

COM1013

INTRODUCTION TO COMPUTER

SCIENCE

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Networking and the Internet

CHAPTER

4

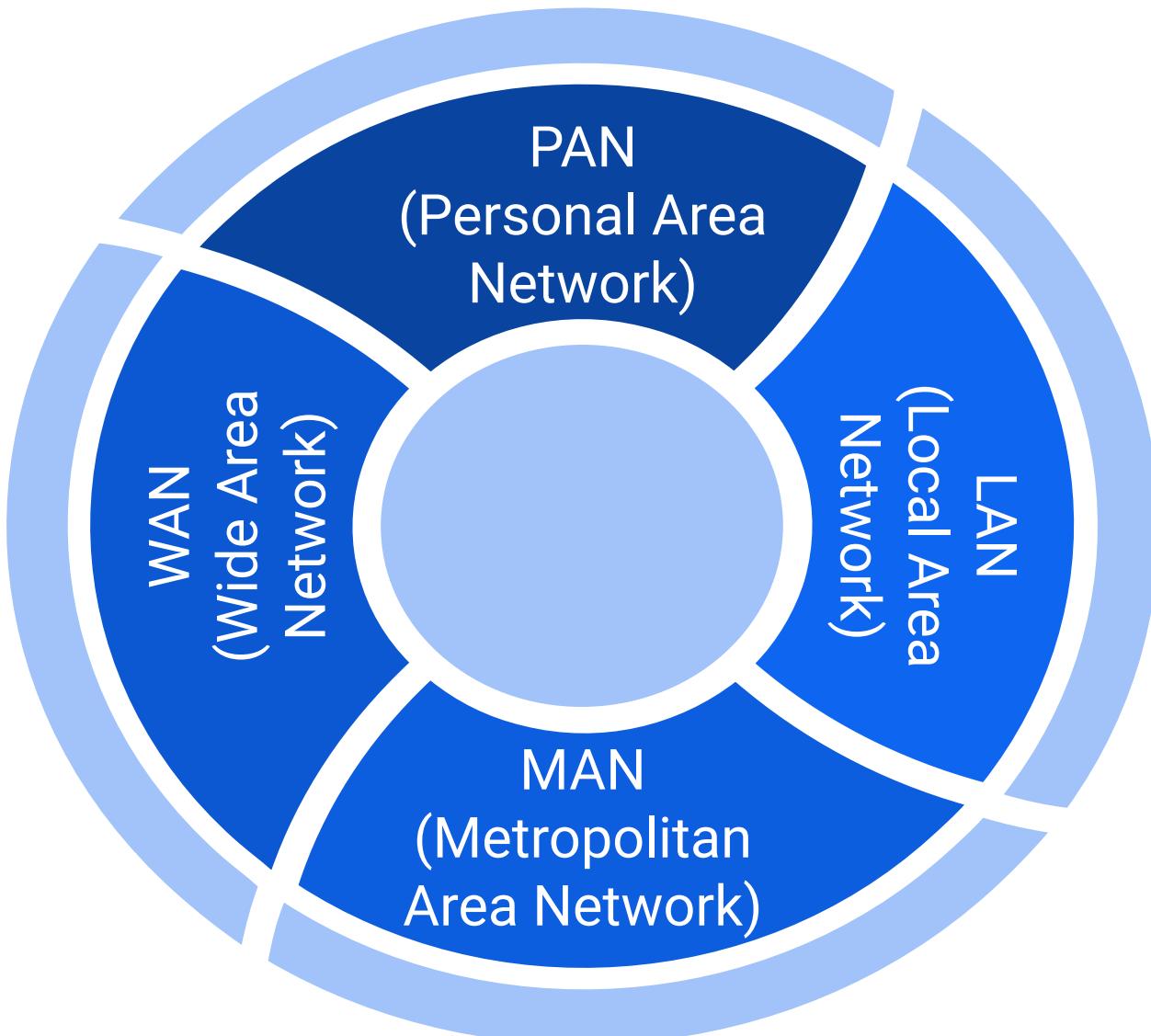
In this chapter we discuss the area of computer science known as networking, which encompasses the study of how computers can be linked together to share information and resources. Our study will include the construction and operation of networks, applications of networks, and security issues. A prominent topic will be a particular worldwide network of networks known as the Internet.

Network

Network: linked computer systems

- To share information and resources
 - computers are connected so that data can be transferred from machine to machine

Network Classifications: network types



Network Classifications: open/close network perspective

1. Open Networks

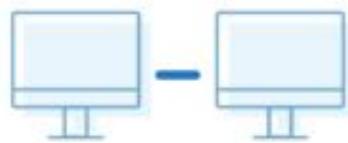
- Internet
 - Communication throughout the Internet is governed by an open collection of standards known as the TCP/IP protocol suite.

2. Close (Proprietary) Network

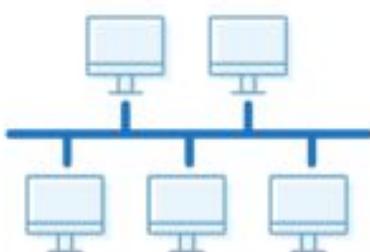
- A company might develop proprietary systems for which it chooses to maintain ownership rights, allowing the company to draw income from selling or leasing these products.

Network Classifications: topology perspective

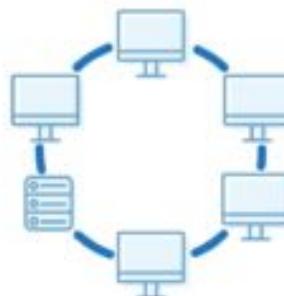
1 Point to point



2 Bus



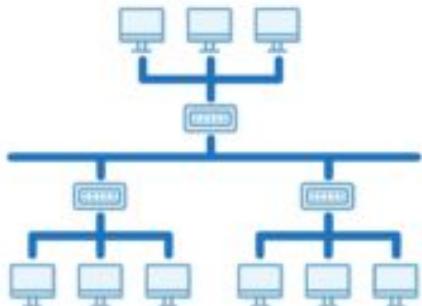
3 Ring



4 Star



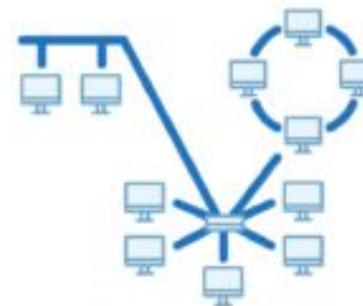
5 Tree



6 Mesh

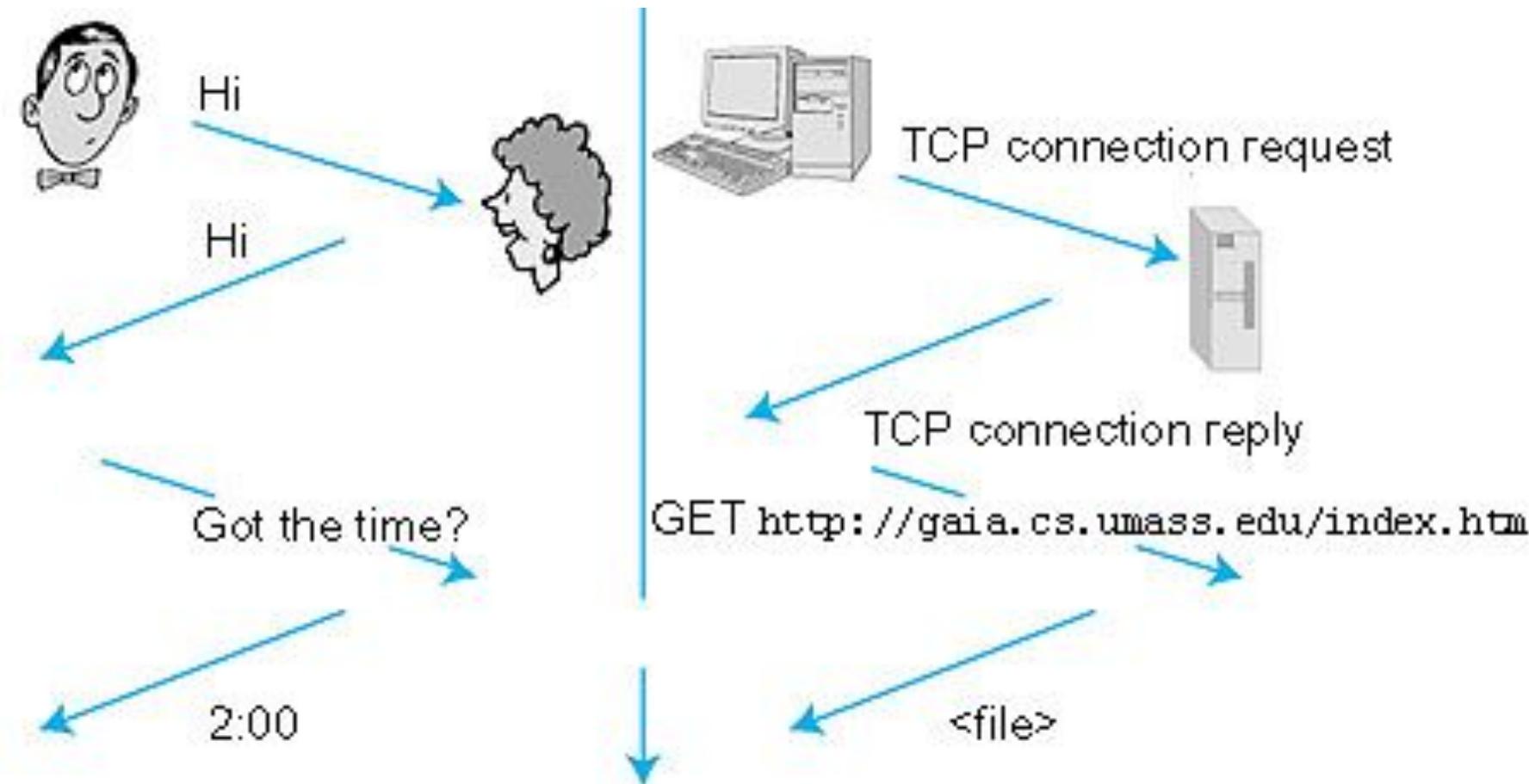


7 Hybrid



Protocol

For a network to function reliably, it is important to establish rules by which activities are conducted. Such rules are called **protocols**.



Combining Networks

Sometimes it is necessary to connect existing networks to form an extended communication system.

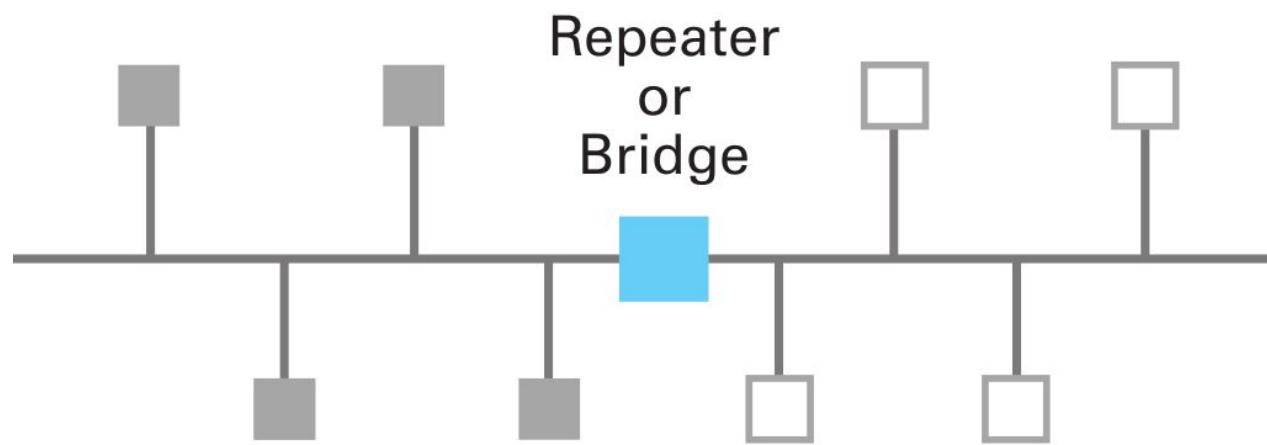
This can be done by connecting the networks to form a larger version of the **same “type”** of network.

To combine busnetworks based on Ethernet protocols:

- it is often possible to connect the buses to form a single long bus
 - By repeaters, bridges and switches

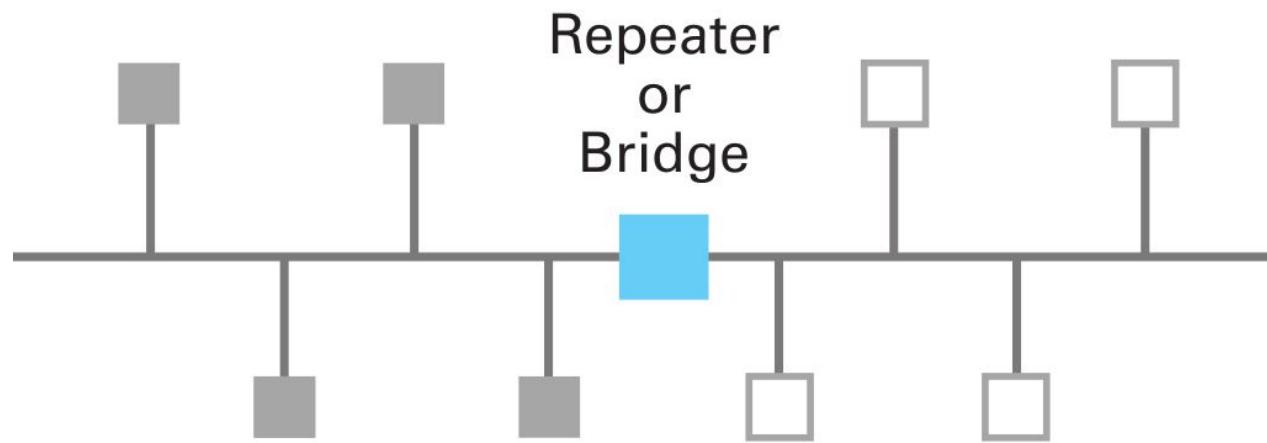
Combining Networks: repeater

- The simplest of these devices
- passes signals back and forth between the two original buses without considering the meaning of the signals



Combining Networks: bridge

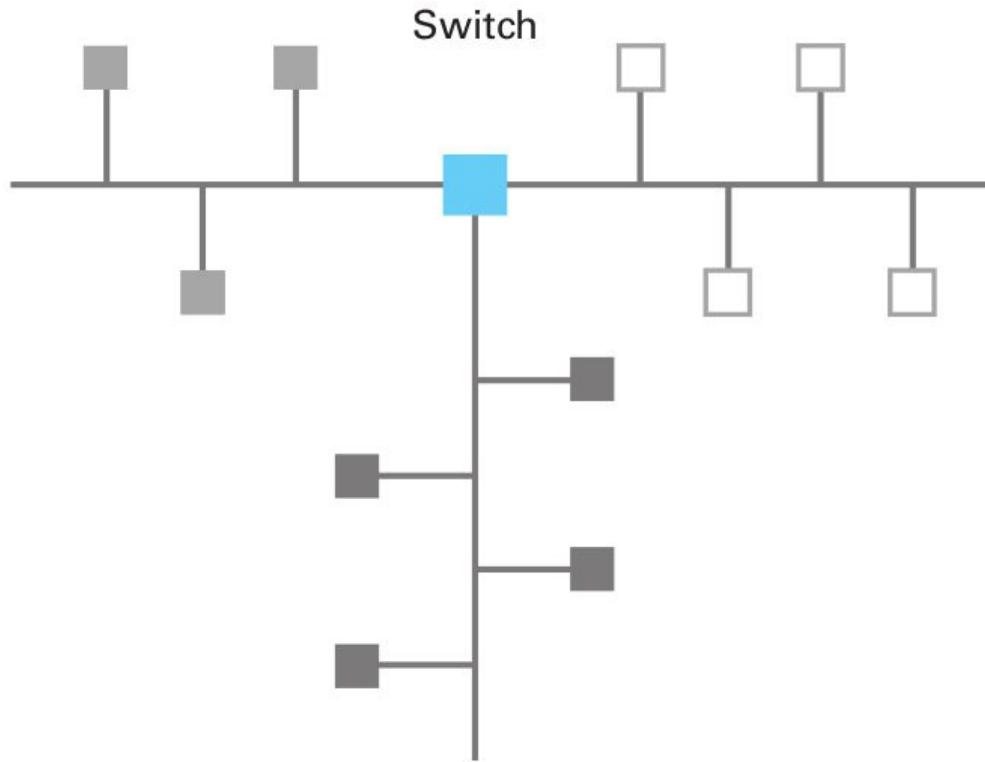
- Similar to but more complex and efficient than a repeater
- It does not necessarily pass all messages across the connection
- it looks at the destination address and forwards a message across the connection
 - only when the message is destined for a computer on the other side



Combining Networks: switch

A switch is essentially a bridge with multiple connections, allowing it to connect several buses rather than just two.

Thus, a switch produces a network consisting of several buses



Combining Networks

The networks to be connected can be incompatible characteristics

For instance, the characteristics of a WiFi network (star) are not readily compatible with an Ethernet network (bus).

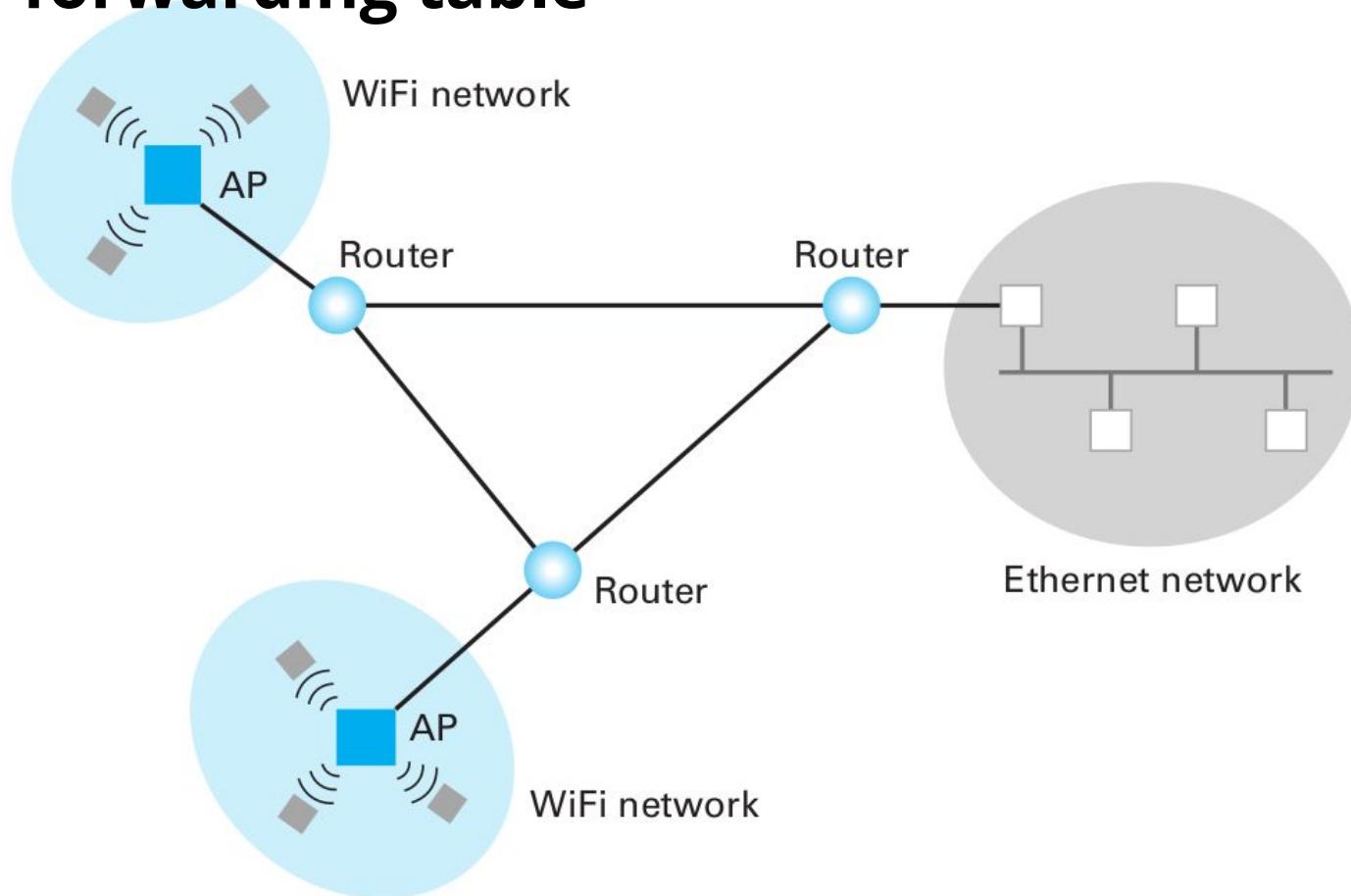
In these cases the networks must be connected in a manner that builds a network of networks, known as an **internet**.

P.s.: internet ≠ The Internet

Combining Networks: routers

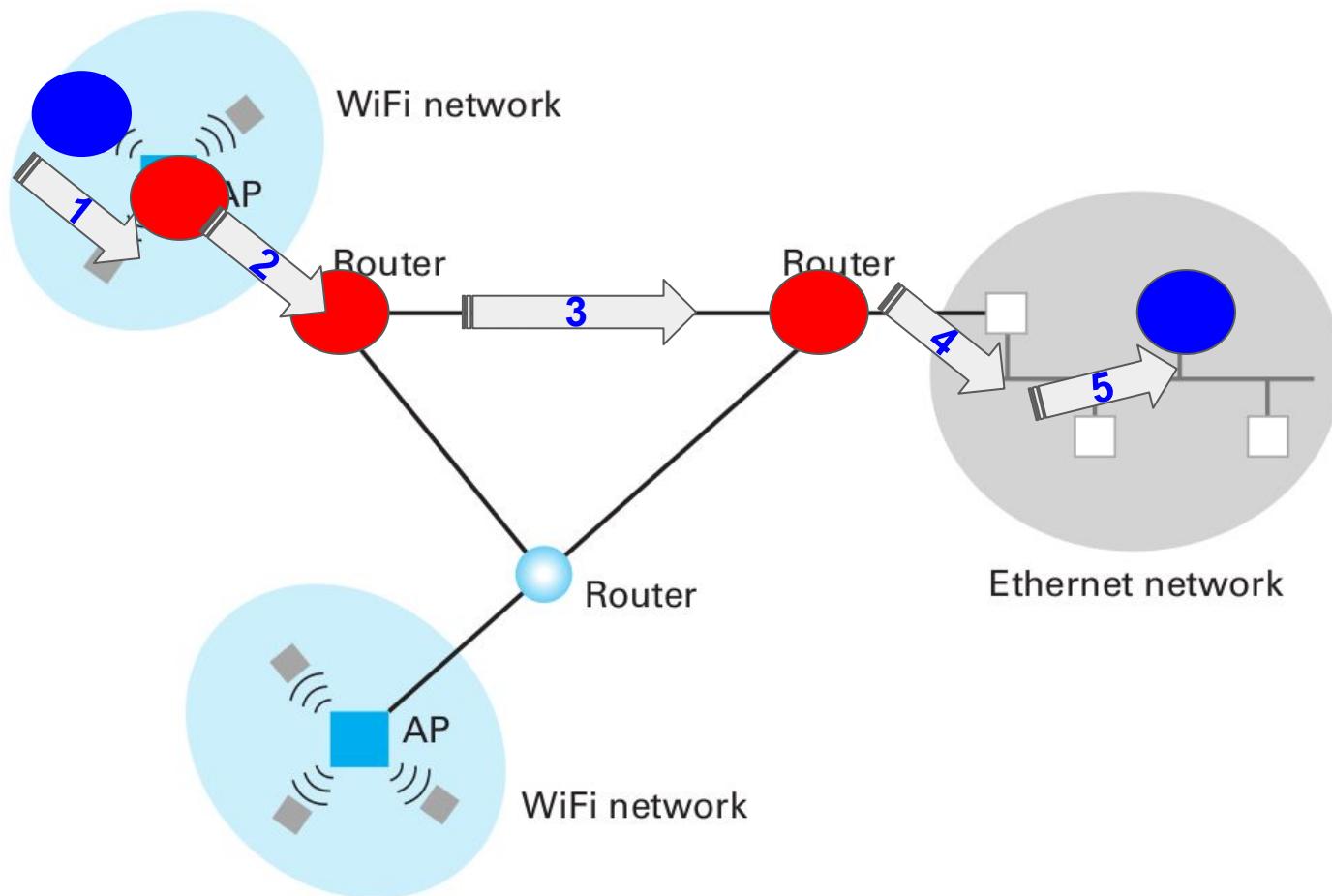
The connection between networks to form an internet is handled by devices known as **routers**

- By forwarding table



Combining Networks: routers

The connection between networks to form an internet is handled by devices known as **routers**



Methods of Process Communication

Interprocess communication

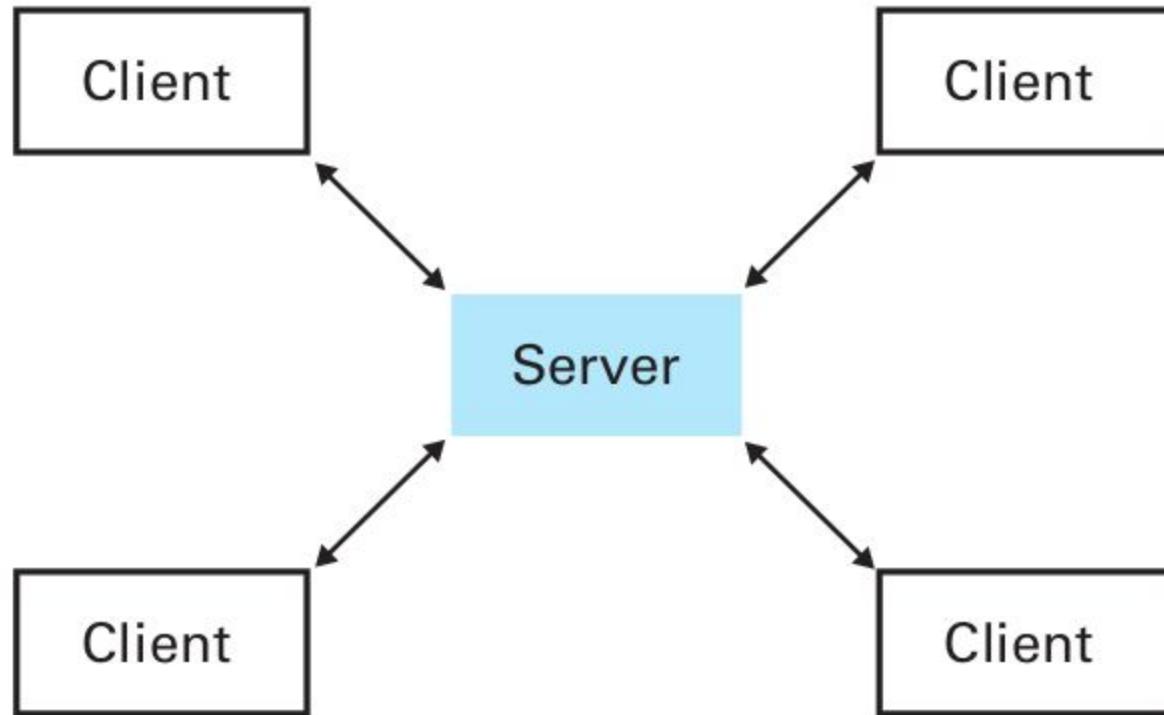
- Between different computers within a network
- Between various activities running on a single machine

A popular convention used for interprocess communication is the **client/server model**.

This model defines the basic roles played by the processes as either client or server.

- A client **makes requests** of other processes,
- A server **satisfies the requests** made by clients.

Methods of Process Communication



Methods of Process Communication

Another Interprocess communication model is the peer-to-peer (**P2P**) model.

P2P model involves processes that **provide service to** and **receive service from each other**.

- Peers communicate as equals on a one-to-one basis.



Methods of Process Communication

Client/Server

- Involves one process (the server) providing a service to numerous others (clients)
- A server must execute continuously so that it is prepared to serve its clients at any time
- E.g. File server

P2P

- Involves processes that provide service to and receive service from each other
- Usually involves processes that execute on a temporary basis
- E.g. Distributed file sharing

P.s.: A process might use the peer-to-peer model to communicate with another process and later use the client/server model to communicate with another process over the same network.

Extra Reading

Brookshear JG, Smith D, Brylow D.

“Computer science: an overview”.

Read the following section in the textbook.

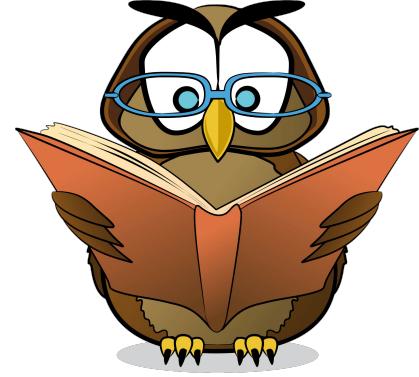
Chapter: 4.1. Network Fundamentals

- Distributed Systems

Summarize the section in 1 page (no figure should be included.)

Template for summarization assignments:

https://docs.google.com/document/d/1i1tU3AdIvPgRxqzGmXrsnVVCRXws5V3caDTCPMbPJ_0/edit?usp=sharing



The Internet

((note the uppercase I))

Originated from research projects going back to the early 1960s.

The goal was to develop the ability to link a variety of computer networks so that they could function as a connected system that would not be disrupted by local disasters.

Much of this work was sponsored by the U.S. government through the Defense Advanced Research Projects Agency (DARPA—pronounced “DAR-pa”).

Today: worldwide combination of PANs, LANs, MANs, and WANs involving millions of computers

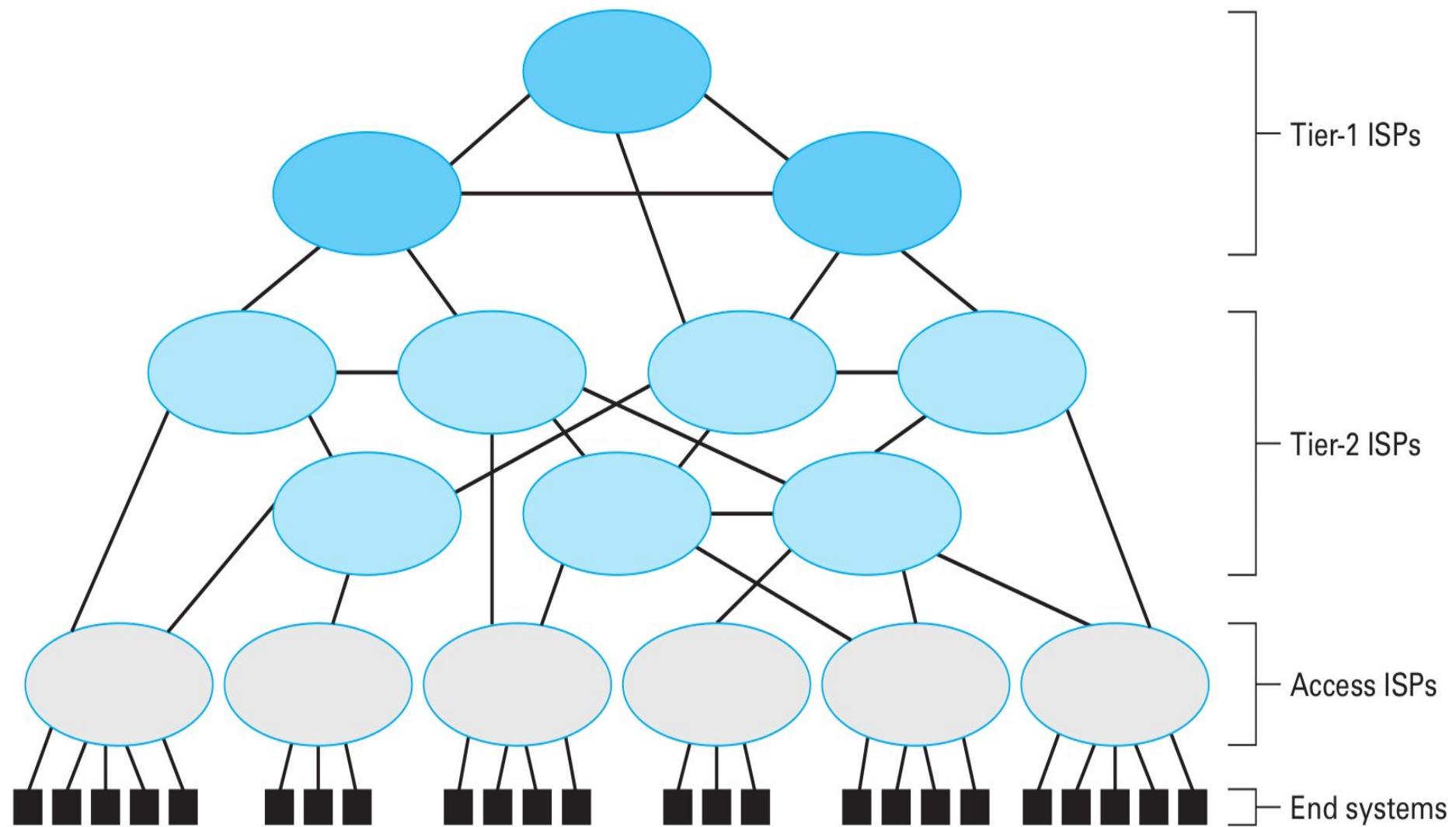
Internet Architecture

Internet Service Providers (ISPs)

- Organizations that construct and maintain the networks.

The system of networks operated by the ISPs can be classified in a hierarchy according to the role they play in the overall Internet structure.

Internet Architecture



Tier-1 ISPs

At the top of this hierarchy

- relatively few ISPs
- that consist of
 - very high-speed,
 - high-capacity,
 - international WANs.
- The backbone of the Internet.
- Typically operated by large companies that are in the communications business.
- Operated by companies in the communications business

Tier-2 ISPs

- More regional in scope and less potent in their capabilities.
- Operated by companies in the communications business

Tier-1 and tier-2 ISPs are essentially networks of routers that collectively provide the Internet's communication infrastructure.

Tier-3 ISPs

Tier-1 and Tier-2 is the core of the internet.

Access to this core is usually provided by an intermediary called an **access** or tier-3 ISP.

An access ISP is essentially an independent internet, **sometimes called an intranet**,

- operated by a single authority that is in the business of supplying Internet access to individual homes and businesses.

Examples:

- cable and telephone companies that charge for their service
- organizations such as universities or corporations that take it upon themselves to provide Internet access to individuals

End systems or hosts

The devices that individual users connect to the access ISPs

- Laptops-PCs
- Telephones
- Video cameras
- Automobiles
- Home appliances

Internet Addressing

IP Address:

Numerical label for devices on a network.

Enables communication between devices over the internet or network.

Identifies the host and its location in the network.

Two main versions: IPv4 and IPv6.

IPv4: Written as four sets of numbers (e.g., 192.168.1.1). 32 bits

IPv6: Longer, in hexadecimal notation (e.g., 2001:0db8:85a3:0000:0000:8a2e:0370:7334). 128 bits

Internet Addressing

DNS (Domain Name System):

Translates human-friendly domain names to IP addresses.

Acts as the internet's phonebook.

Allows users to type domain names instead of complex IP addresses.

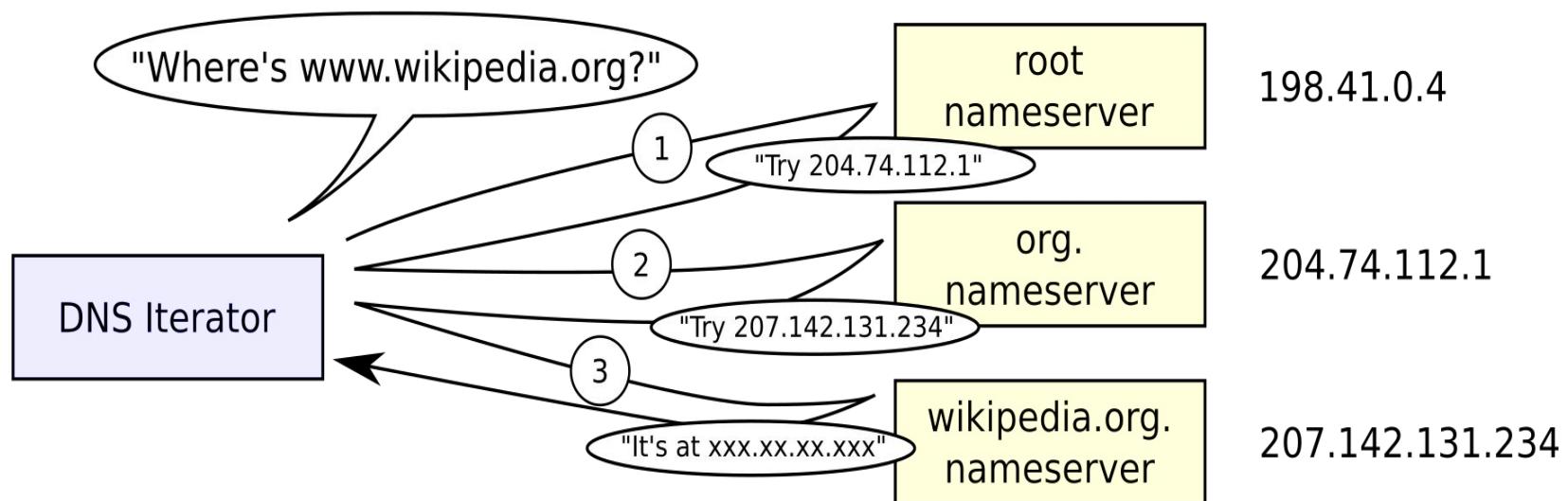
Works through a hierarchical structure.

DNS (Domain Name System)

Local DNS resolver provided by ISP is often the first point of contact.

If resolver doesn't have the IP, it queries higher-level DNS servers.

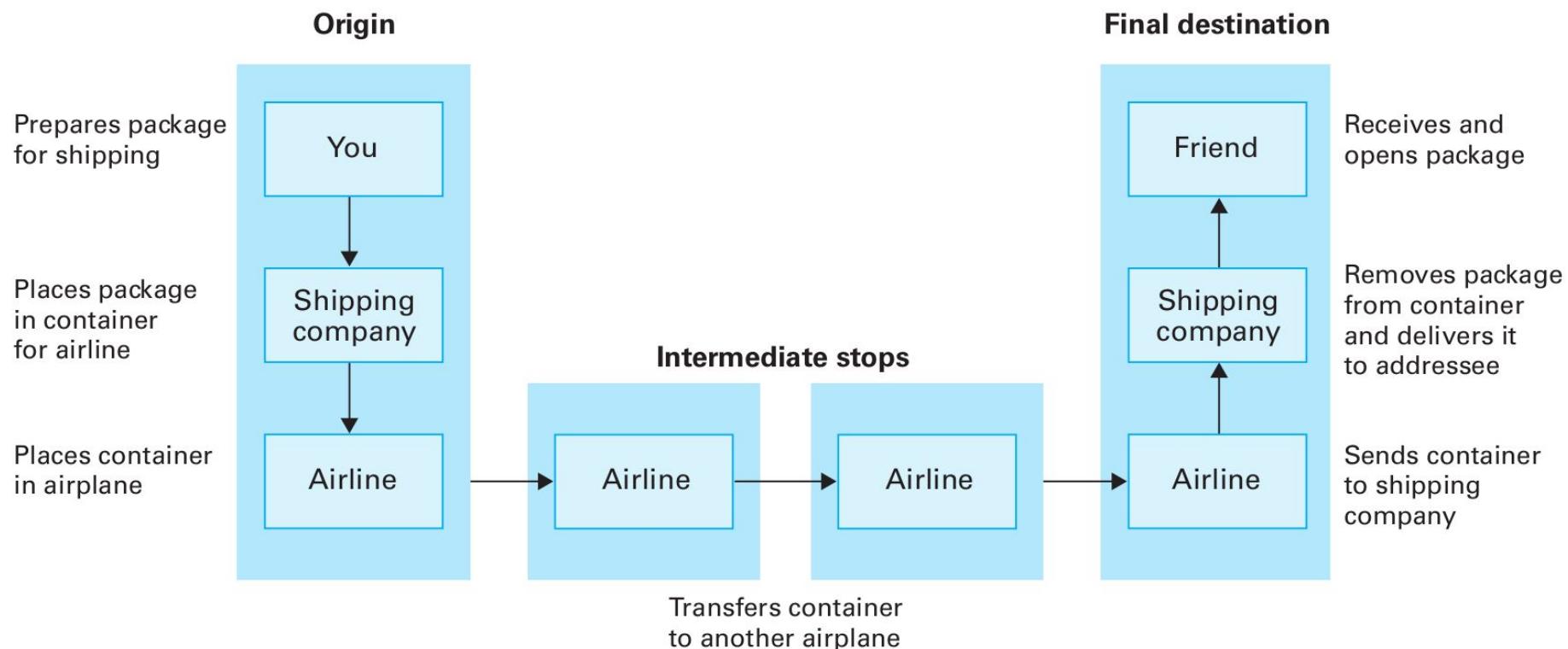
Ensures efficient and distributed translation of domain names to IP addresses.



Internet Protocols

A principal task of networking software is

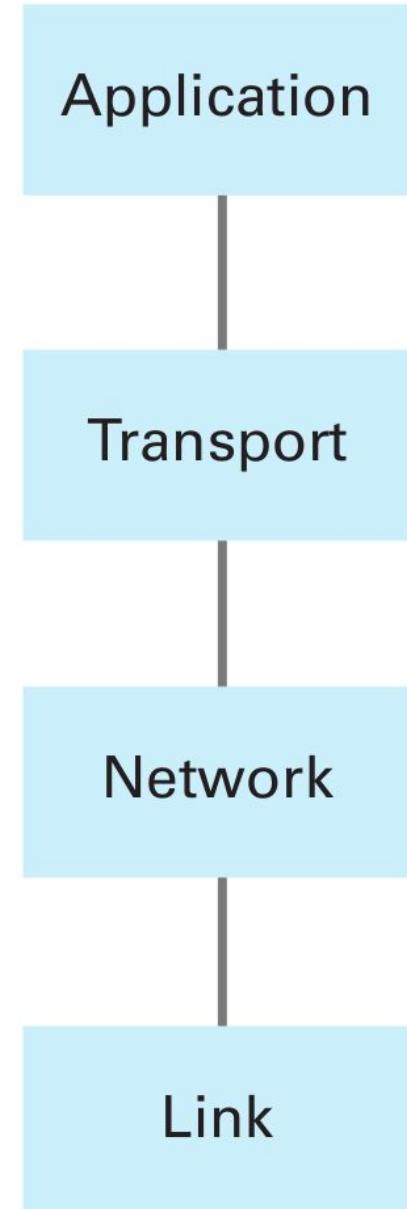
- To provide the infrastructure required for transferring messages from one machine to another.



Internet Protocols

Software for controlling communication over the Internet.

- A message typically originates in the application layer.
- From there it is passed down through the transport and network layers
- and finally it is transmitted by the link layer.
- The message is received by the link layer at the destination
- and passed back up the hierarchy until it is delivered to the application layer at the message's destination.



Prepares message and provides destination address

Application

Chops message into packets

Transport

Assigns intermediate address to each packet

Network

Transfers packet

Link

At each intermediate stop the network layer determines the direction in which the packet should be forwarded.

Network

Link

Network

Link

Network

Link

Origin

Intermediate stops

Final destination

Application

Receives message

Transport

Collects packets and reassembles message

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Detects that packet has reached its final destination

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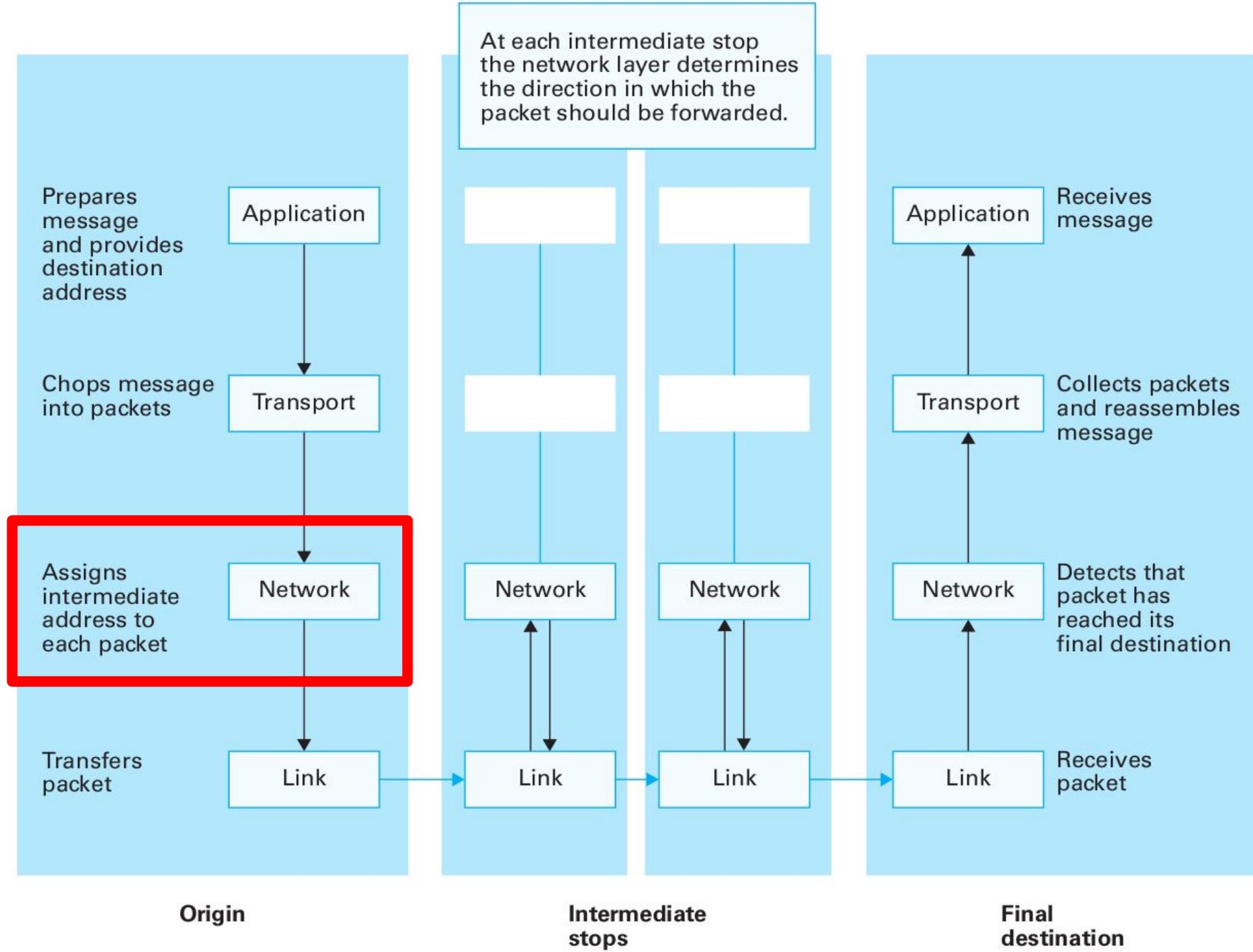
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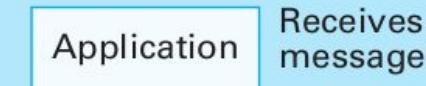
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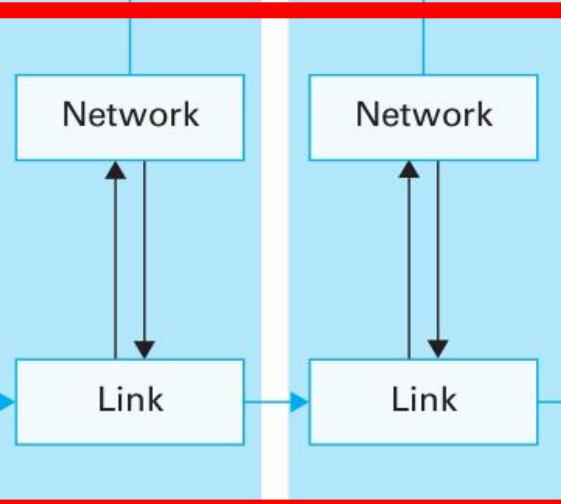
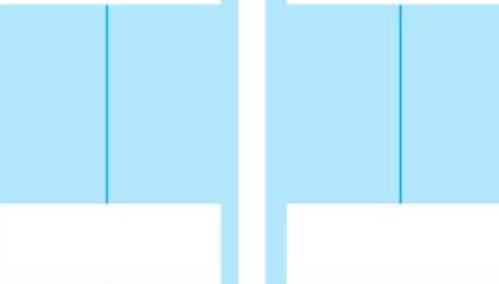
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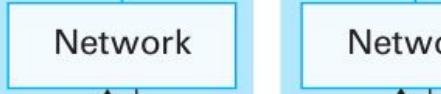
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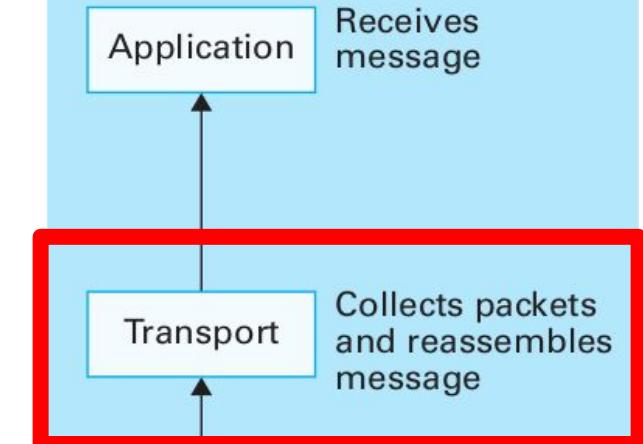
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The TCP/IP Protocol Suite

The demand for open networks has generated a need for published **standards** by which manufacturers can supply equipment and software that function properly with products from other vendors.

One standard that has resulted is the Open System Interconnection (**OSI**) reference model, produced by the International Organization for Standardization.

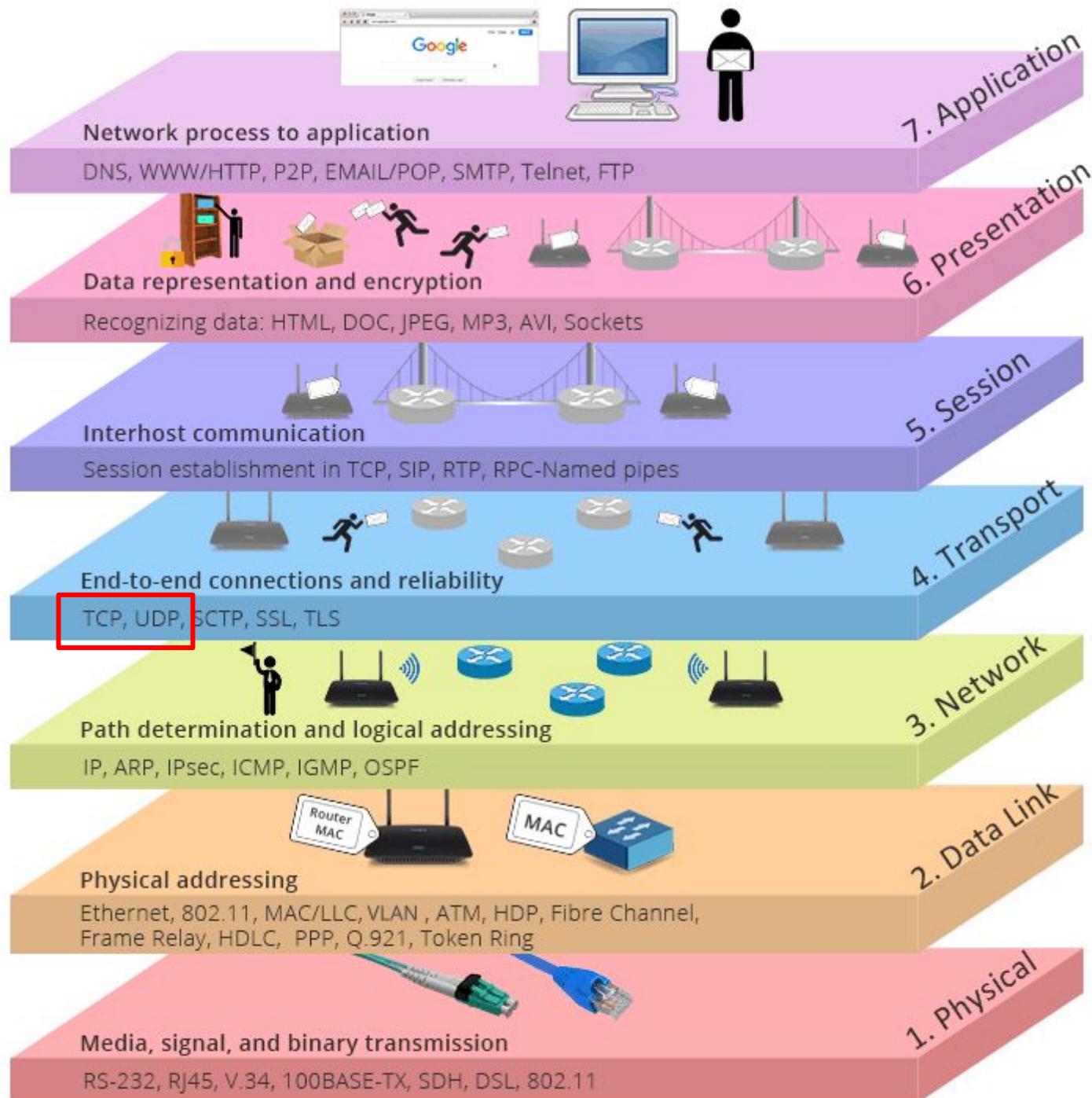
The TCP/IP Protocol Suite

OSI is based on a **seven-level hierarchy** as opposed to the four-level hierarchy we have just described.

It is an often-quoted model because it carries the authority of an international organization,

- but it has been **slow to replace the four-level point of view**,
 - mainly because it was established after the four-level hierarchy had already become the de-facto standard for the Internet.

OSI Layers



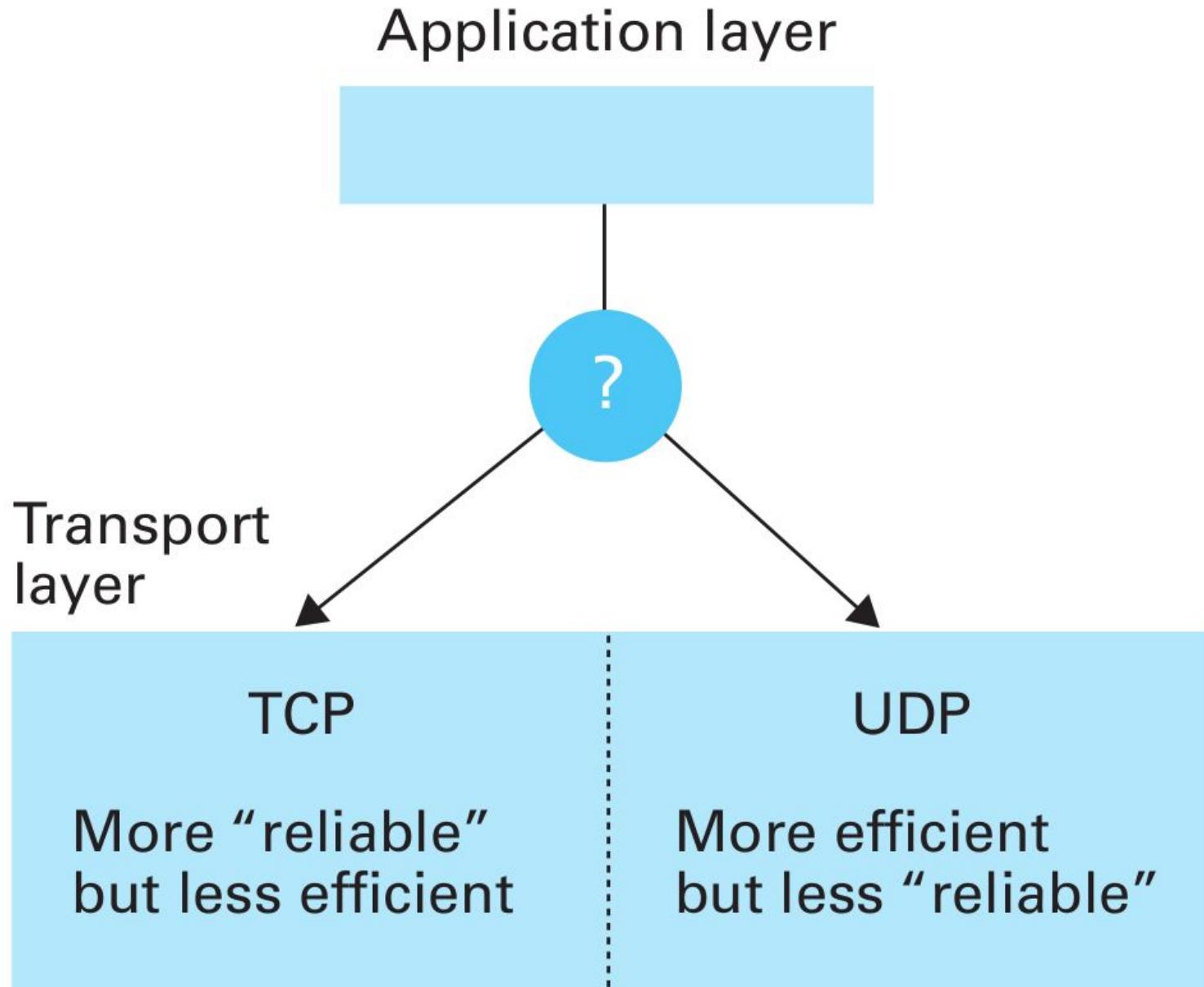
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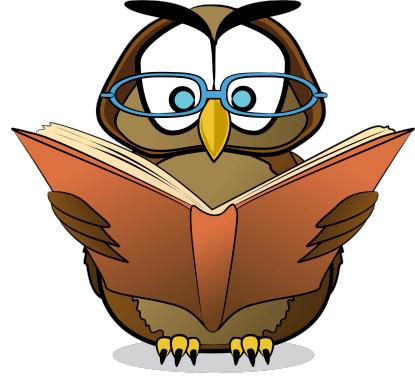
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Extra Reading

Brookshear JG, Smith D, Brylow D.

“Computer science: an overview”.



Read the following section in the textbook.

Chapter: 4.5. Security

- Forms of Attack
- Protection and Cures
- Encryption
- Legal Approaches to Network Security

Summarize the section in 2 page (no figure should be included.)

Template for summarization assignments:

https://docs.google.com/document/d/1i1tU3AdIvPgRxqzGmXrsnVVCRXws5V3caDTCPMbPJ_0/edit?usp=sharing

Research Themes

1. Network operating systems
2. Cloud computing
3. Fog computing
4. Internet of Things
5. Network security
6. Software defined networks

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