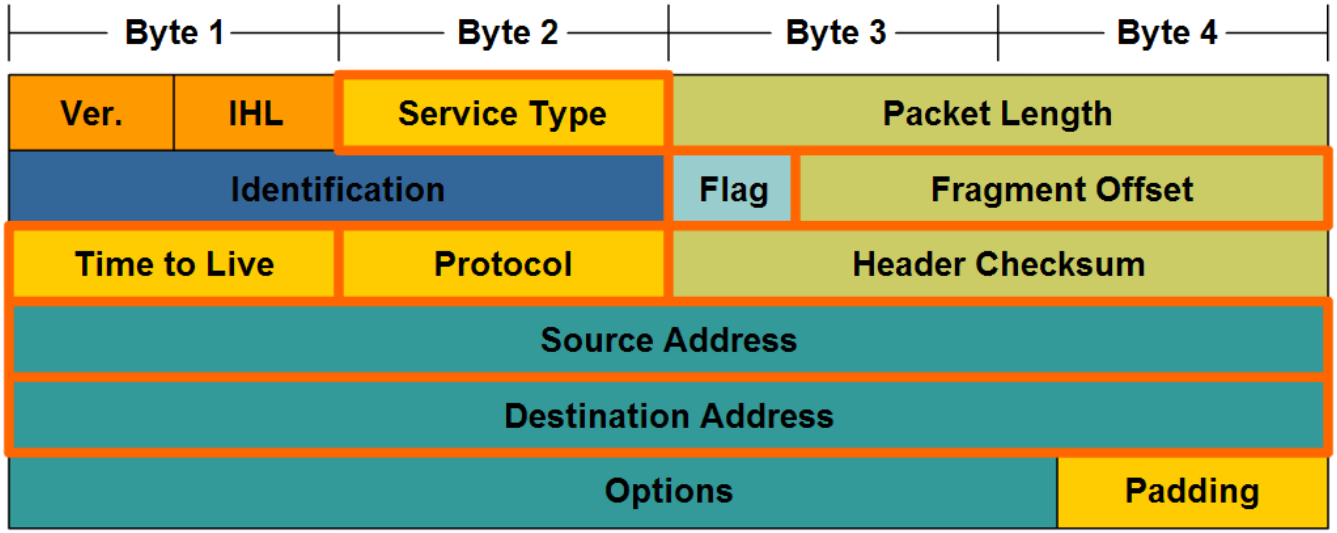
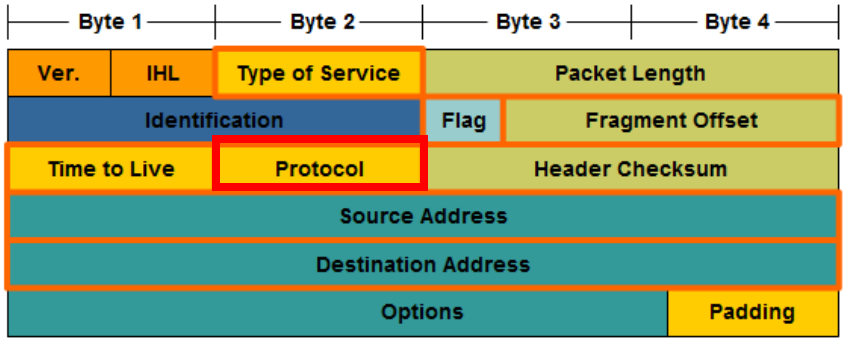
IPv4 packet header

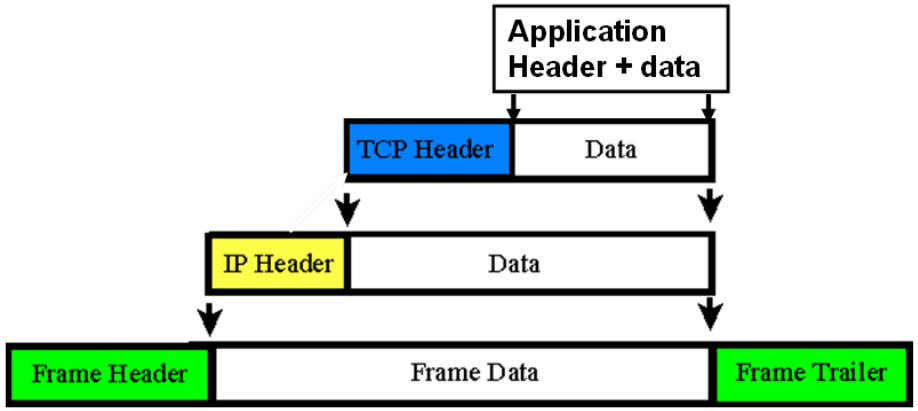
- Identify the major header fields in the IPv4 protocol and describe each field's role in transporting packets

IPv4 Packet Header Fields



IP's Protocol Field





- **Protocol field** enables the Network layer to pass the data to the appropriate upper-layer protocol.
- Example values are:

  01 ICMP

  06 TCP

  17 UDP

IP Fragmentation

Original IP Packet

IP	Data = 1480 bytes

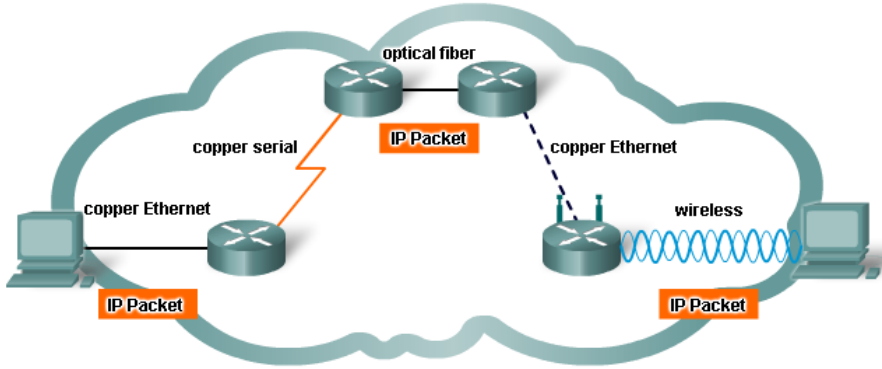
IP Header = 20 bytes

IP Packet Fragments

IP	Data = 500

IP	Data = 500

IP	Data = 480



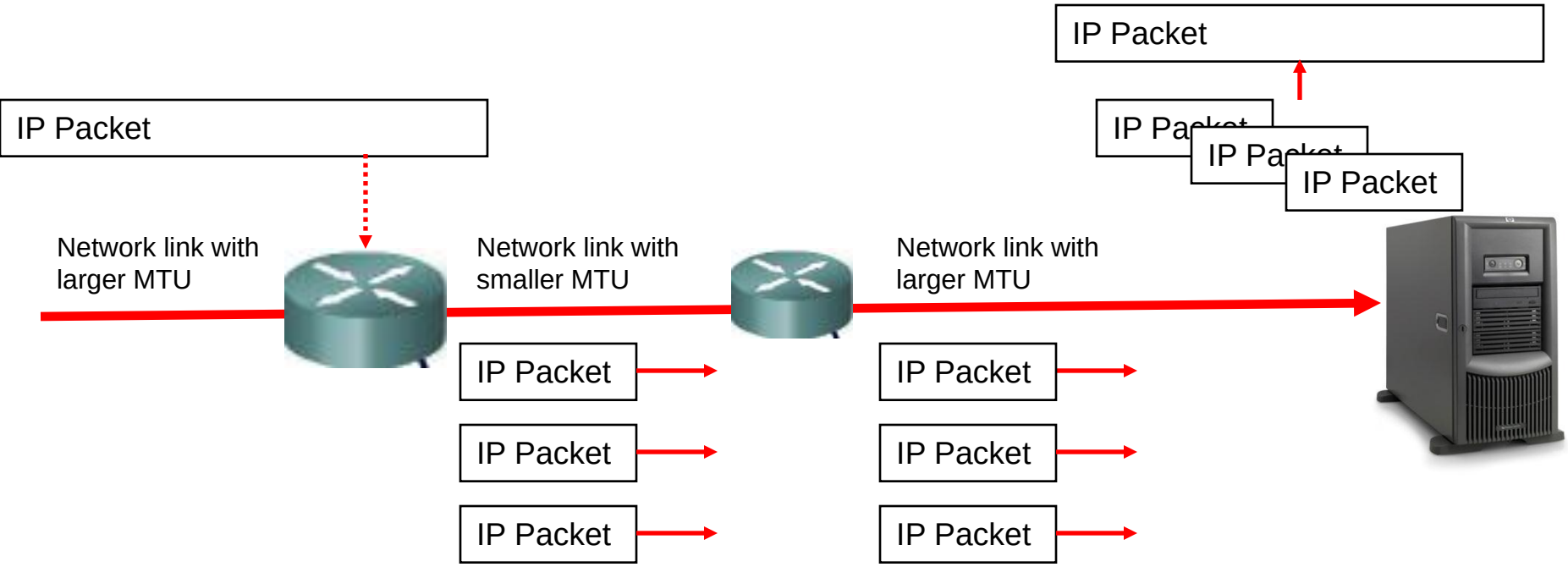
L2	Data = 500	L2

- A router may have to fragment a packet when forwarding it from one medium to another medium that has a smaller MTU.

  If **Don't Fragment flag** set, it will not fragment packet, but discard it.

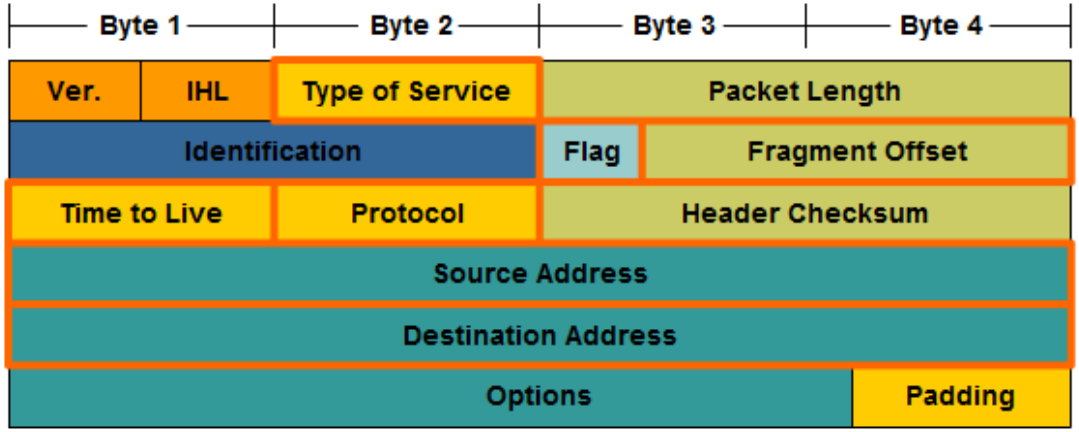
- **Fragment Offset field** and **More Fragments flag** is used to reconstruct the packet at the destination host.

IP Fragmentation



- When fragmentation occurs, it does not get reconstructed until it reaches the host.
  - This takes processing time.
  - Fragment Offset field identifies the order

Other IPv4 fields



- **Version** - Contains the IP version number (4)
- **Header Length (IHL)** - Specifies the size of the packet header.
- Packet Length - This field gives the entire packet size, including header and data, in bytes.
- **Identification** - This field is primarily used for uniquely identifying fragments of an original IP packet
- **Header Checksum** - The checksum field is used for error checking the packet header.
- **Options** - There is provision for additional fields in the IPv4 header to provide other services but these are rarely used.

ROUTING OVERVIEW

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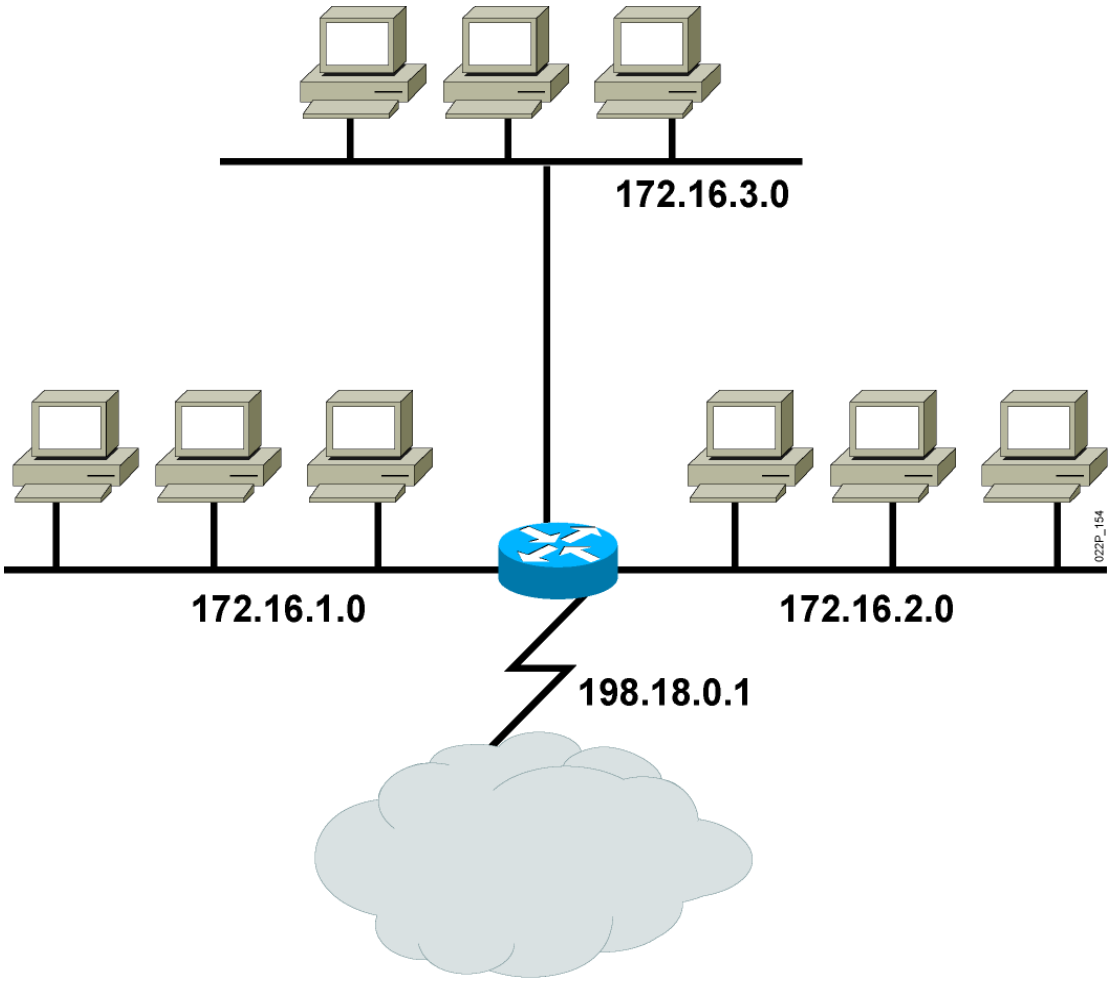
Layer 3 devices

Router :

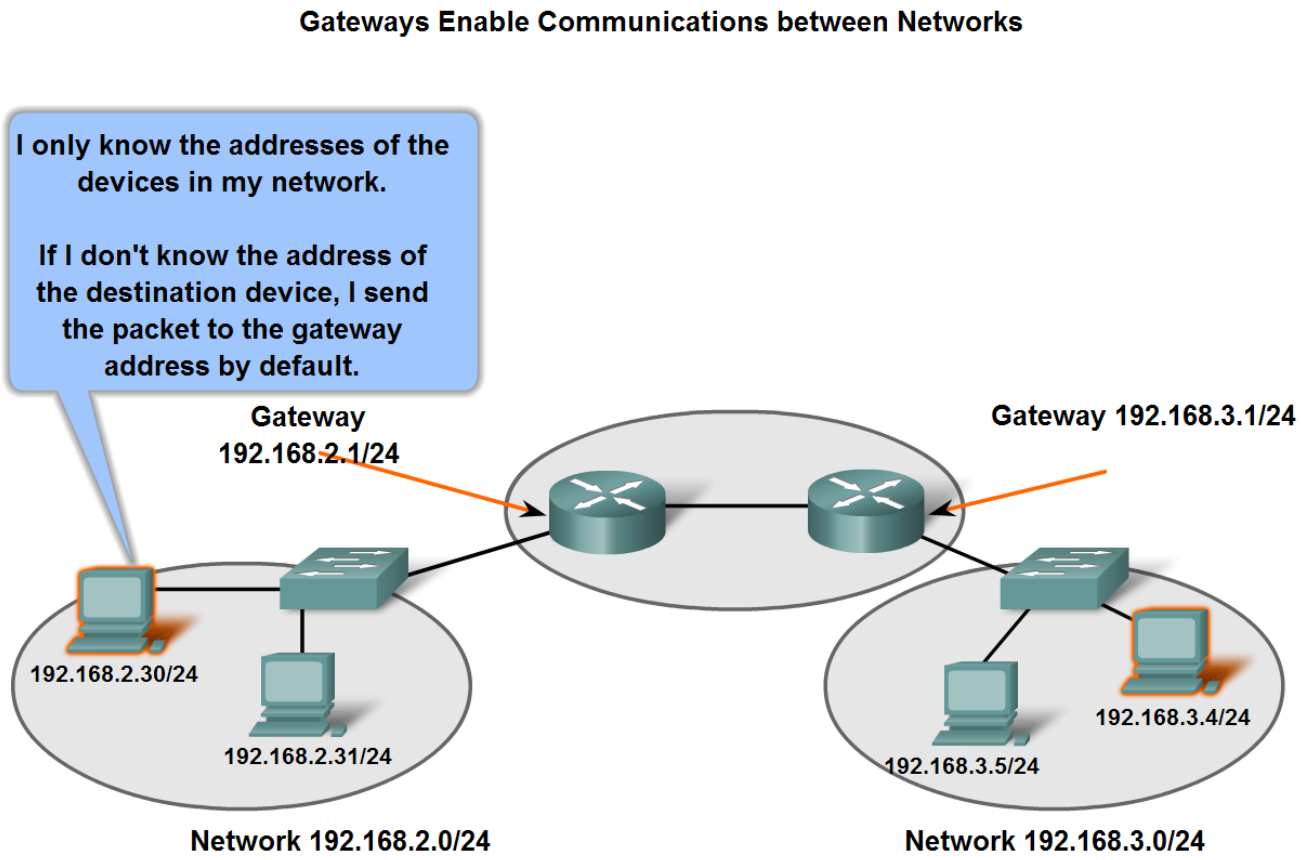
- best path determination
- creating routing table
- connecting different LANs



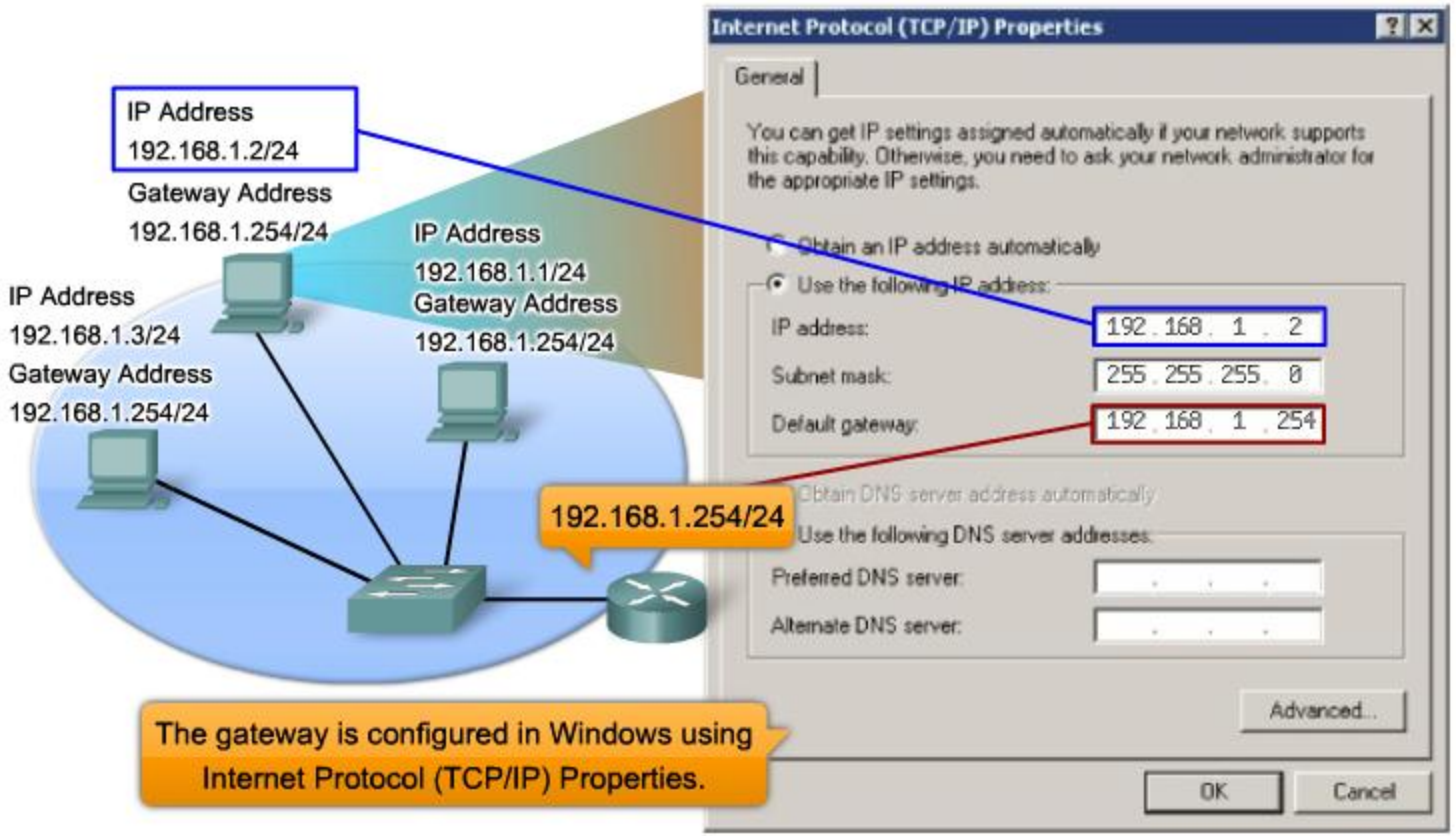
All interfaces of the router are members in a multiple broadcast domain, and multiple collision domains

Device parameters – ip addresses

- Describe the role of an intermediary gateway device in allowing devices to communicate across sub-divided networks



A gateway - the way out of our network



A gateway - the way out of our network

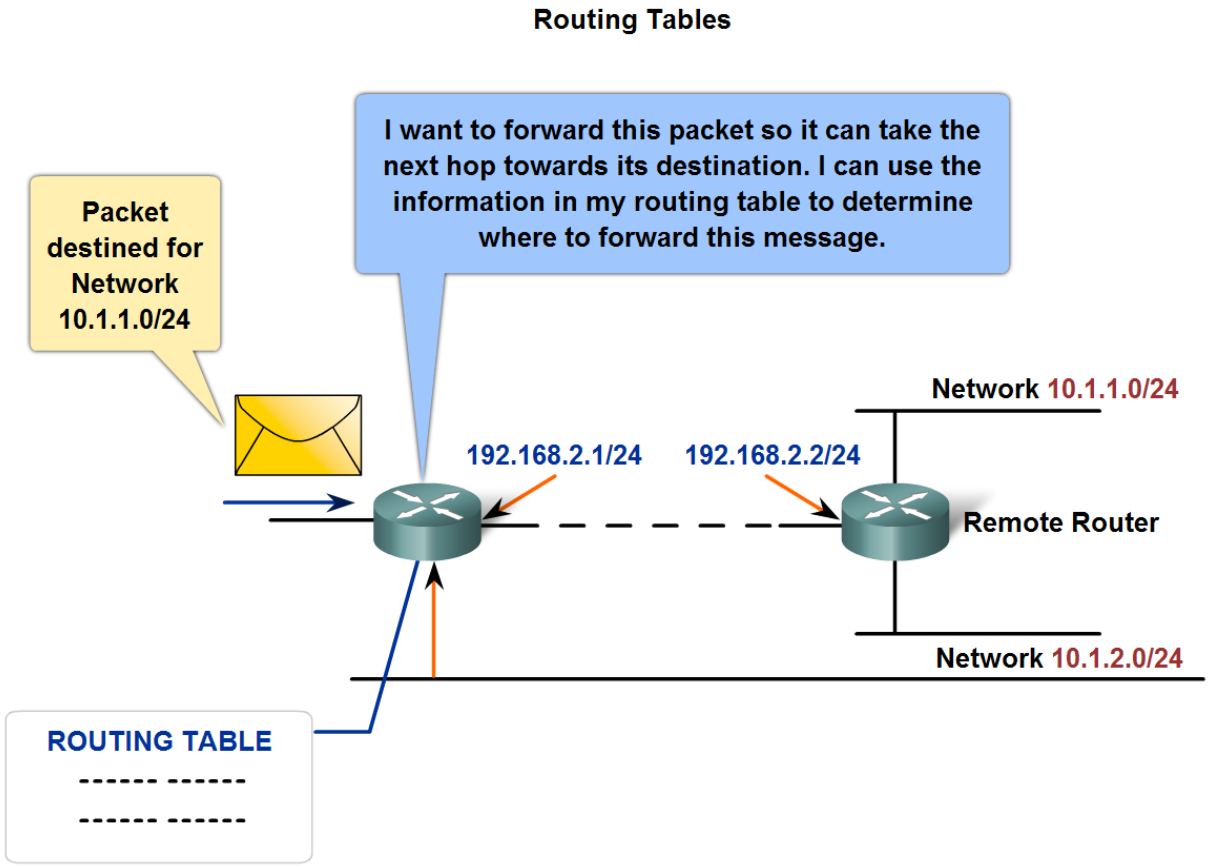
Confirming the Gateway Settings

```
C:\>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:

        Connection-specific DNS Suffix  . :
     ① IP Address. . . . . . . . . . . . : 192.168.1.2
     ② Subnet Mask . . . . . . . . . . . : 255.255.255.0
     ③ Default Gateway . . . . . . . . . : 192.168.1.254
```

IP address for this host computer

A gateway - the way out of our network

- Describe the role of a gateway and the use of a simple route table in directing packets toward their ultimate destinations



A gateway - the way out of our network

- Define a route and its three key parts