# EC5.204 Communications & Controls in IoT

## Networking Basics

**Instructors: Sachin Chaudhari**

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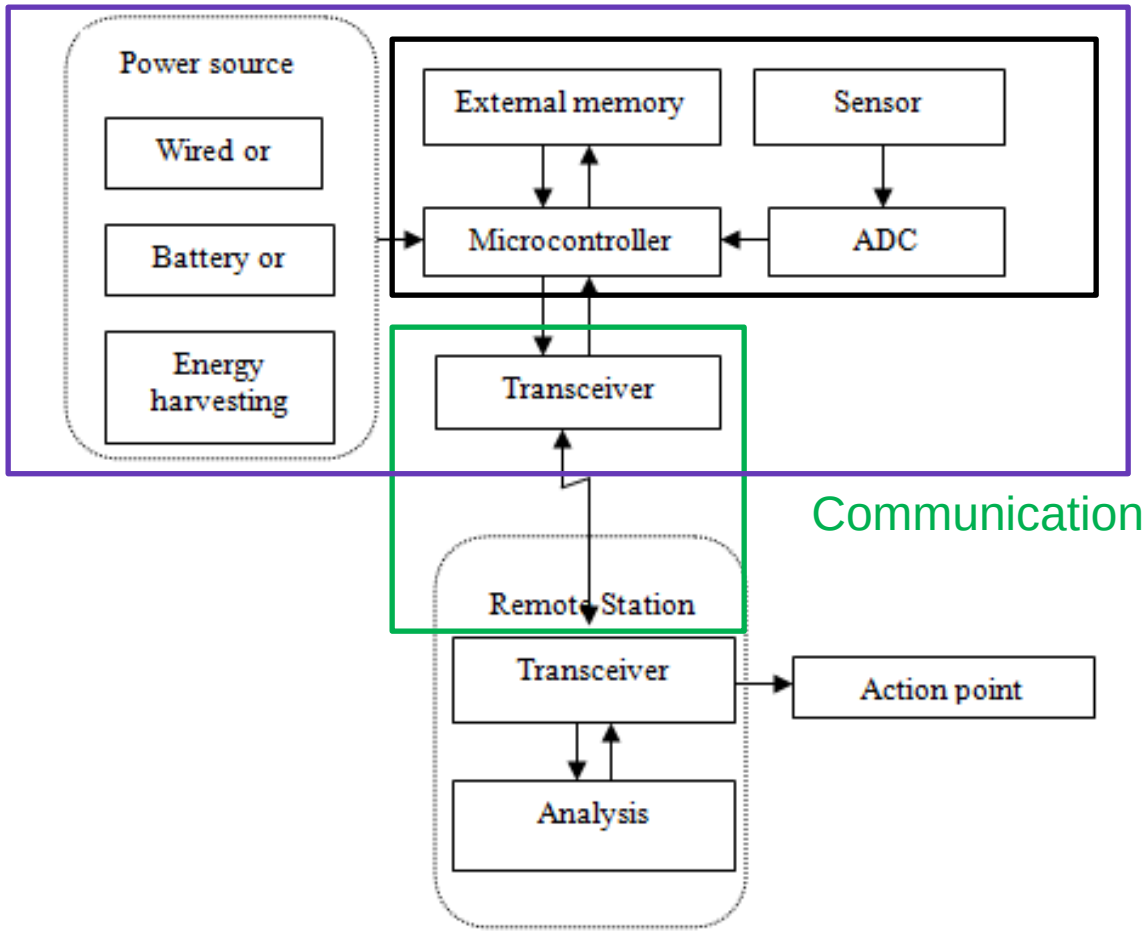
INTERNATIONAL INSTITUTE OF
INFORMATION TECHNOLOGY
HYDERABAD

# Block Diagram of Sensor Node



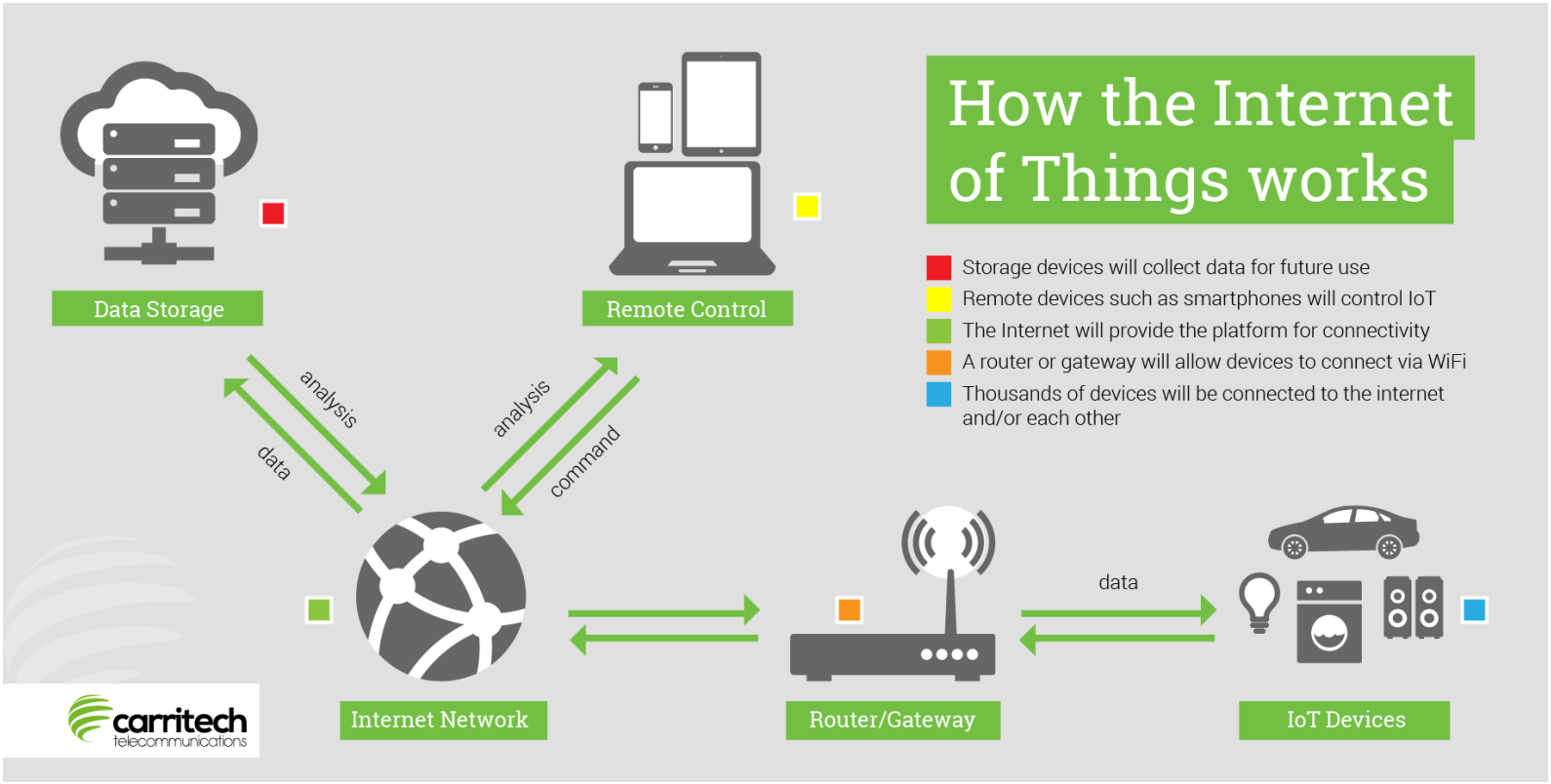

Till Now in Course

Communication

https://www.researchgate.net/publication/269310409_A_review_of_sensor_networks_Technologies_and_applications/figures?lo=1&utm_source=google&utm_medium=organic

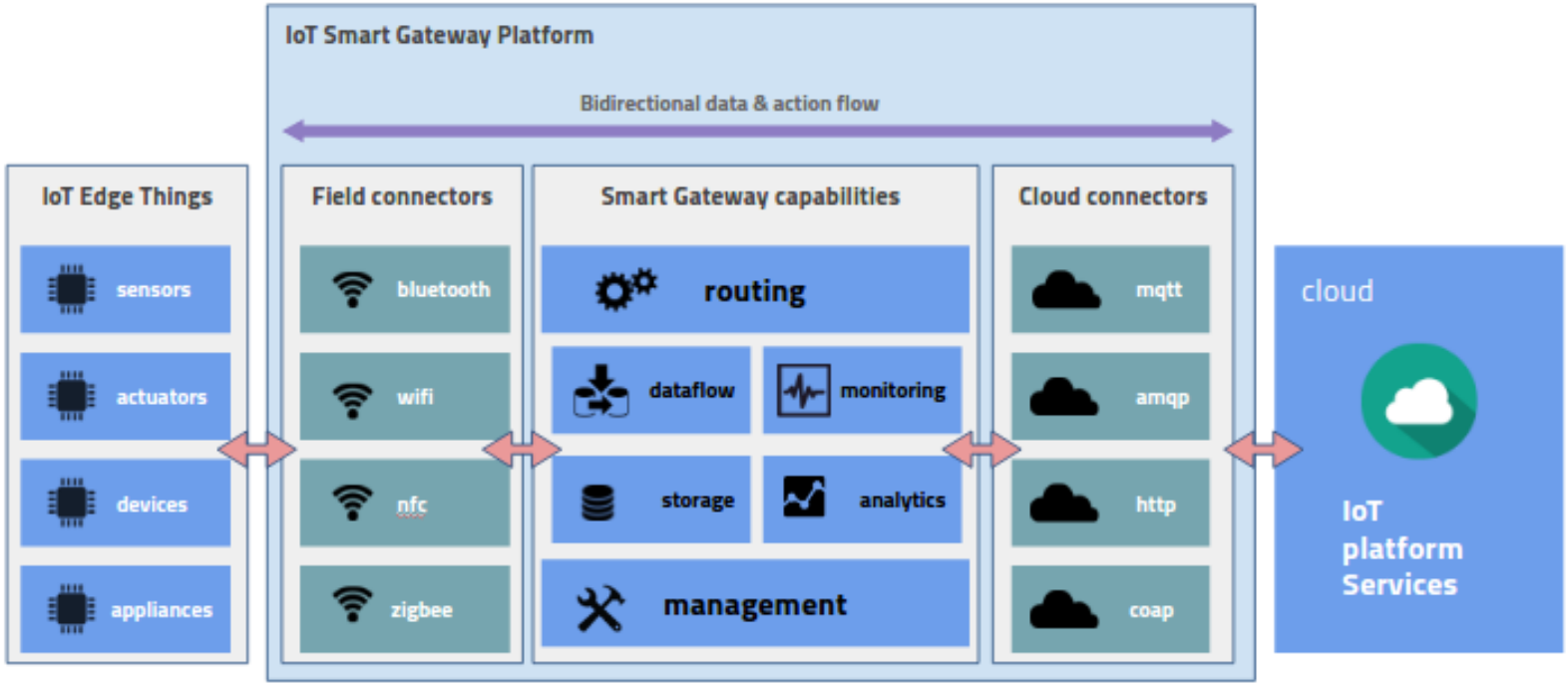
**[Leverage: Intro to IoT]** ***To be smart, a thing doesn't need to have super storage or a supercomputer inside of it . All a thing has to do is connect to super storage or to a super computer.***

# How does IoT work?




Picture Credit: *http://www.carritech.com/news/internet-of-things/*

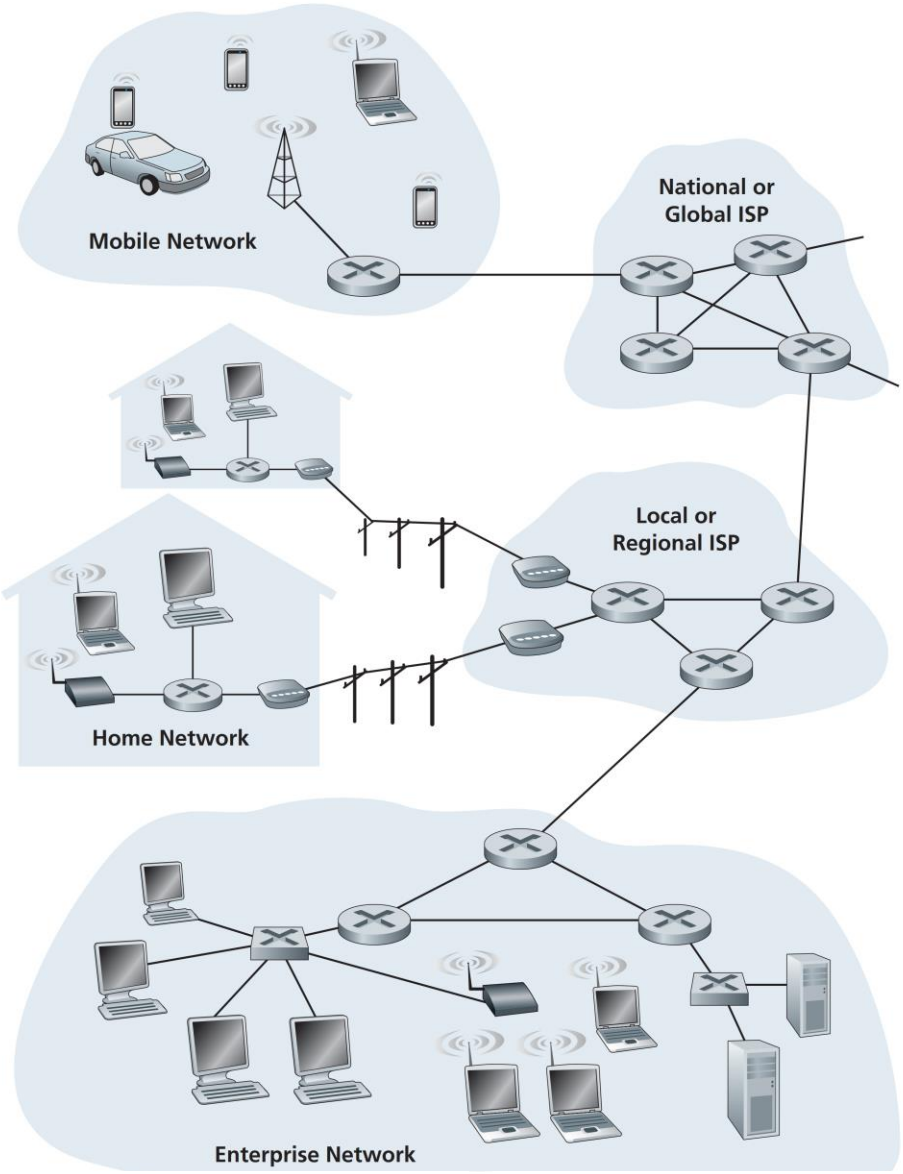
# IoT Network Setup




Picture Credit: https:https://www.iotcentral.io/blog/the-iot-architecture-at-the-edge

# Main Reference

- [Kurose2012] J. Kurose and K. Ross, *Computer Networking*, Pearson, 2012.



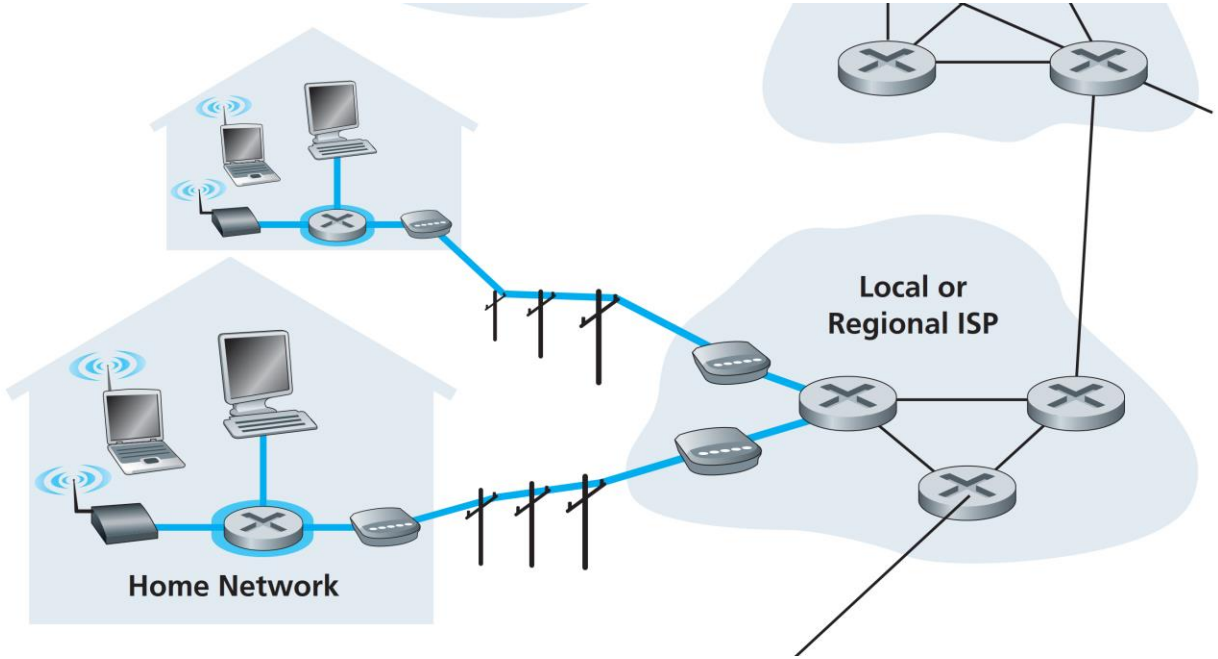

# Some Pieces of Internet

The Internet is a computer network that interconnects hundreds of millions of computing devices throughout the world

# Few Internet Terminologies

- Host or end-devices
  - computing devices connected to the internet
- Communication links
  - Connect the different elements in the network
- Packet switches
  - takes a packet arriving on one of its incoming communication links and forwards that packet on one of its outgoing communication links
  - Most prominent
    - Routers: Network core
    - Link-layer switches: access network
- Route or Path
  - The sequence of communication links and packet switches traversed by a packet from the sending end system to the receiving end system
- Internet service providers (ISPs)

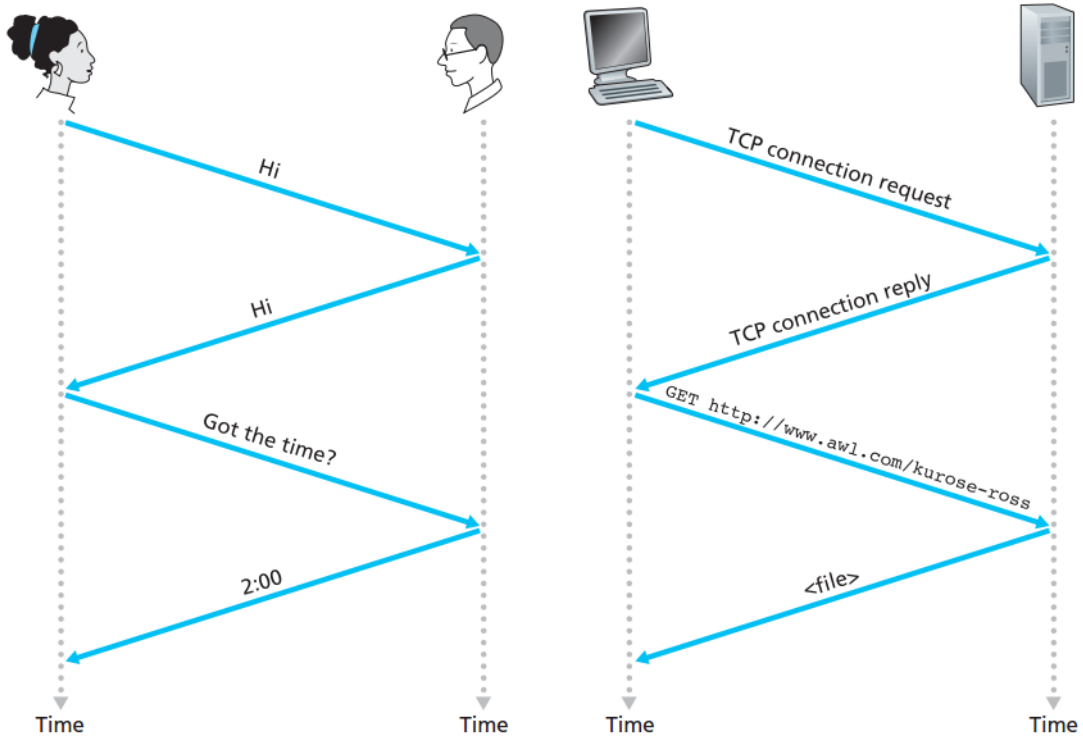
# Example of route



# Communication Protocol Basics

# Protocol

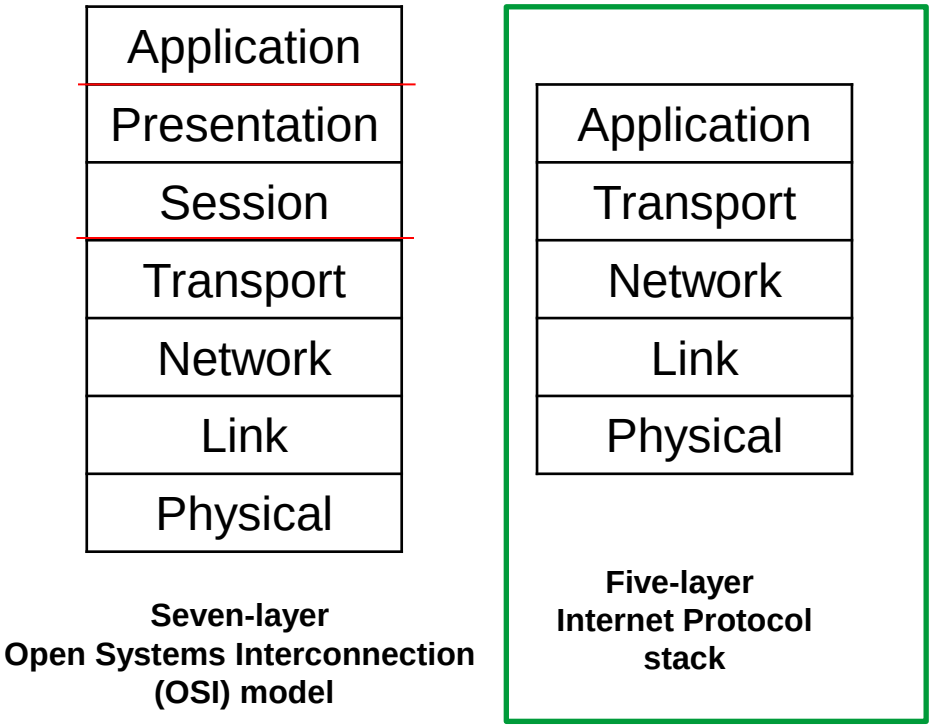
- A protocol defines the **format** and the **order** of messages exchanged between two or more communicating entities as well as the actions taken on the transmission and/or receipt of a message or other event. [Kurose2012]




[Kurose2012]

Analogy of human protocol and a computer network protocol

# Internet protocol stack and OSI model



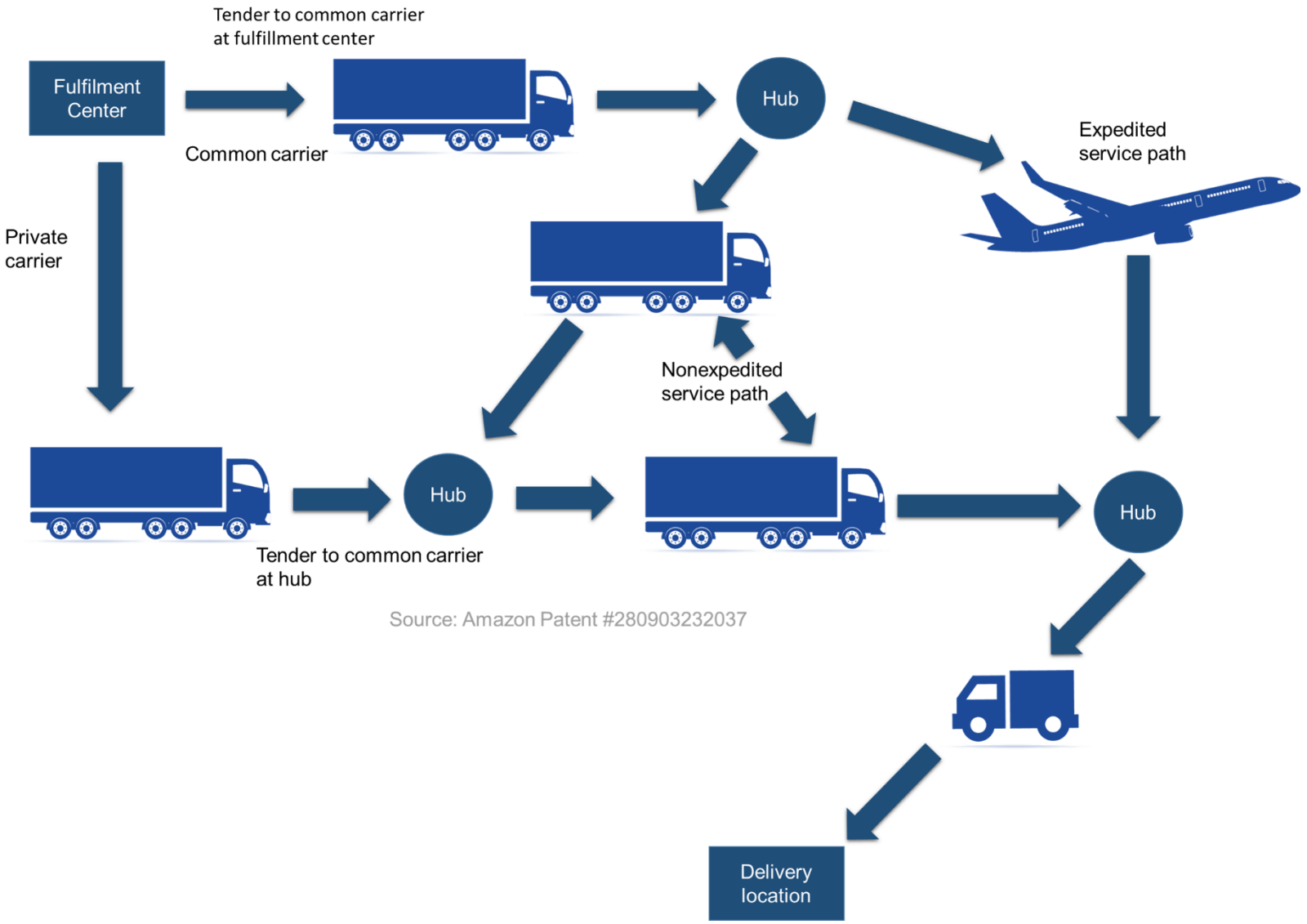
# Protocols Layers and Their Service Models

- A layered architecture allows us to discuss a well-defined, specific part of a large and complex system.
- Provides modularity, making it much easier to change the implementation of the service provided by the layer.
- As long as the layer provides the same service to the layer above it and uses the same services from the layer below it, the remainder of the system remains unchanged when a layer's implementation is changed.

# Internet protocol stack: Toy Example

- Sending a courier from company branch in Hyderabad to company branch in New York
  - Application Layer: Individuals giving parcels
  - Transport Layer: office boy or admin assistant
  - Network Layer: Speed post/ Blue Dart (representative)
  - Link Layer: Different drivers (and vehicles)
  - Physical Layer: Road/Air/Water

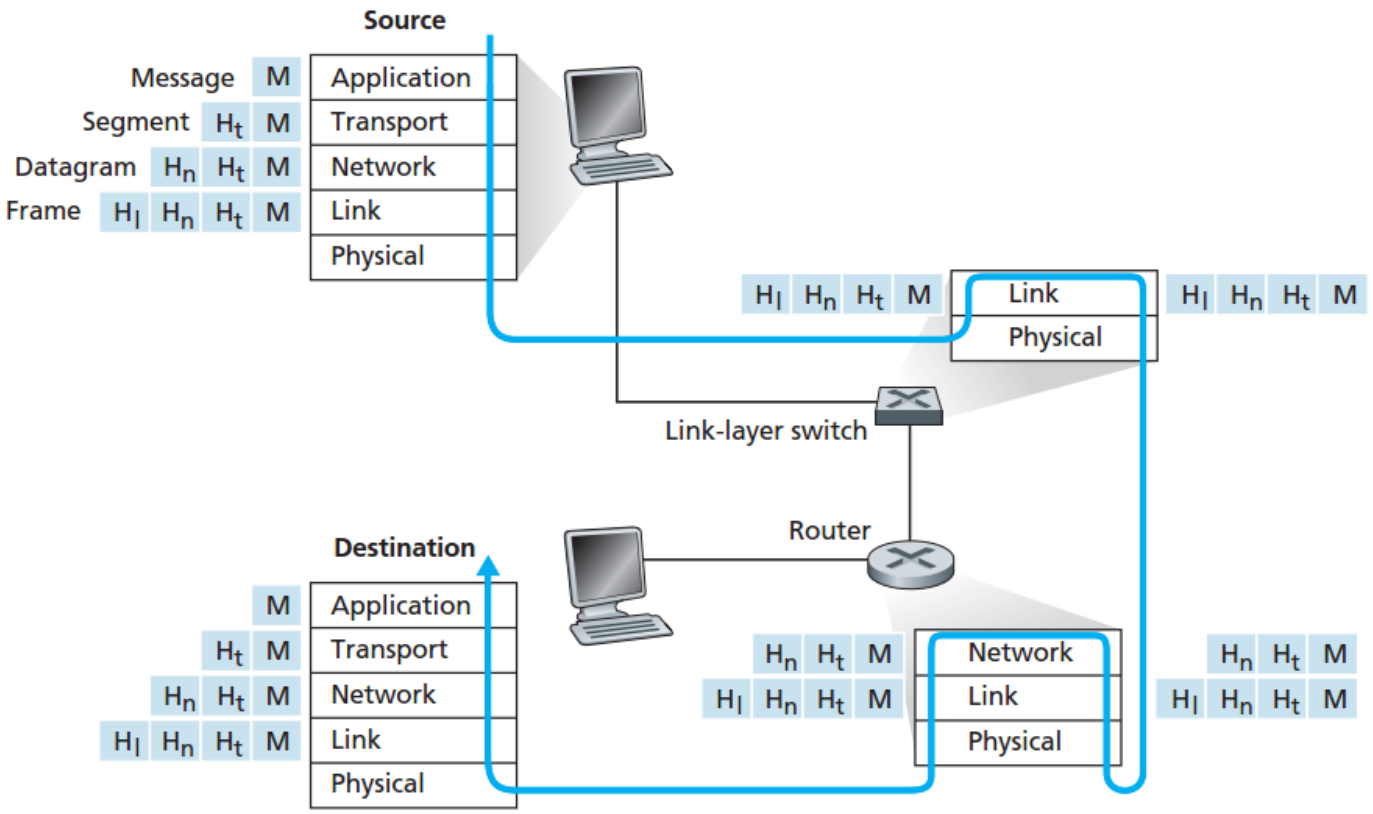
# Analogy: e-Commerce supply chain




Source: Amazon Patent #280903232037

https://blog.driv.in/en/customer-centric-logistics-amazons-supply-chain-success-case/

# Encapsulation of data across layers




[Kurose2012]

# Questions?

# **Internet Protocol Stack:** *Application Layer*

- The application layer is where **network applications** and their application-layer protocols reside
- Example of network applications: www, file sharing, text chat, electronic commerce, instant messaging, video chat

- The *Application layer* provides applications the ability to access the services of the other layers and defines the protocols that applications use to exchange data
- Many services: file transfer, web surfing, web chat, email clients, virtual terminals, various file and data operations
- Protocol Examples: HTTP, SMTP, FTP, DNS, MQTT, TelNet

# Communication between Applications

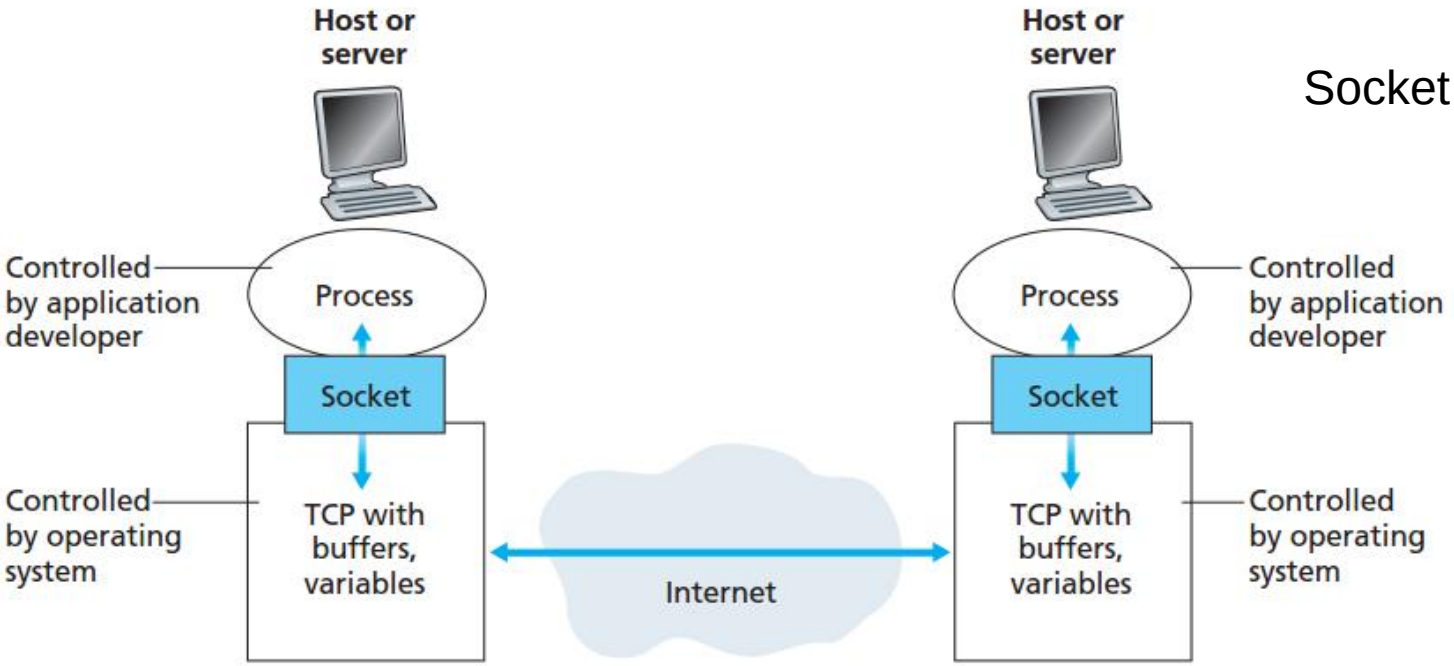



**Figure 2.3** ♦ Application processes, sockets, and underlying transport protocol

- In network applications, programs/processes are running on different end-systems or hosts and communicating over host
- A process can be thought of as a program running within an end system

# Application Layer: Examples

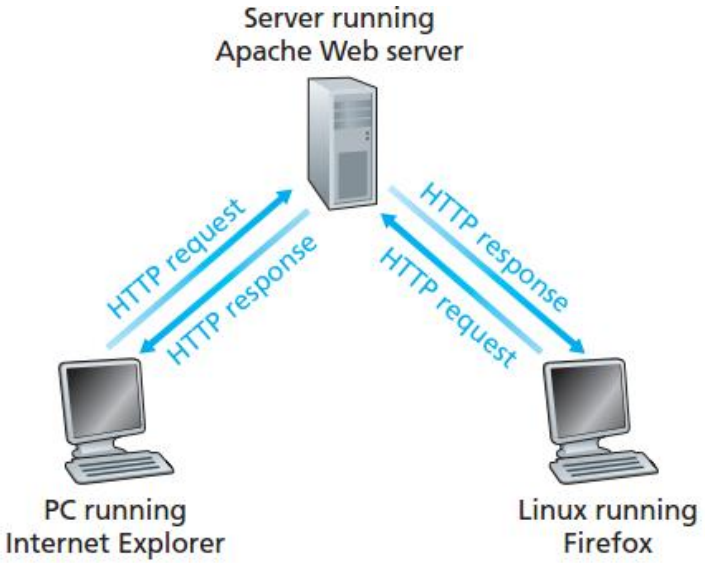



**Figure 2.6** ♦ HTTP request-response behavior

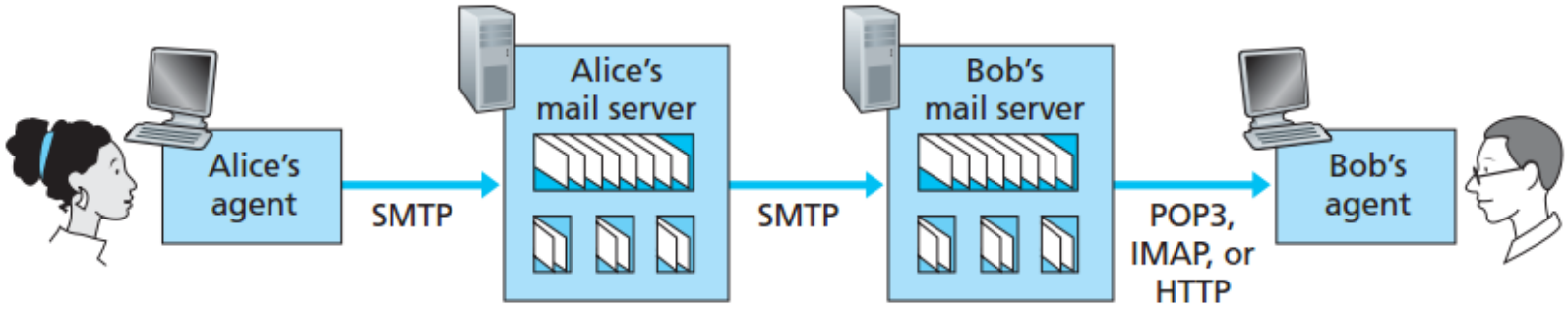



**Figure 2.18** ♦ E-mail protocols and their communicating entities

# Application Layer

*Application layer protocols defines:*

- Types of message exchanged, for example, request and response messages
- Syntax of the various message types, such as the fields in the message and how the fields are delineated
- The semantics of the field, that is, the meaning of the information
- Rules for determining when and how a process sends messages and responds to the messages

# Example: HTTP request message

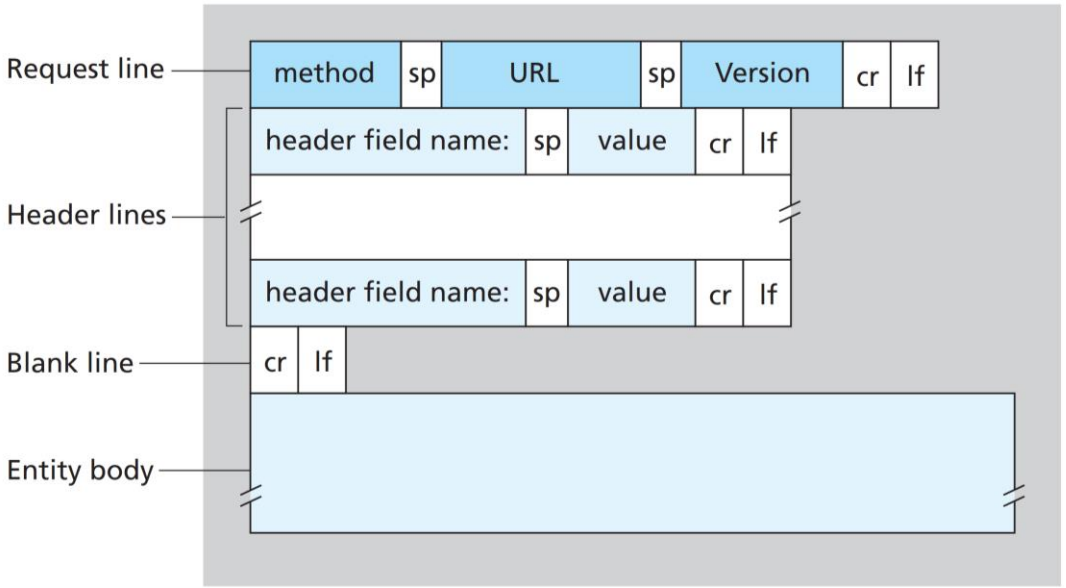
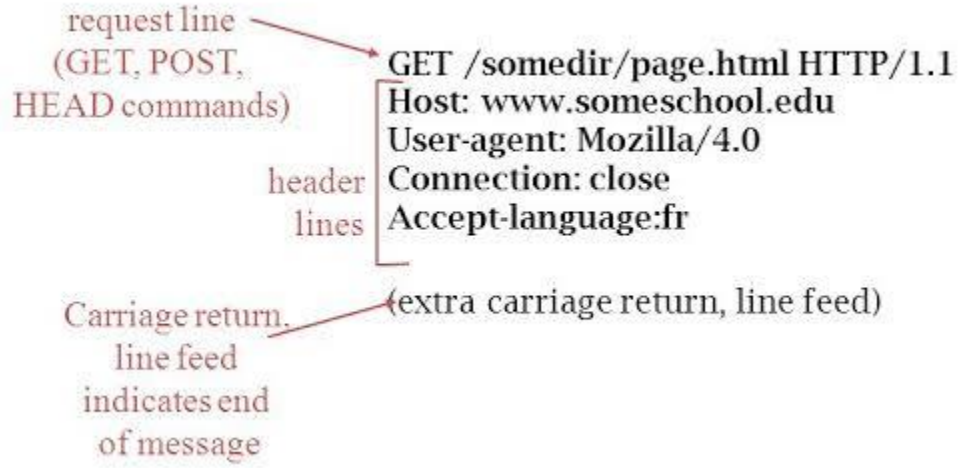



**Figure 2.8** ♦ General format of an HTTP request message

www.somechool.edu/page.html

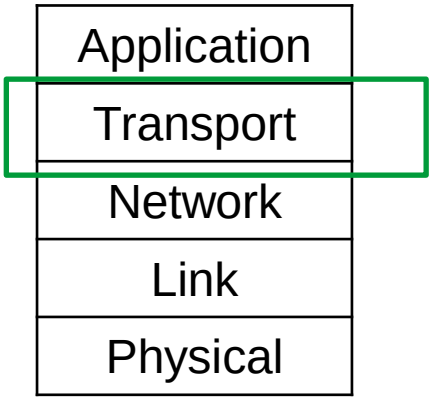


# Addressing Mechanism

- A host has one IP address
- How does the sending host identifies the receiving process running in the receiving host?
- Port Number:
  - Web server : port 80
  - SMTP : port 25

# Questions?

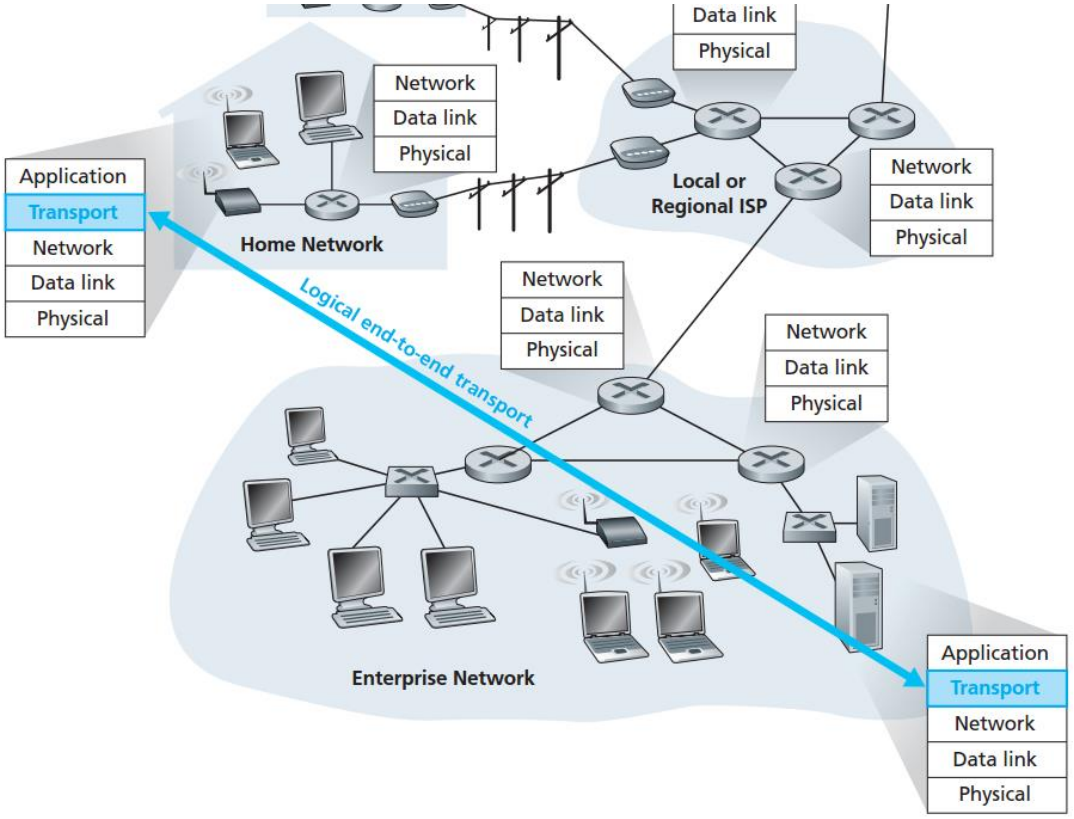
# Internet protocol stack: *Transport Layer*




**Five-layer Internet Protocol stack**

# Internet Protocol Stack: *Transport Layer*

- It provides logical communication between application processes running on different hosts



# Internet Protocol Stack: *Transport Layer*

- It provides logical communication between application processes running on different hosts
- Provides two transport protocols
  - TCP (connection-oriented)
    - provides reliability
    - flow control
    - congestion control
    - Breaks long messages
    - Application layer protocols using TCP: SMTP, HTTP, FTP
  - UDP (connectionless)
    - No frills service
    - No reliability, no flow control, no congestion control
    - Application layer protocols: IP telephony or video (Youtube, Skype)
- Multiplexing and demultiplexing of data

# Multiplexing and Demultiplexing

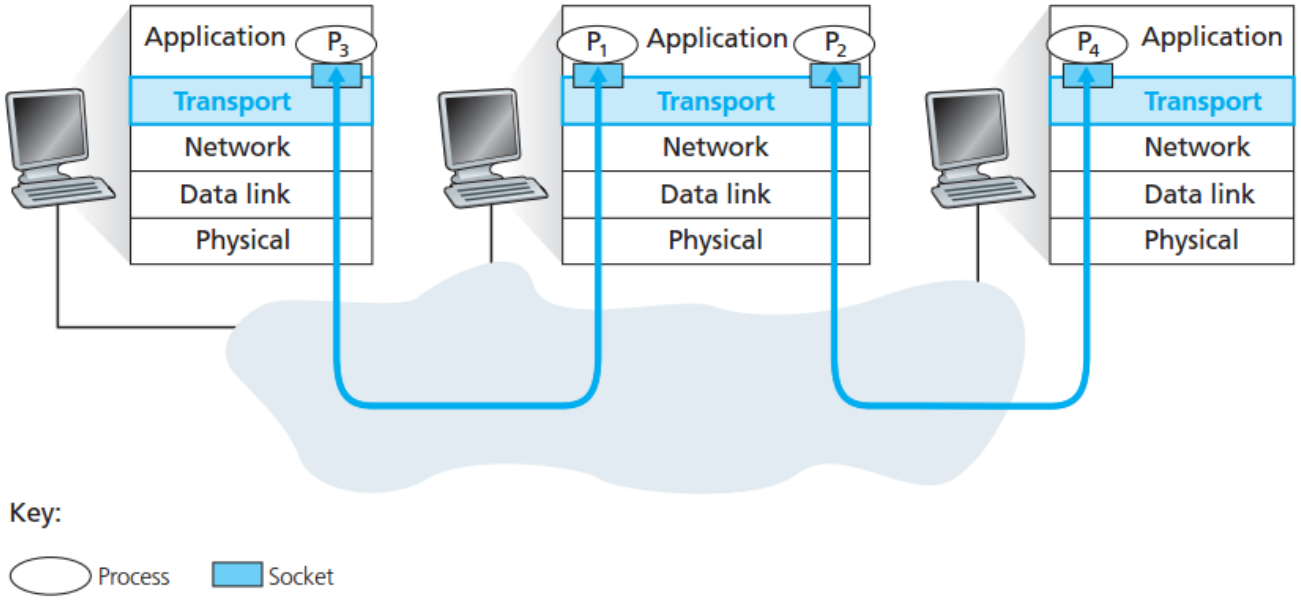



**Figure 3.2** ♦ Transport-layer multiplexing and demultiplexing

# TCP: *Multiplexing and Demultiplexing*

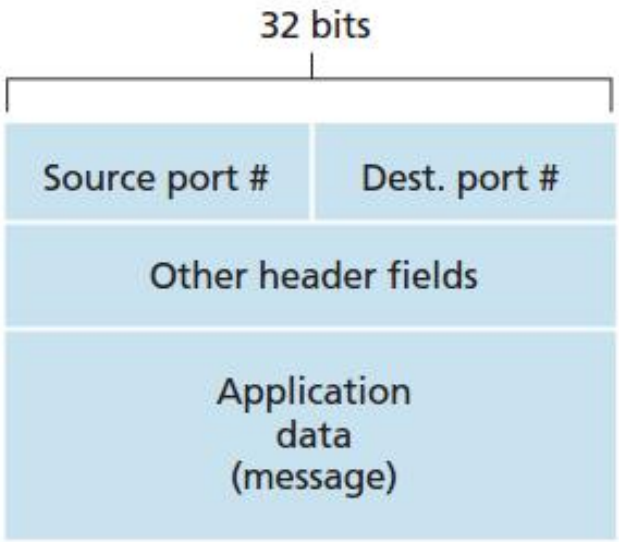



**Figure 3.3** ♦ Source and destination port-number fields in a transport-layer segment

# TCP: *Use of IP and Port Addresses*

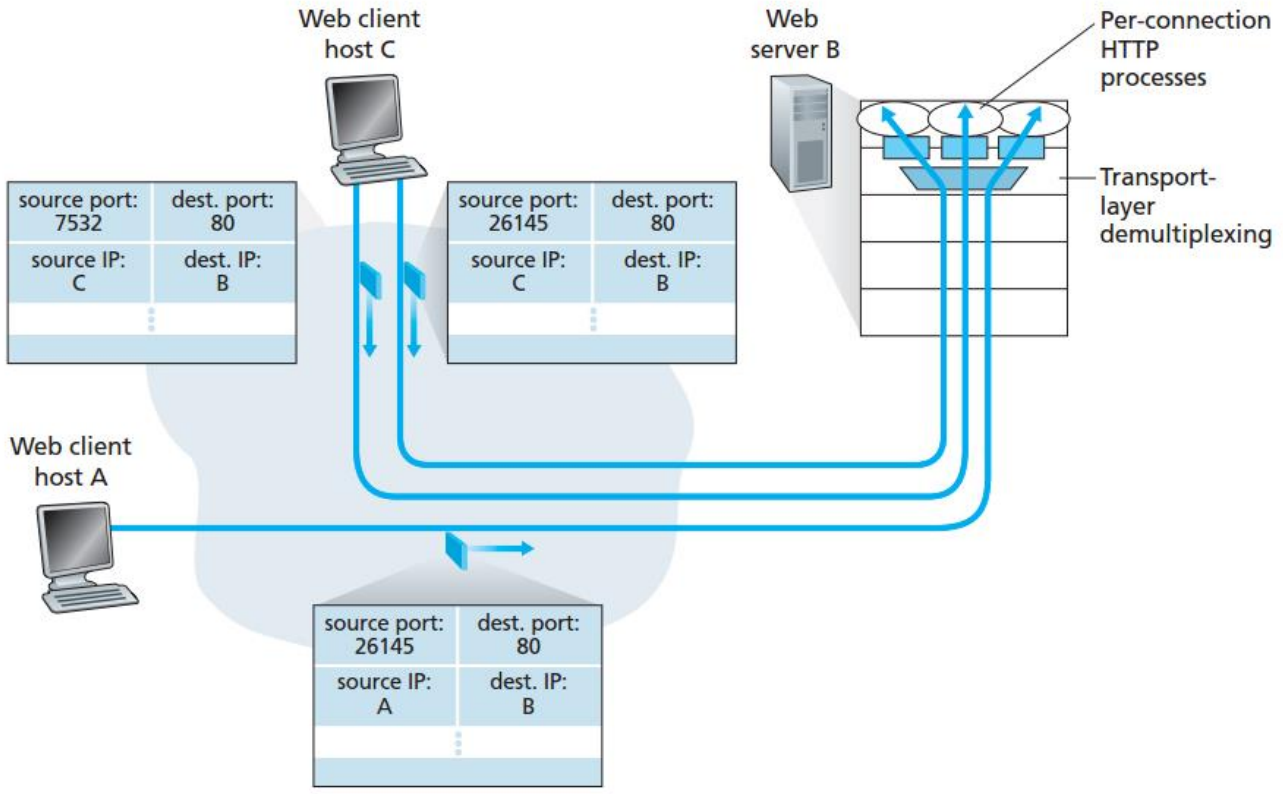



**Figure 3.5** ♦ Two clients, using the same destination port number (80) to communicate with the same Web server application

# TCP: *Connection Oriented*

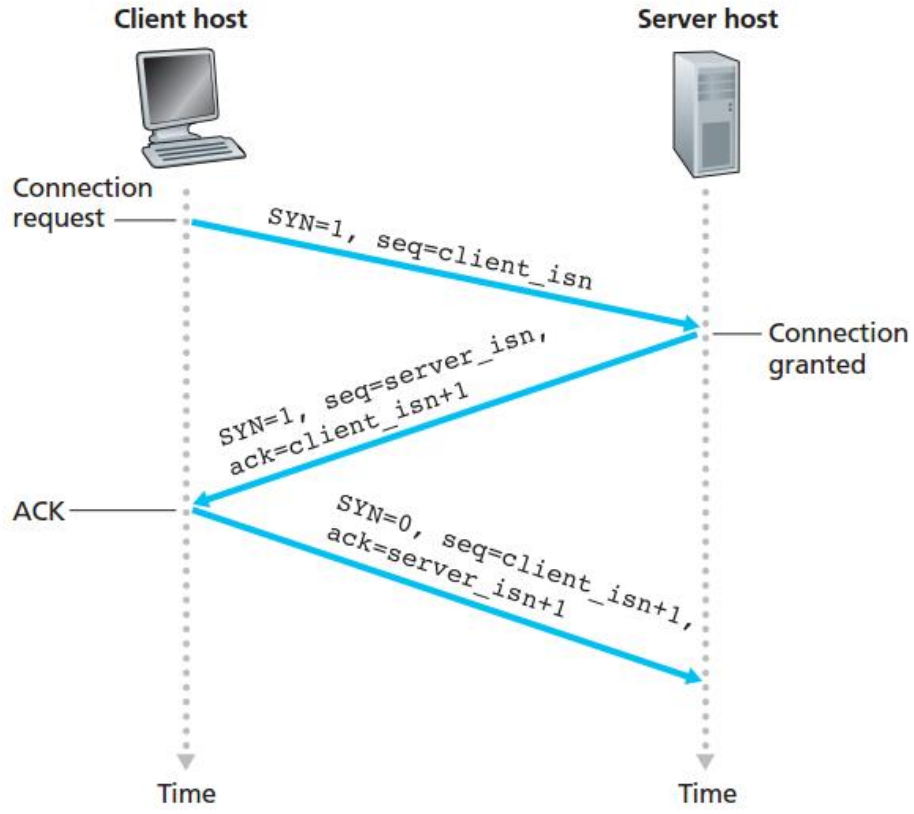
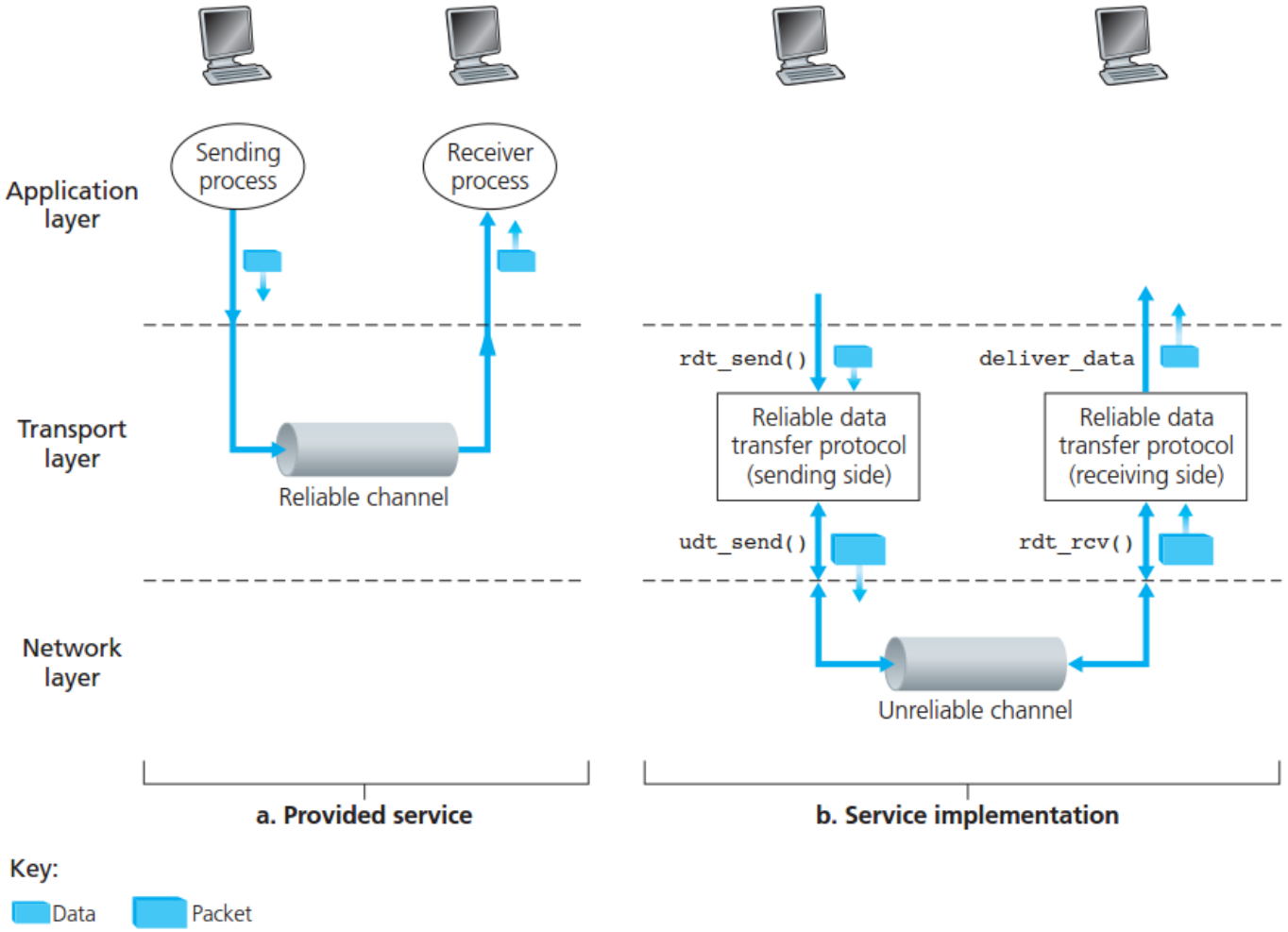



**Figure 3.39** ♦ TCP three-way handshake: segment exchange

# TCP: *Reliable data transfer*




Use of ACK/NACK

**Figure 3.8** ♦ Reliable data transfer: Service model and service implementation

# TCP: *Use of ACK*

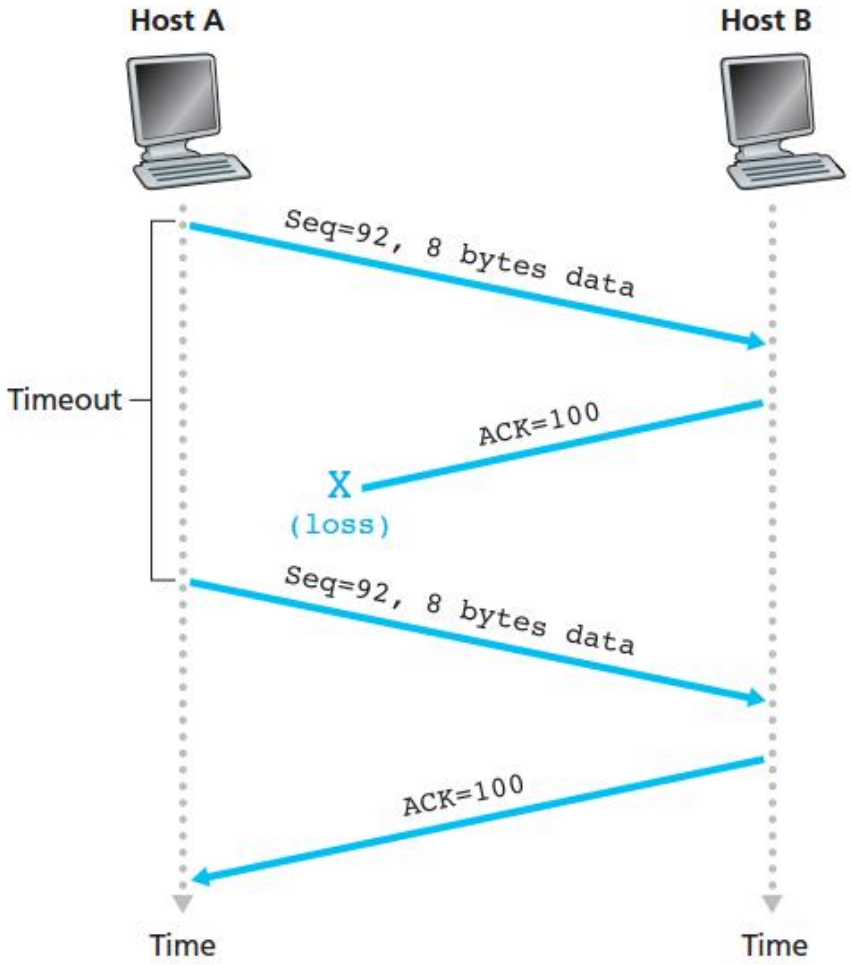



**Figure 3.34** ♦ Retransmission due to a lost acknowledgment

# TCP: *Congestion Control*

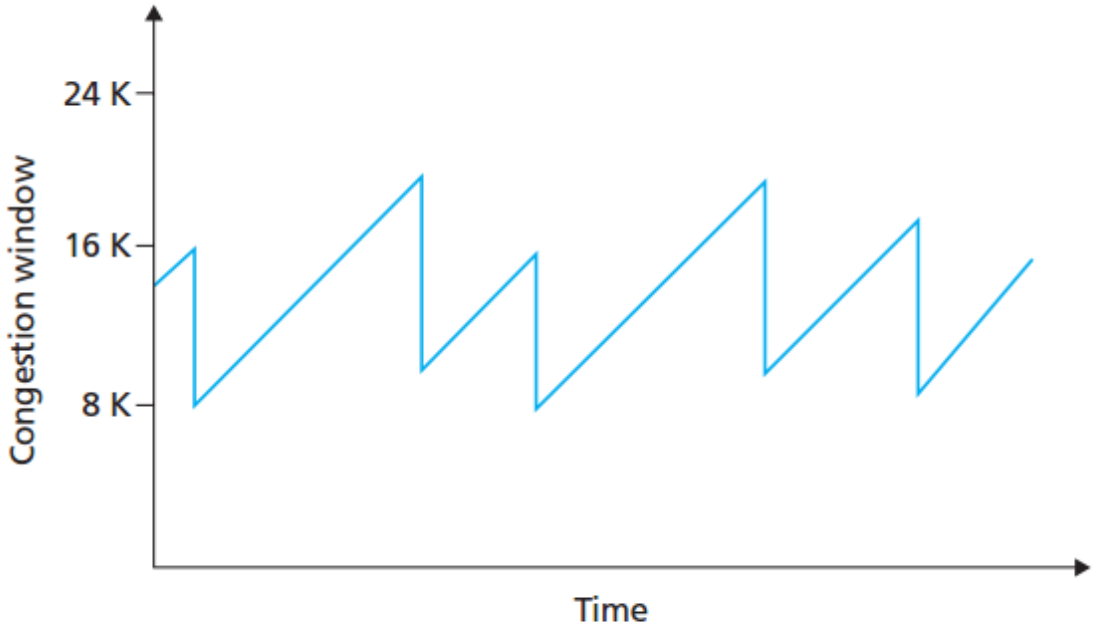



**Figure 3.54** ♦ Additive-increase, multiplicative-decrease congestion control

# TCP: *Header*

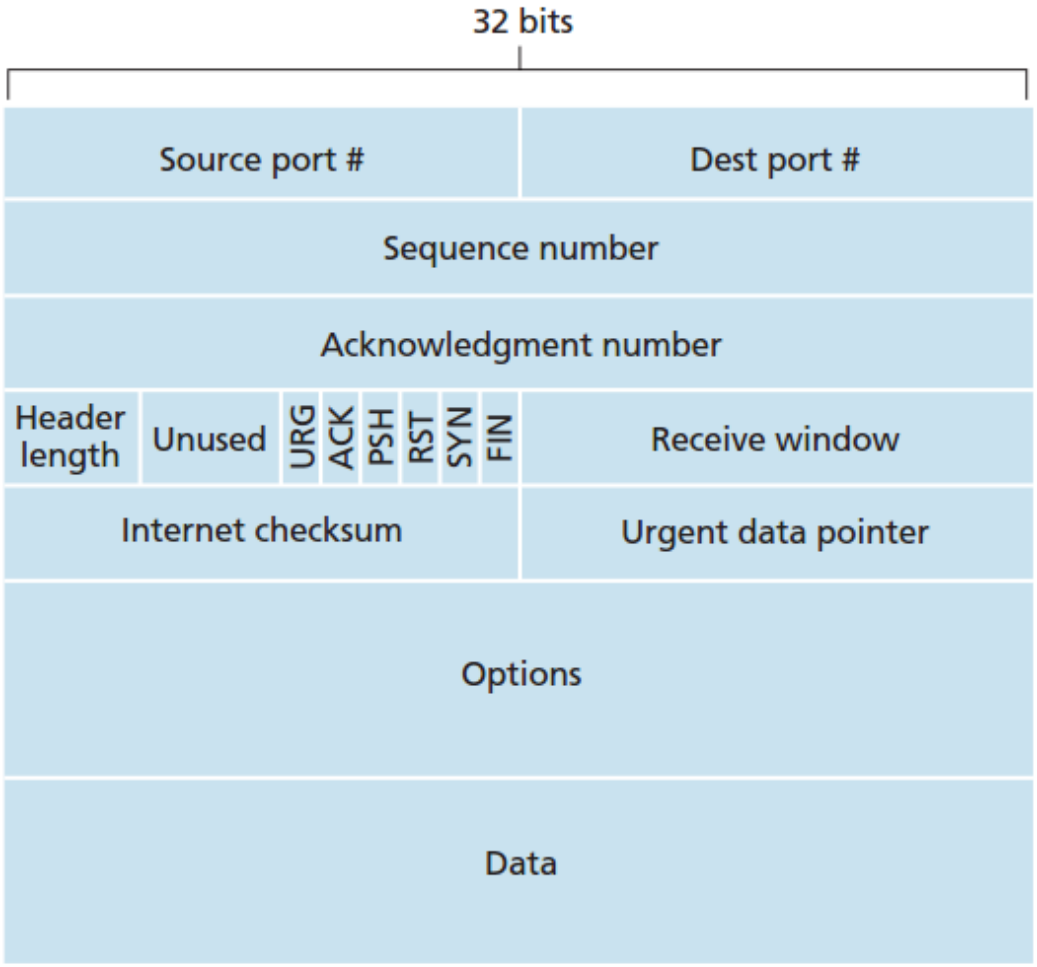



**Figure 3.29** ♦ TCP segment structure

# TCP: *Dividing the packets*

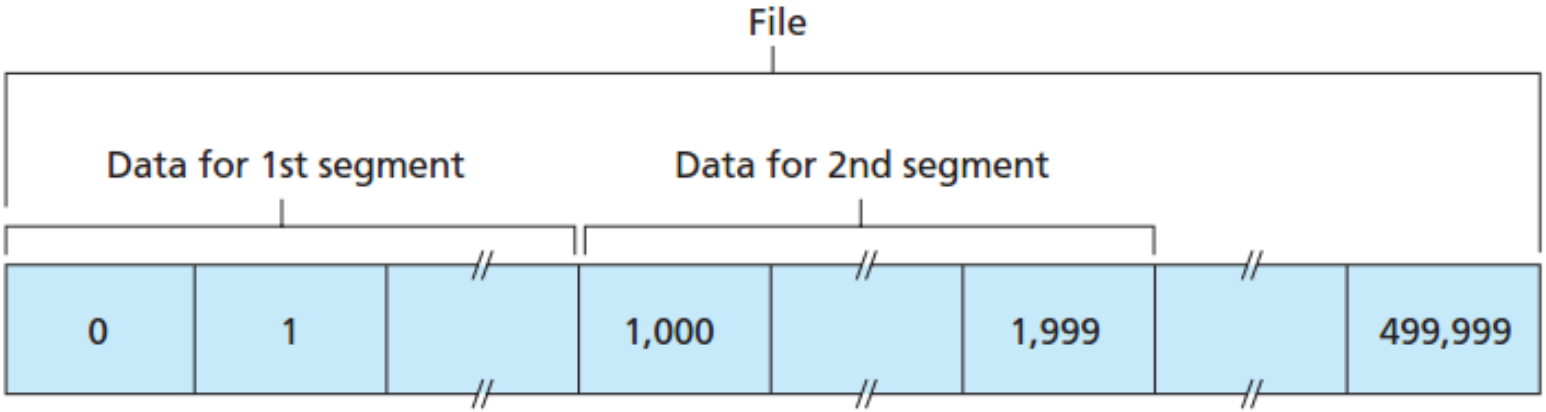
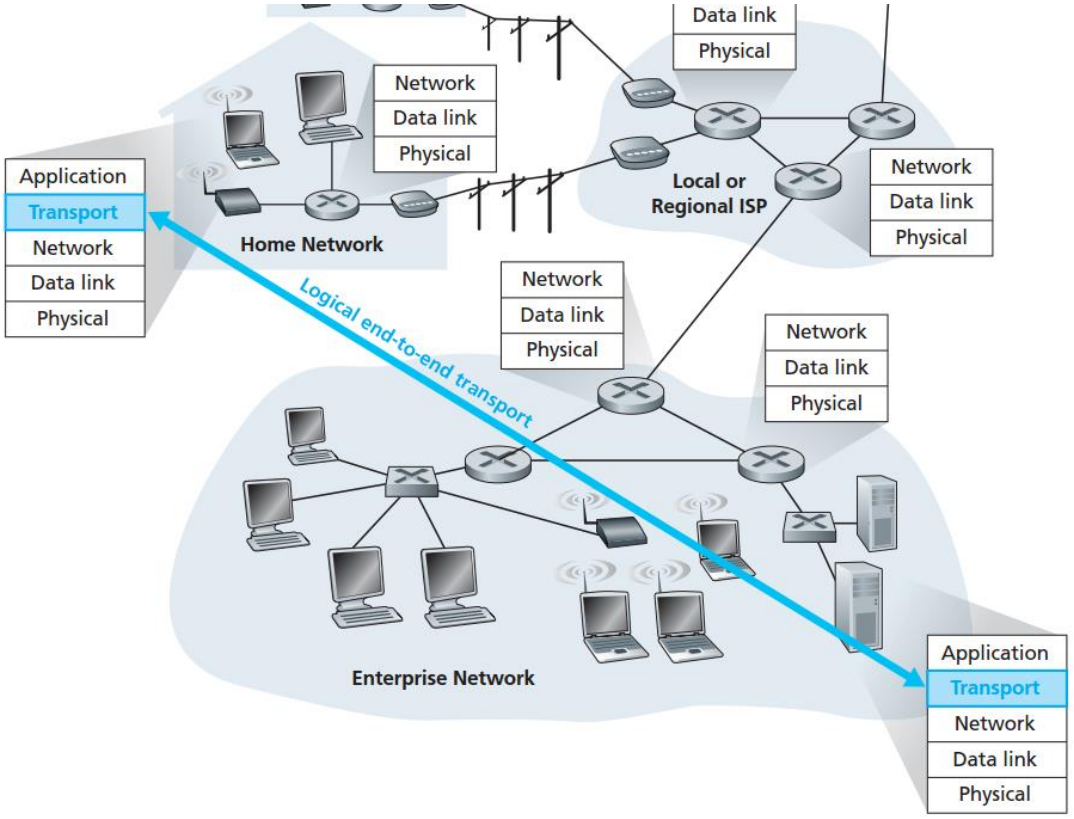



**Figure 3.30** ♦ Dividing file data into TCP segments

# Internet Protocol Stack: *Transport Layer*

- Resides at the end-host!

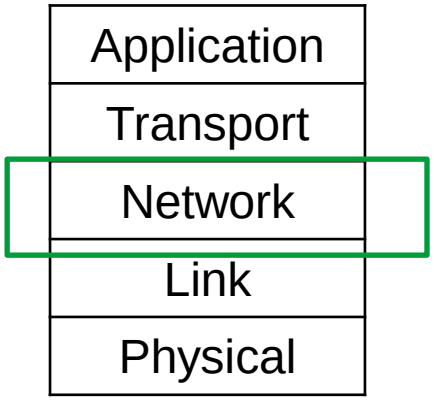


# Questions?

# Quick Quiz

- https://forms.office.com/r/mLfgsuz7yY
- True or False:
  - Route decider
- MCQ:
  - Network Application

# Internet protocol stack: *Network Layer*




**Five-layer Internet Protocol stack**

# Internet Protocol Stack: *Network Layer*

- Network Layer
  - Each host and router has network and below layers
  - Responsible for addressing, packaging, and routing functions
  - Includes Internet protocol (IP): defines the fields in the datagram as well as how the end systems and routers act on these fields
  - Includes routing protocols such as IGMP, OSPF, BGP
  - Includes other supplementary protocols such as internet message control protocol (ICMP) and address resolution protocol (ARP)
  - Uses IPv4 and IPv6 addresses

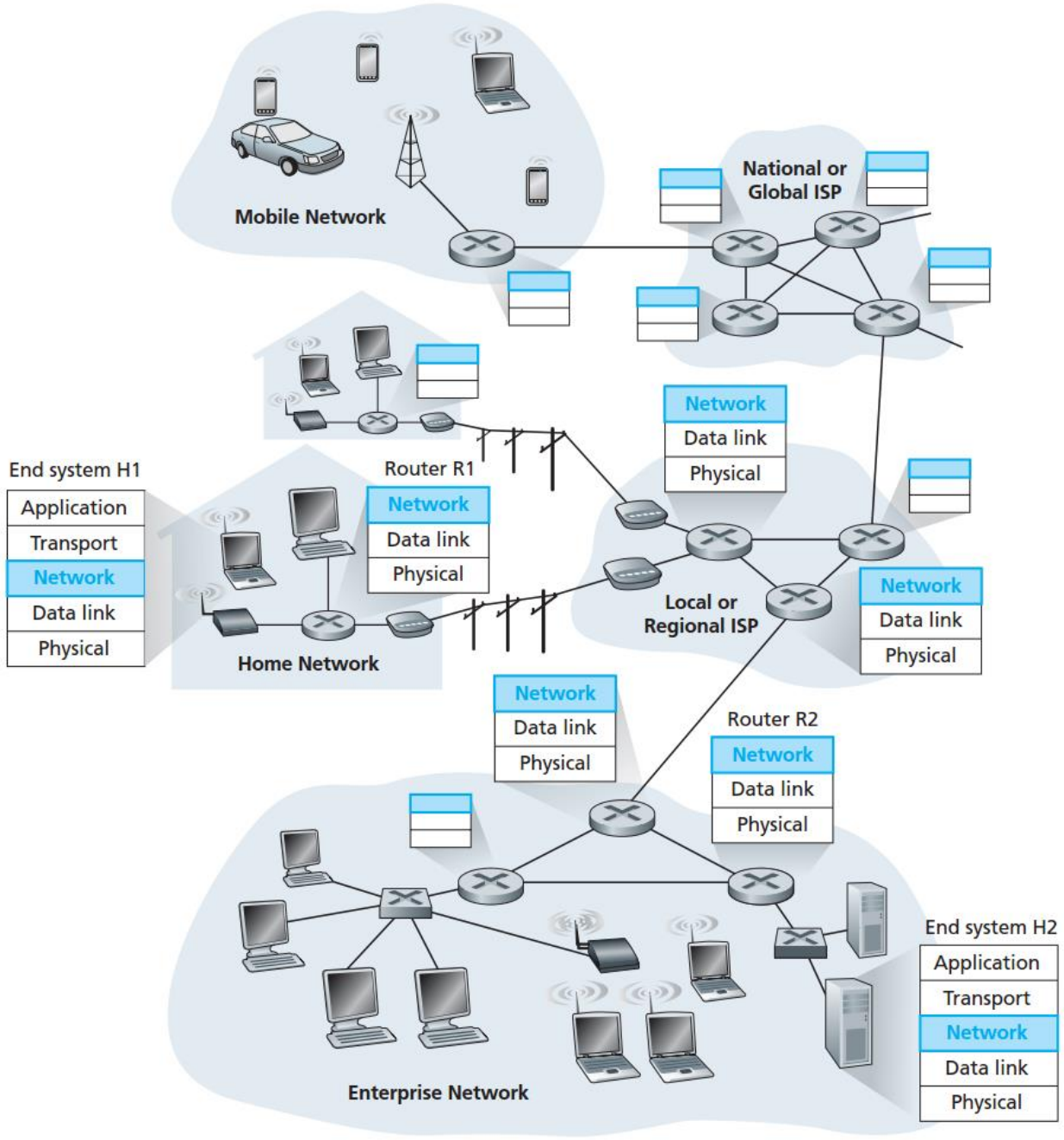
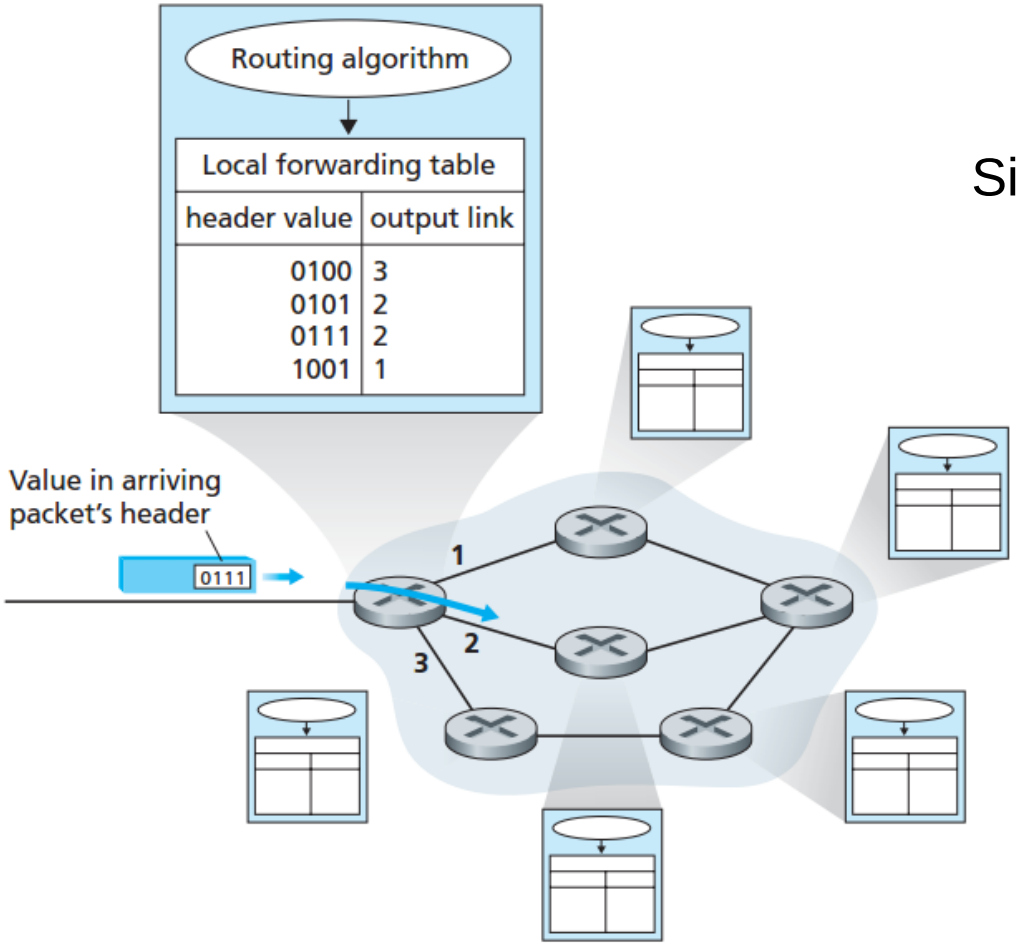



**Figure 4.1** ♦ The network layer

# Network Layer: *Forwarding and Routing*




Sign Post and Route Planning

**Figure 4.2** ♦ Routing algorithms determine values in forwarding tables

# Network Layer: *IPv4 datagram*

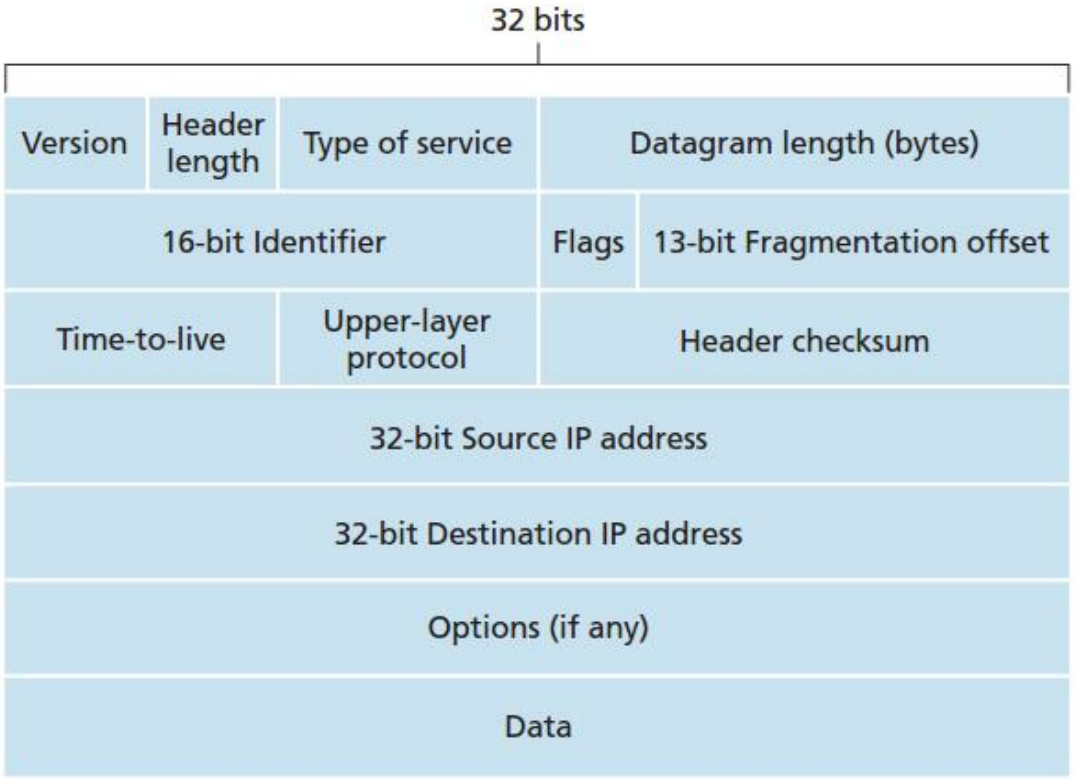
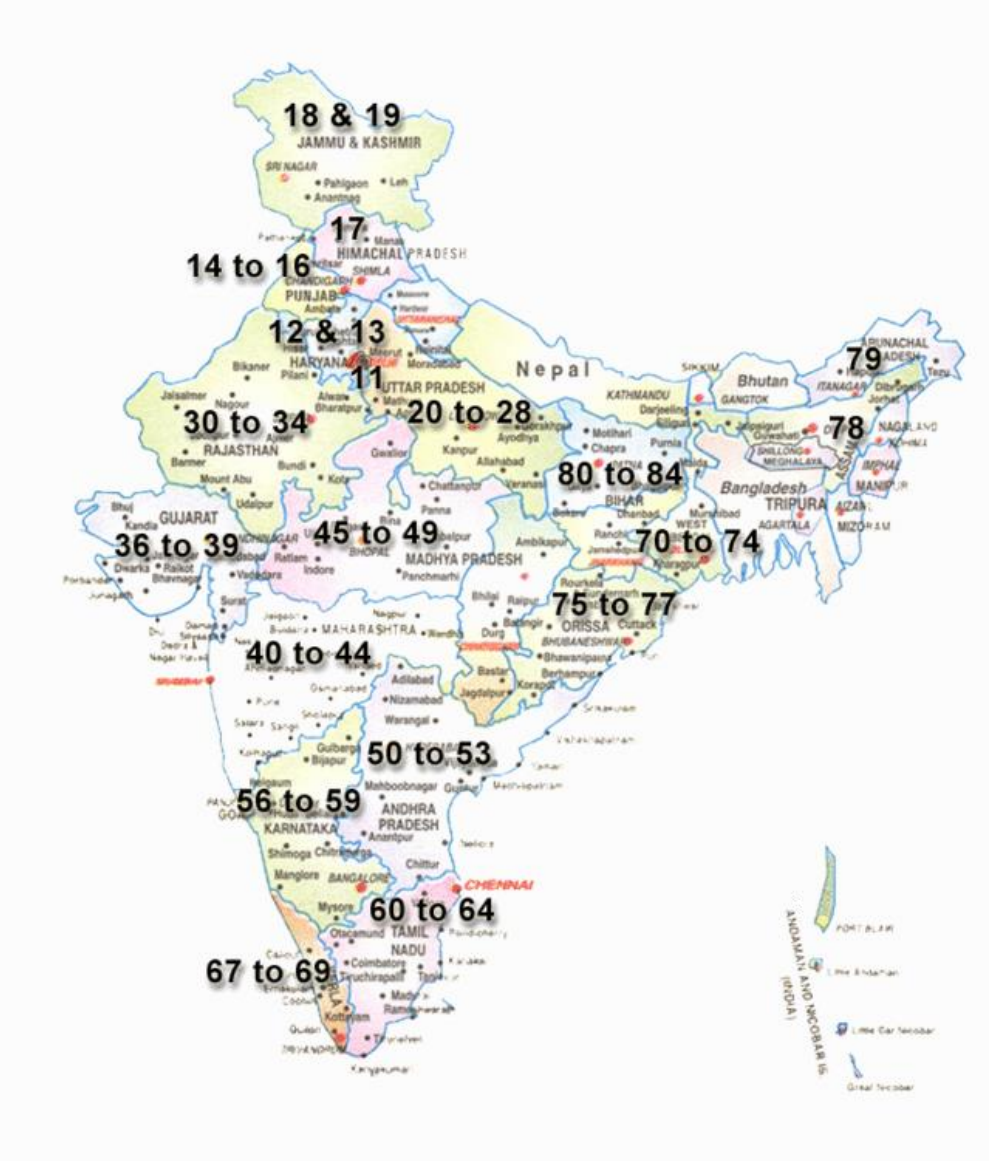



**Figure 4.13** ♦ IPv4 datagram format

# Example: Indian Postal Codes

**456001**

- Zone
- Sub-zone
- Sorting District
- Post Office



# **Network Layer:** *Services offered*

- Logical transport
- Guaranteed delivery
- Guaranteed delivery with bounded delay
- In-order packet delivery
- Guaranteed minimum bandwidth
- Security services

# Network Layer: *Routing Architecture*

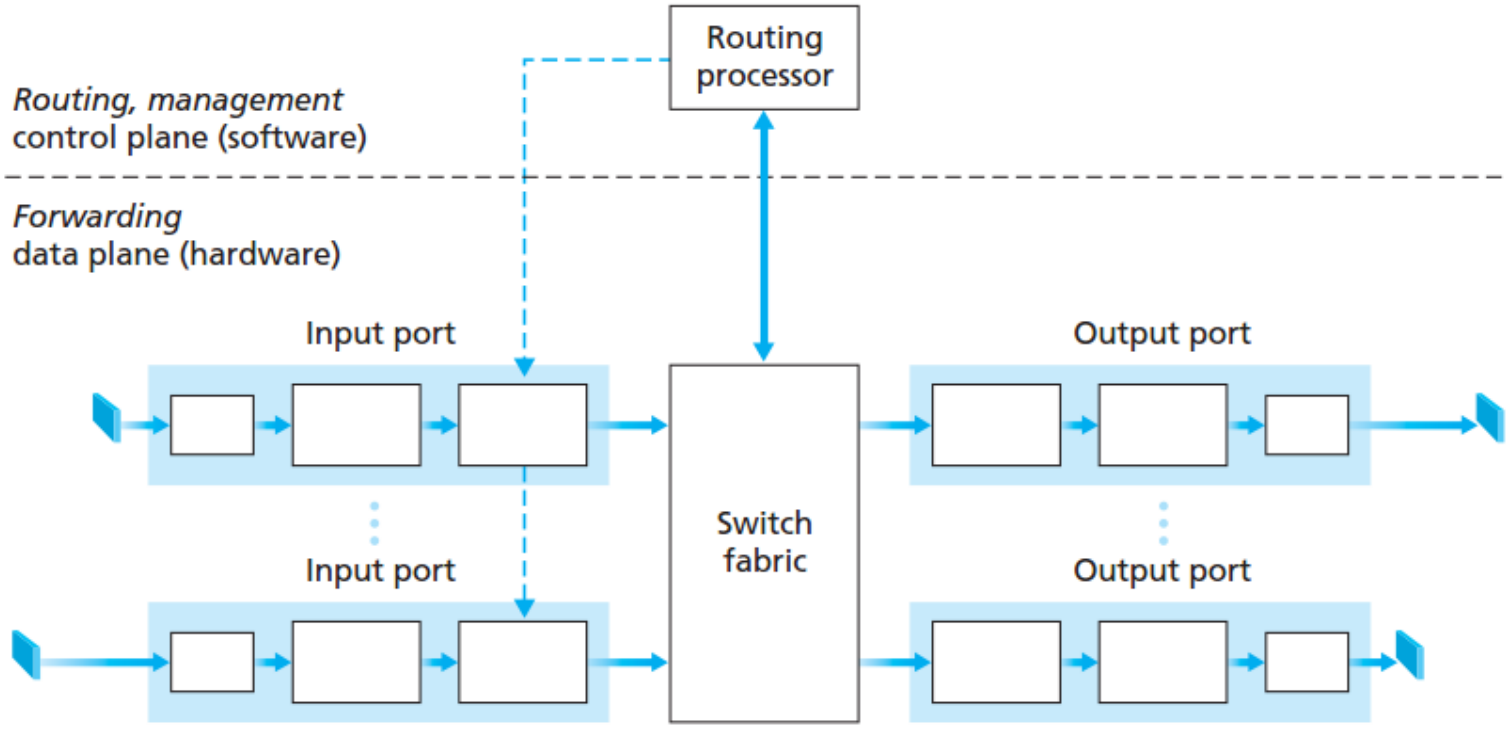



**Figure 4.6** ♦ Router architecture

# Questions?