

# COM1013

# INTRODUCTION TO COMPUTER SCIENCE

Lecturer: Begüm MUTLU BİLGE, PhD

[begummutlubilge+com1013@gmail.com](mailto:begummutlubilge+com1013@gmail.com) (recommended)  
[bmbilge@ankara.edu.tr](mailto:bmbilge@ankara.edu.tr)

# Networking and the Internet

C H A P T E R

4

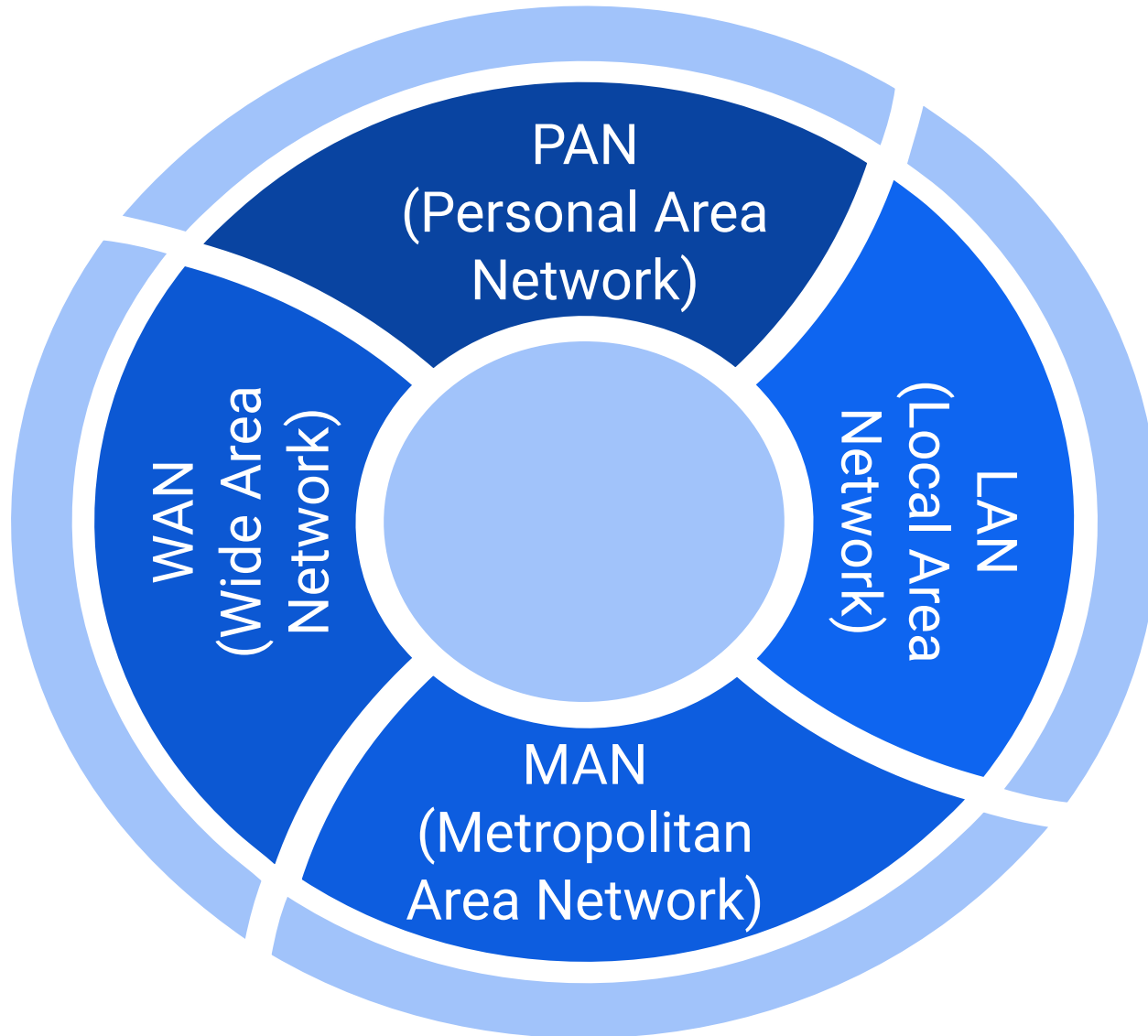
In this chapter we discuss the area of computer science known as networking, which encompasses the study of how computers can be linked together to share information and resources. Our study will include the construction and operation of networks, applications of networks, and security issues. A prominent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

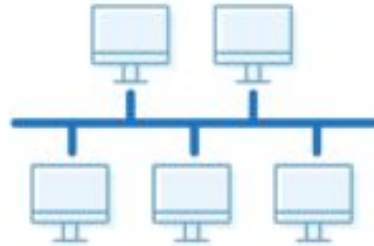
- A company might develop proprietary systems for which it chooses to maintain ownership rights, allowing the company to draw income from selling or leasing these products.

# Network Classifications: topology perspective

1 Point to point



2 Bus



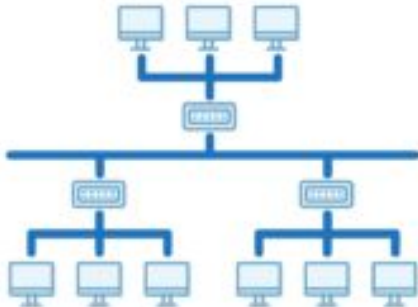
3 Ring



4 Star



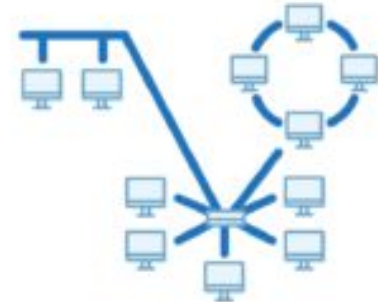
5 Tree



6 Mesh

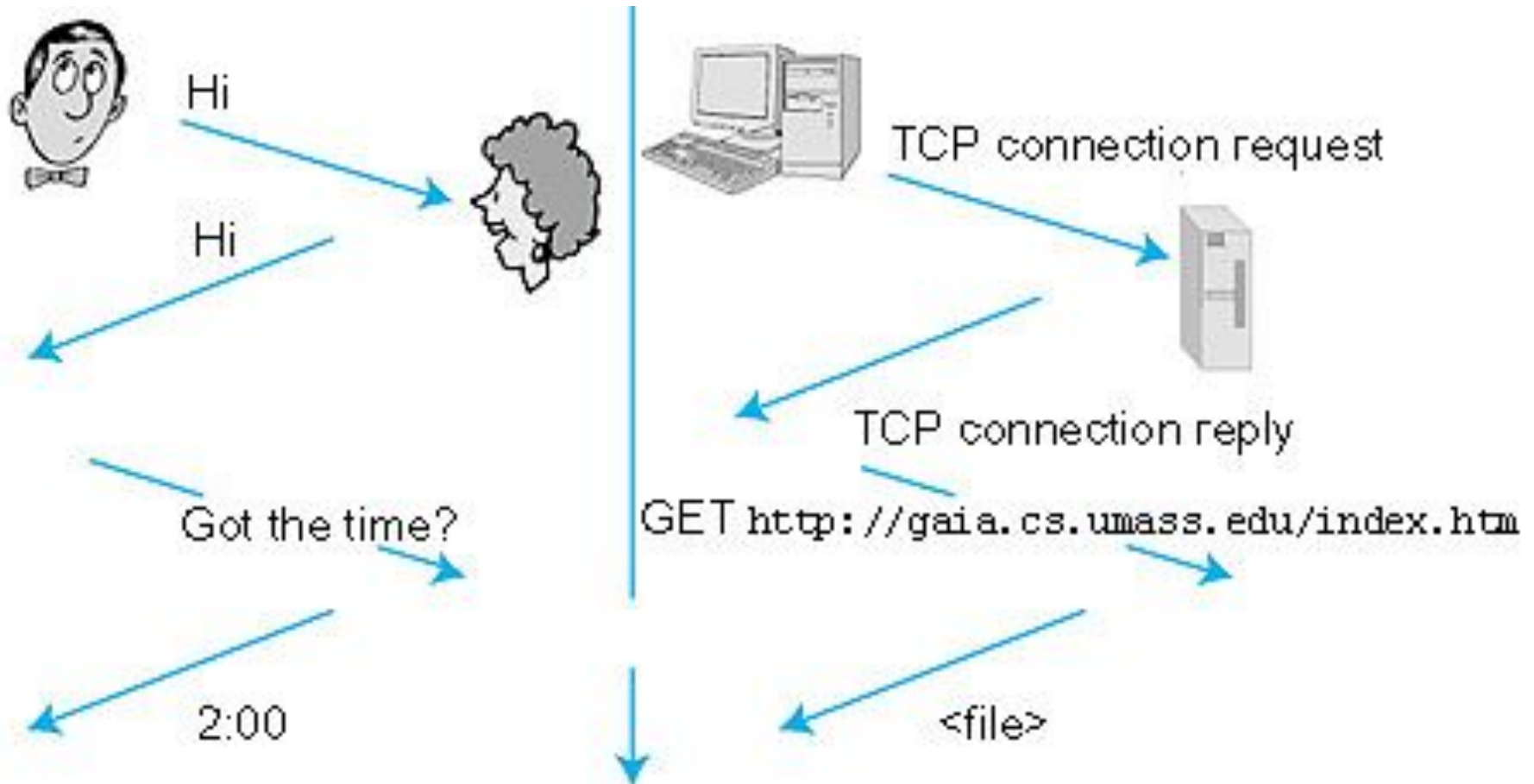


7 Hybrid



# 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.

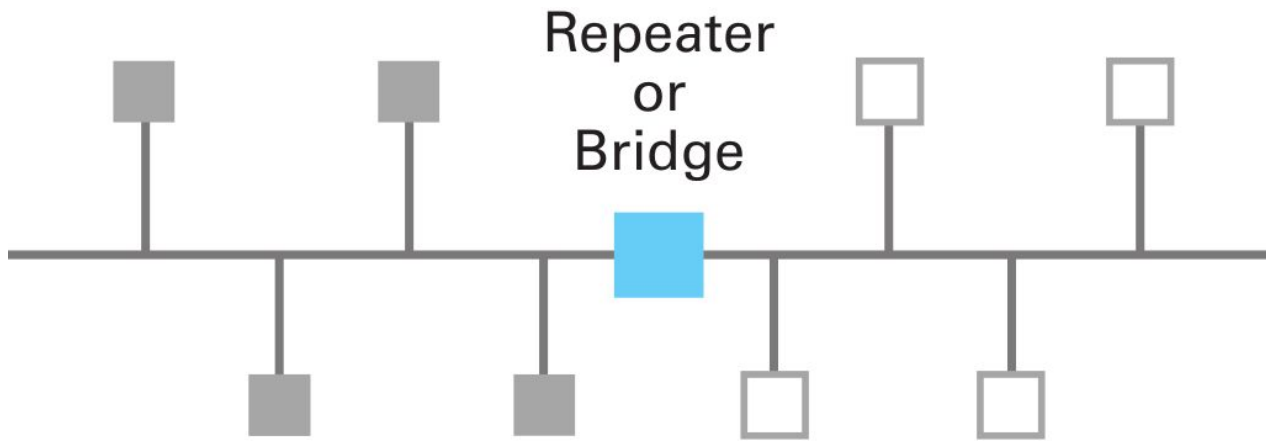
This can be done by connecting the networks to form a larger version of the **same “type”** of network.

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

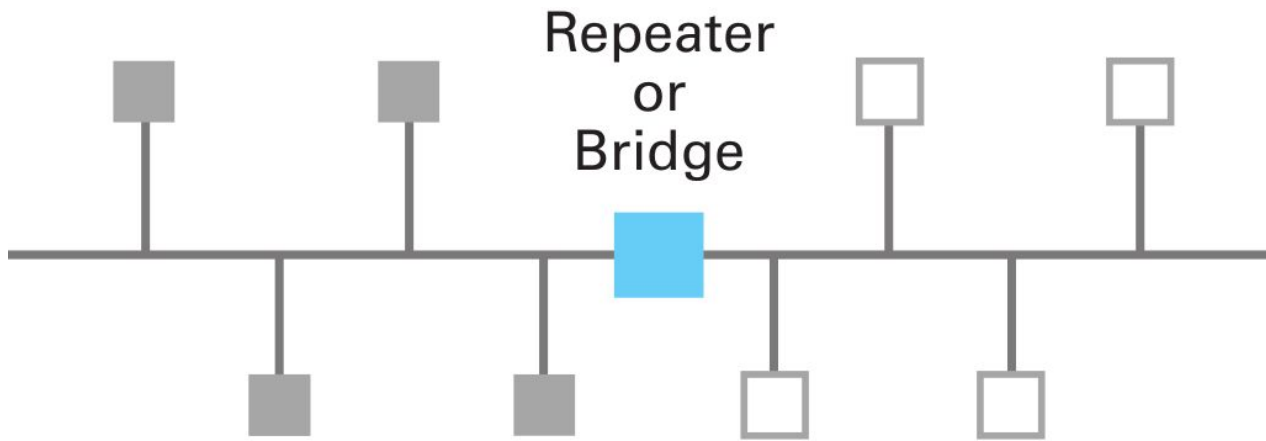
# Combining Networks: repeater

- 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

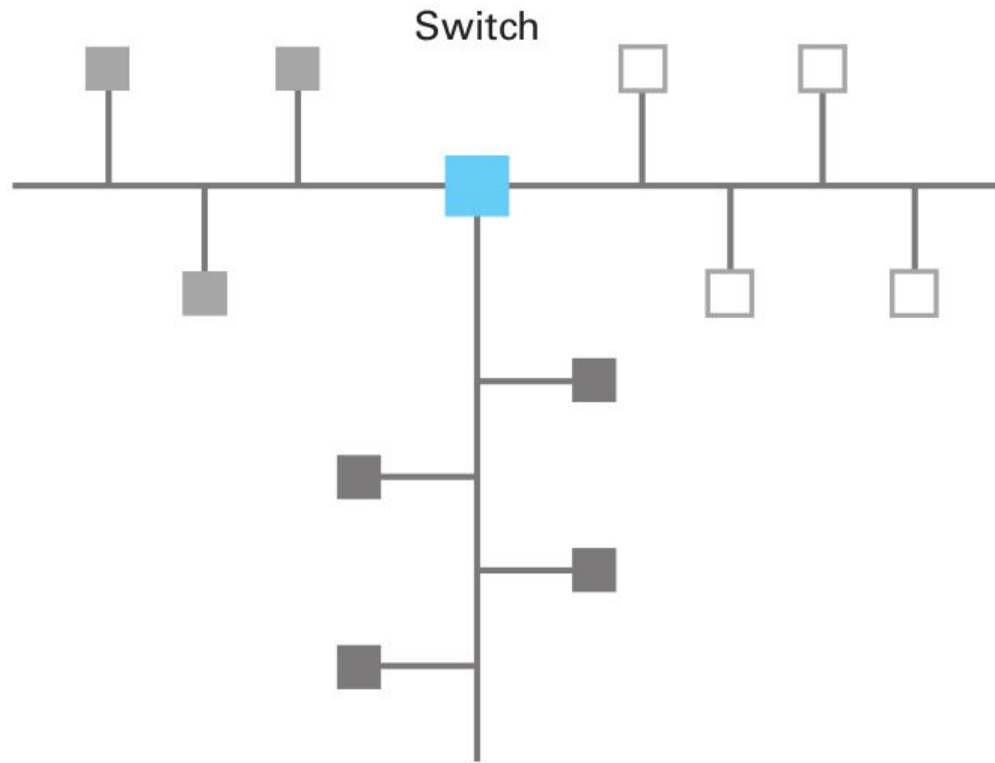
- Similar to but more complex and efficient than a repeater
- It does not necessarily pass all messages across the connection
- it looks at the destination address and forwards a message across the connection
  - only when the message is destined for a computer on the other side



# 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).

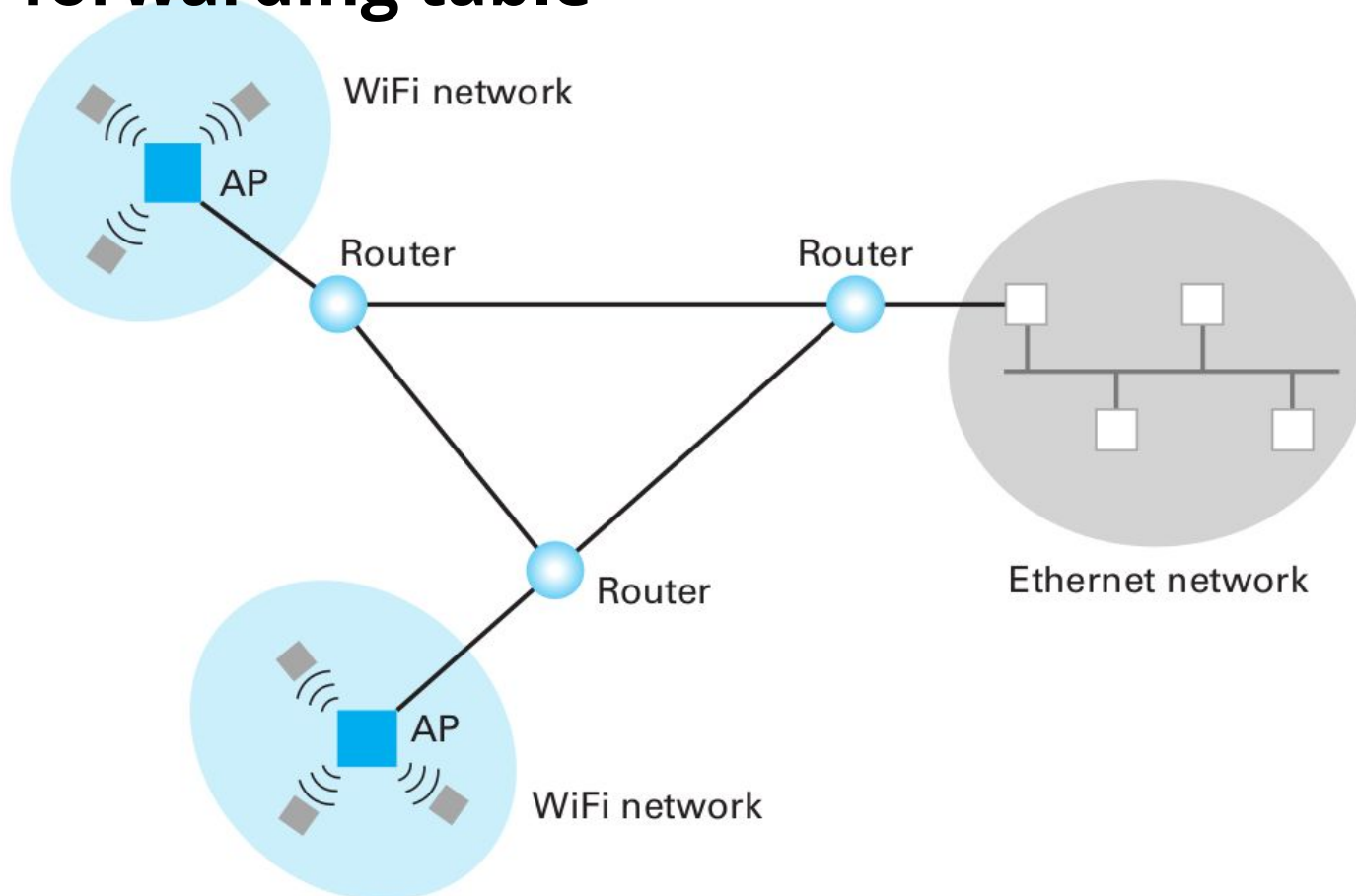
In these cases the networks must be connected in a manner that builds a network of networks, known as an **internet**.

**P.s.: internet ≠ The Internet**

# Combining Networks: routers

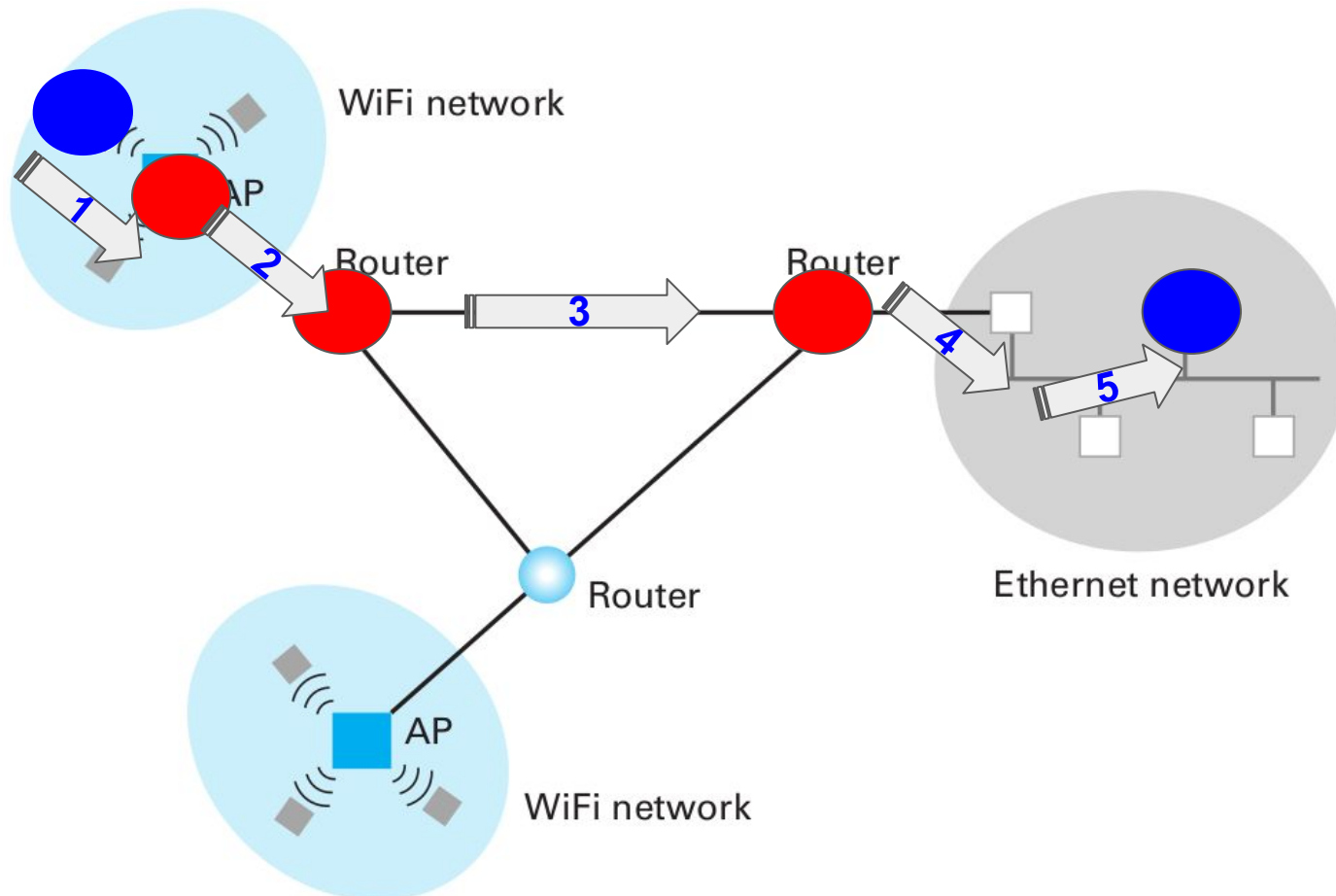
The connection between networks to form an internet is handled by devices known as **routers**

- **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

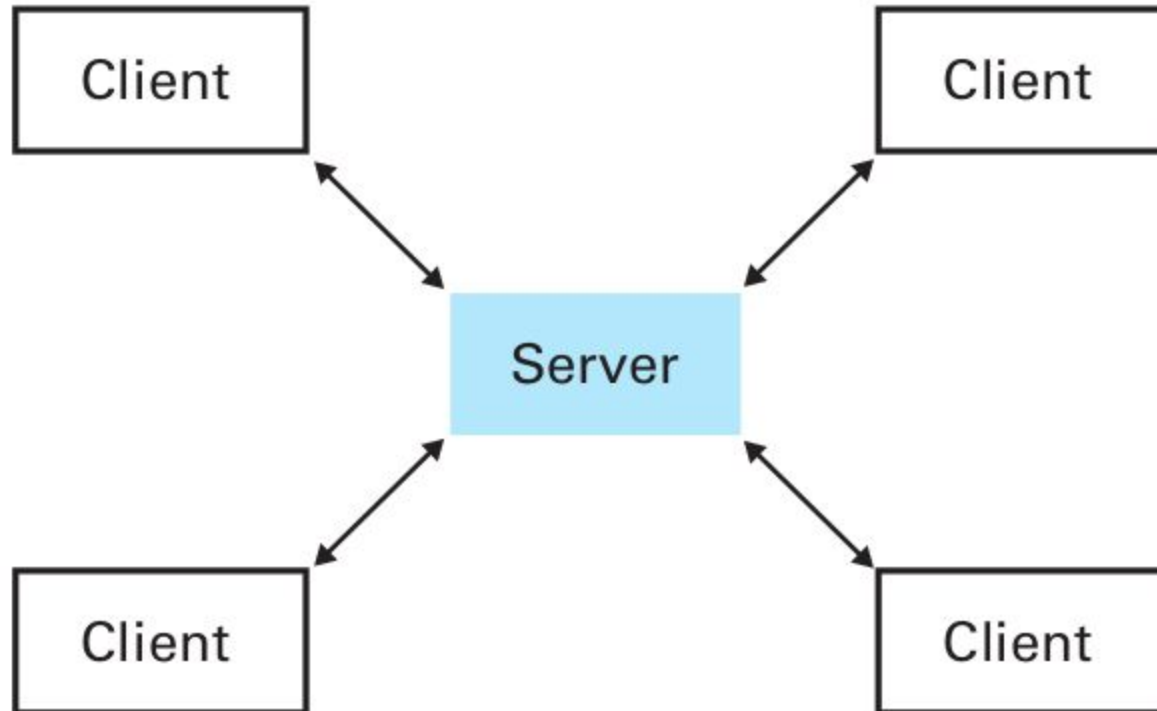
- Between different computers within a network
- Between various activities running on a single machine

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/1i1tU3AdlvPgRxqzGmXrsnVVCRXws5V3caDTCPMbPJ\\_0/edit?usp=sharing](https://docs.google.com/document/d/1i1tU3AdlvPgRxqzGmXrsnVVCRXws5V3caDTCPMbPJ_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

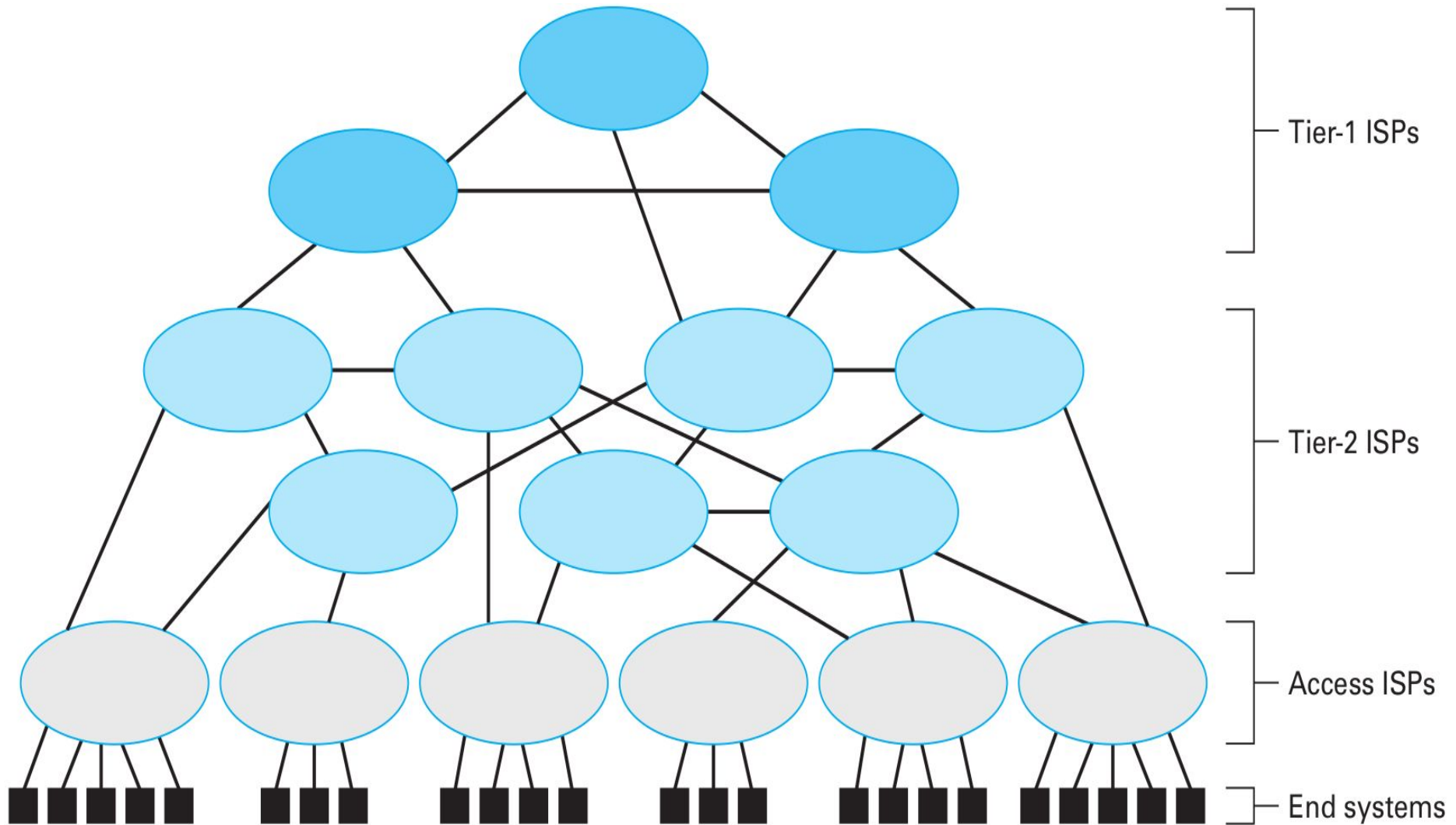
# Internet Architecture

## 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.

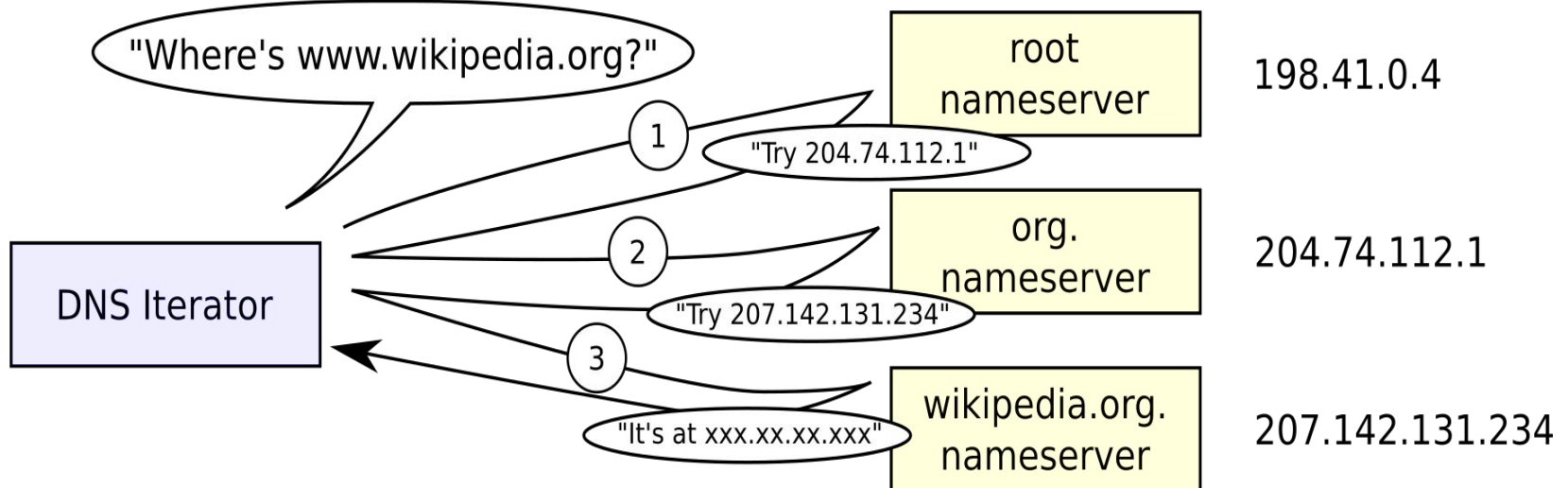
Works through a hierarchical structure.

# 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.

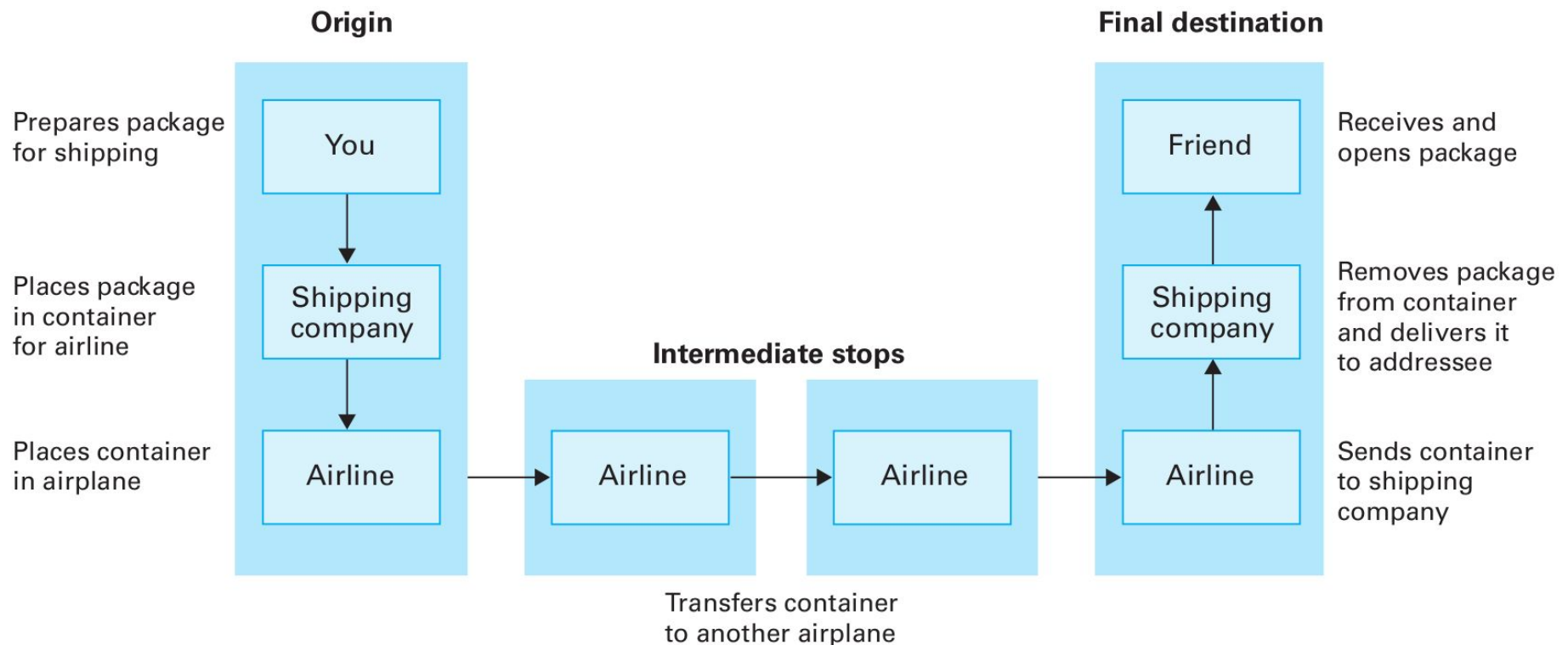
Ensures efficient and distributed translation of domain names to IP addresses.



# Internet Protocols

A principal task of networking software is

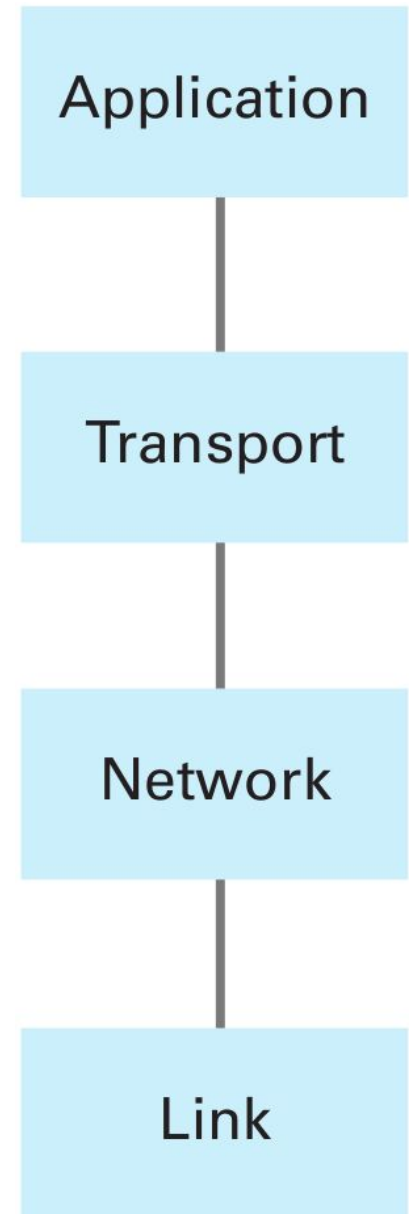
- To provide the infrastructure required for transferring messages from one machine to another.



# 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.



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

Prepares message and provides destination address

Application

Chops message into packets

Transport

Assigns intermediate address to each packet

Network

Transfers packet

Link

Network

Link

Network

Link

Application

Receives message

Transport

Collects packets and reassembles message

Network

Detects that packet has reached its final destination

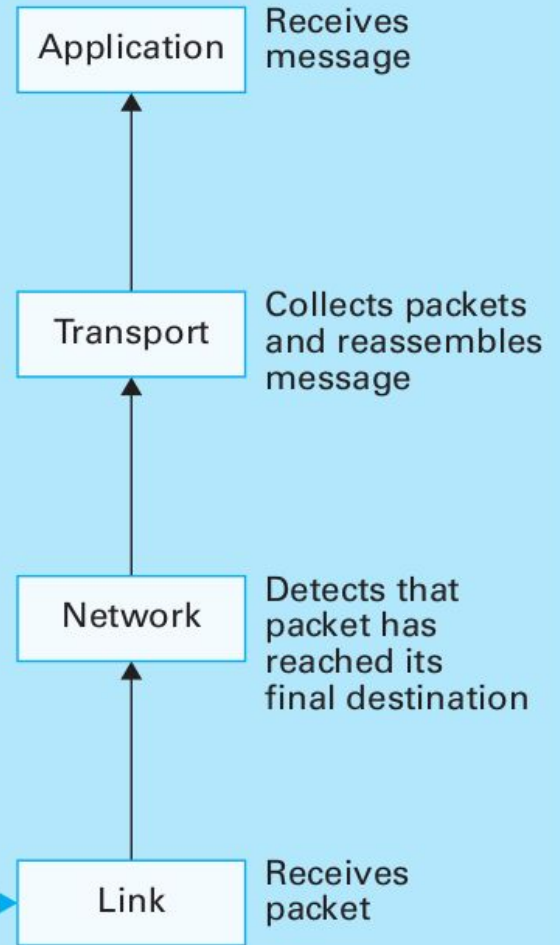
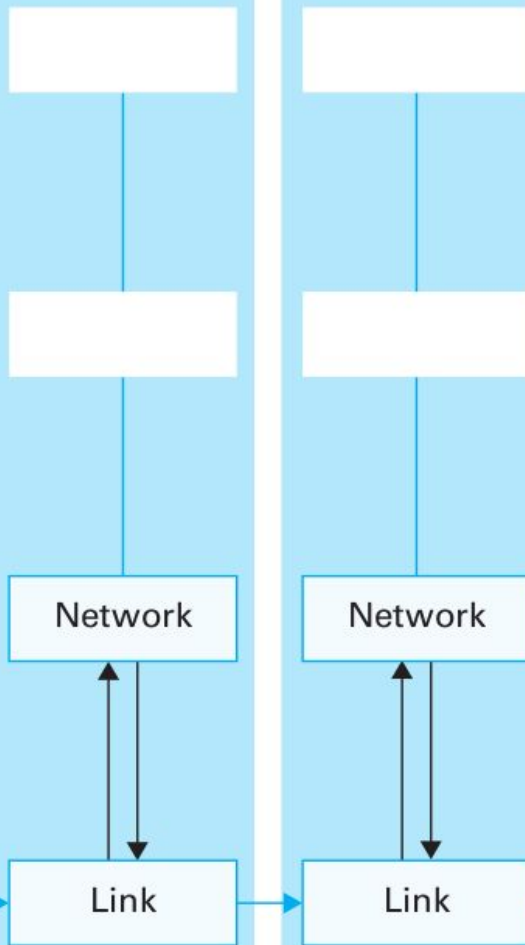
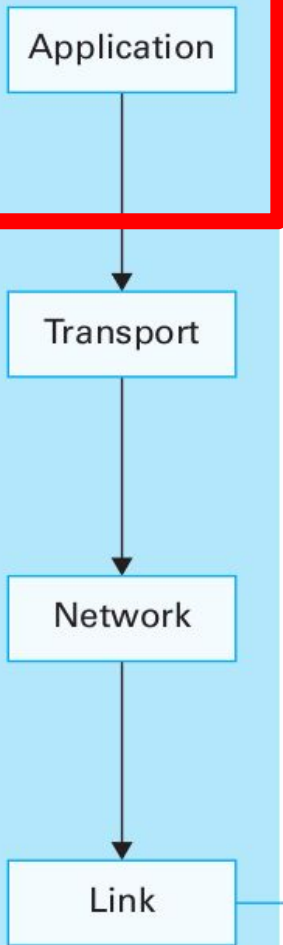
Link

Receives packet

Origin

Intermediate stops

Final destination



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

Prepares  
message  
and provides  
destination  
address

Application

Chops message  
into packets

Transport

Assigns  
intermediate  
address to  
each packet

Network

Transfers  
packet

Link

Origin

Network

Link

Intermediate  
stops

Network

Link

Application

Receives  
message

Transport

Collects packets  
and reassembles  
message

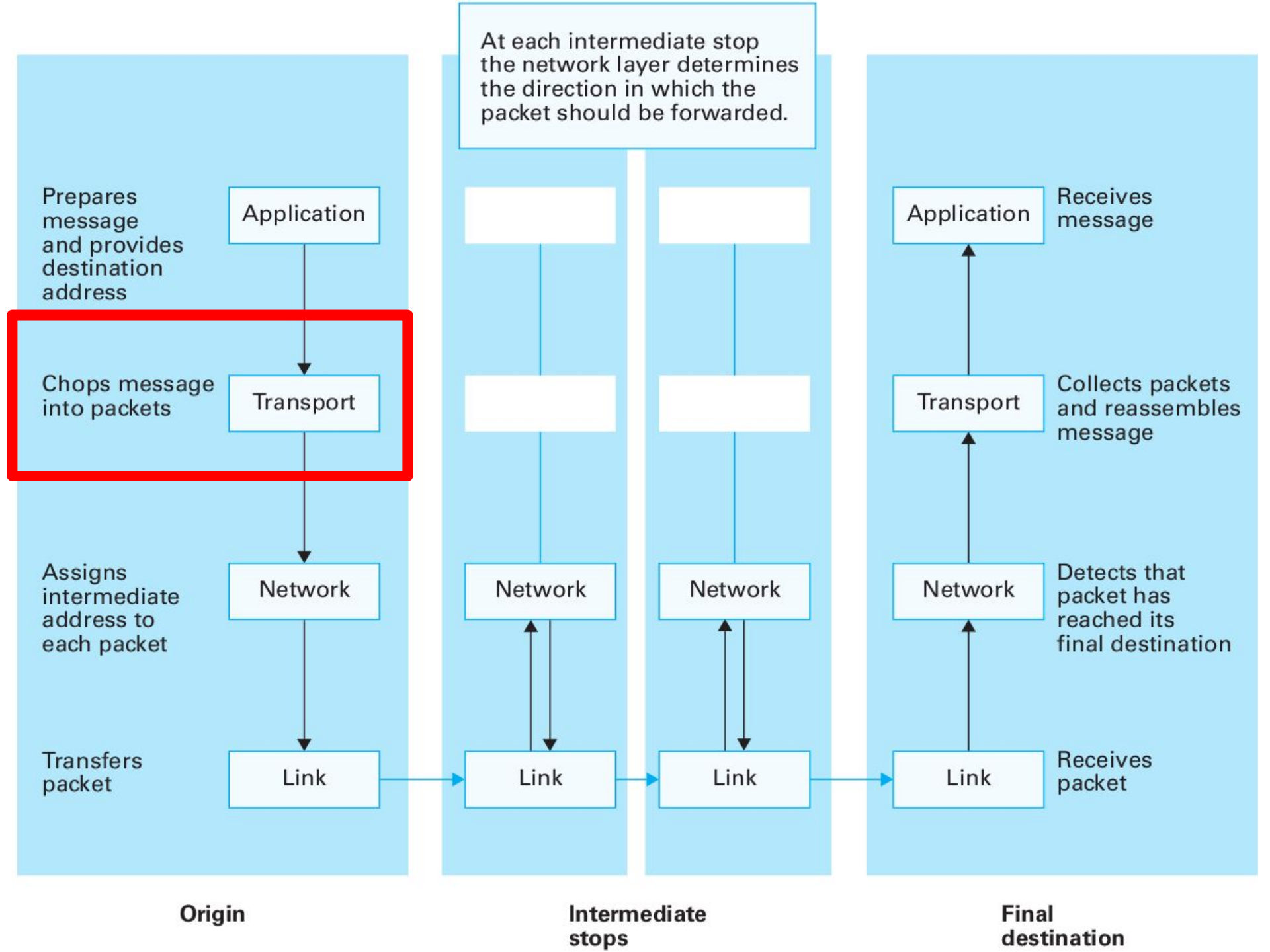
Network

Detects that  
packet has  
reached its  
final destination

Link

Receives  
packet

Final  
destination



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

Prepares  
message  
and provides  
destination  
address

Application

Chops message  
into packets

Transport

Assigns  
intermediate  
address to  
each packet

Network

Transfers  
packet

Link

Origin

Network

Link

Intermediate  
stops

Network

Link

Final  
destination

Application

Receives  
message

Transport

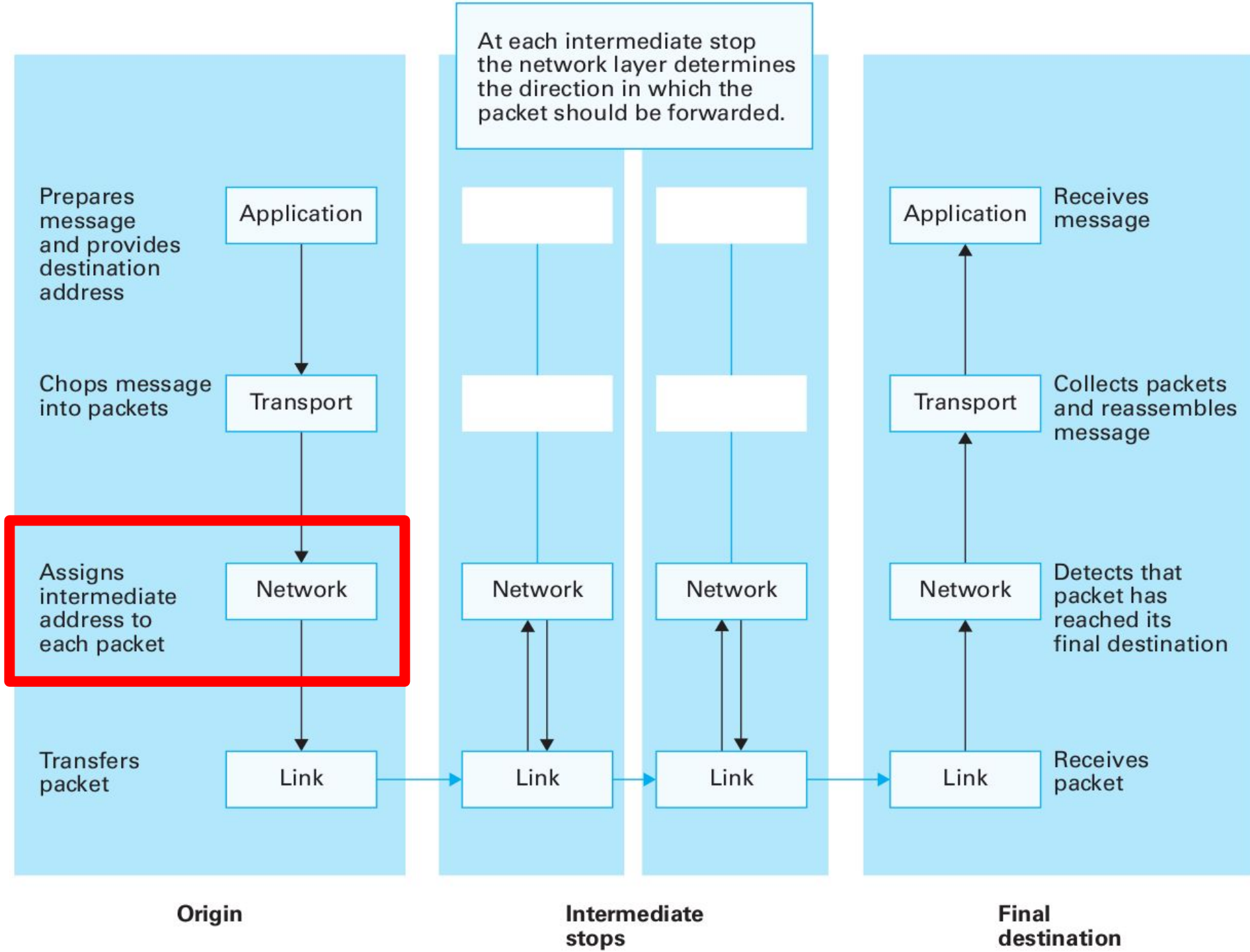
Collects packets  
and reassembles  
message

Network

Detects that  
packet has  
reached its  
final destination

Link

Receives  
packet



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

Prepares  
message  
and provides  
destination  
address

Application

Chops message  
into packets

Transport

Assigns  
intermediate  
address to  
each packet

Network

Transfers  
packet

Link

Origin

Network

Link

Intermediate  
stops

Network

Link

Application

Receives  
message

Transport

Collects packets  
and reassembles  
message

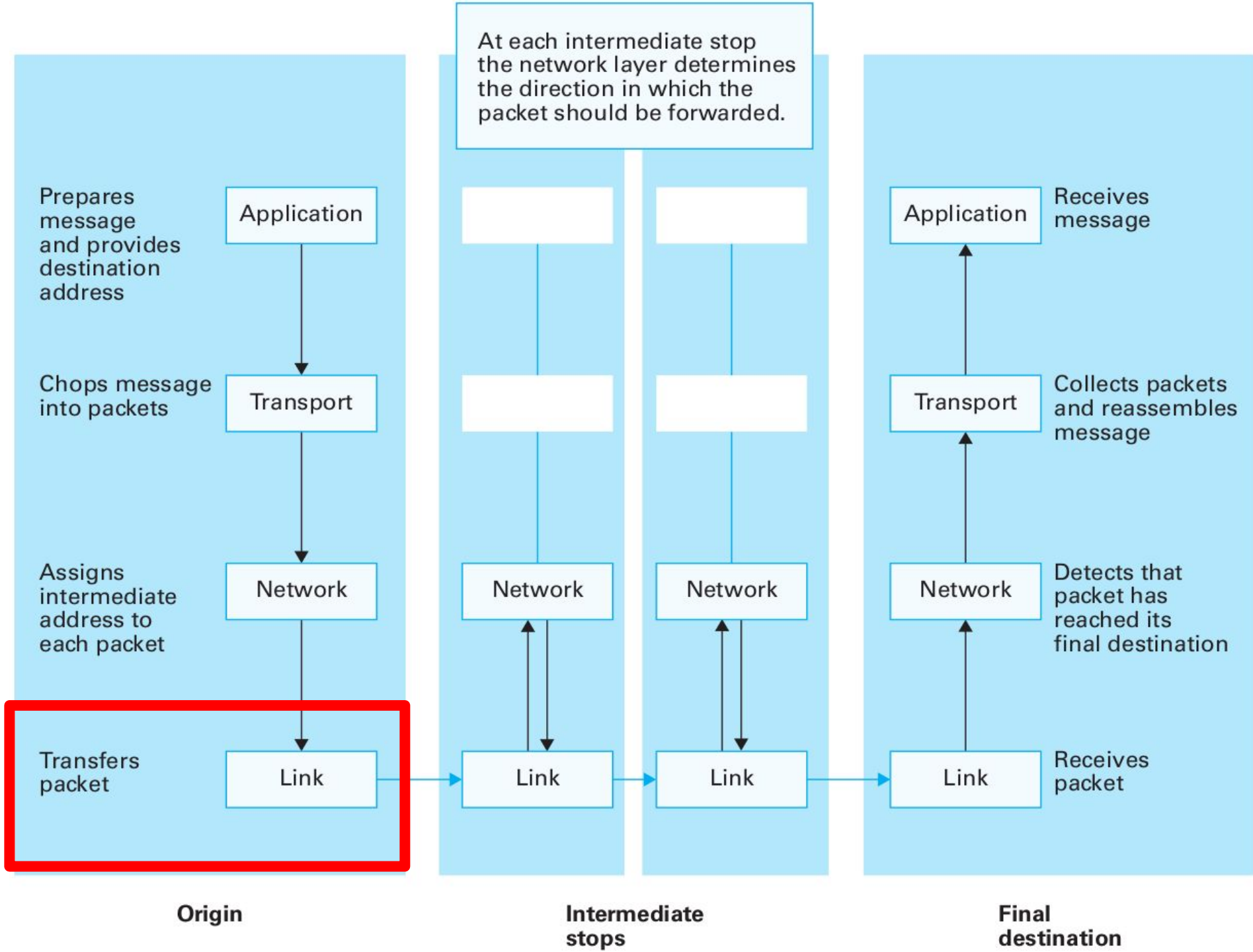
Network

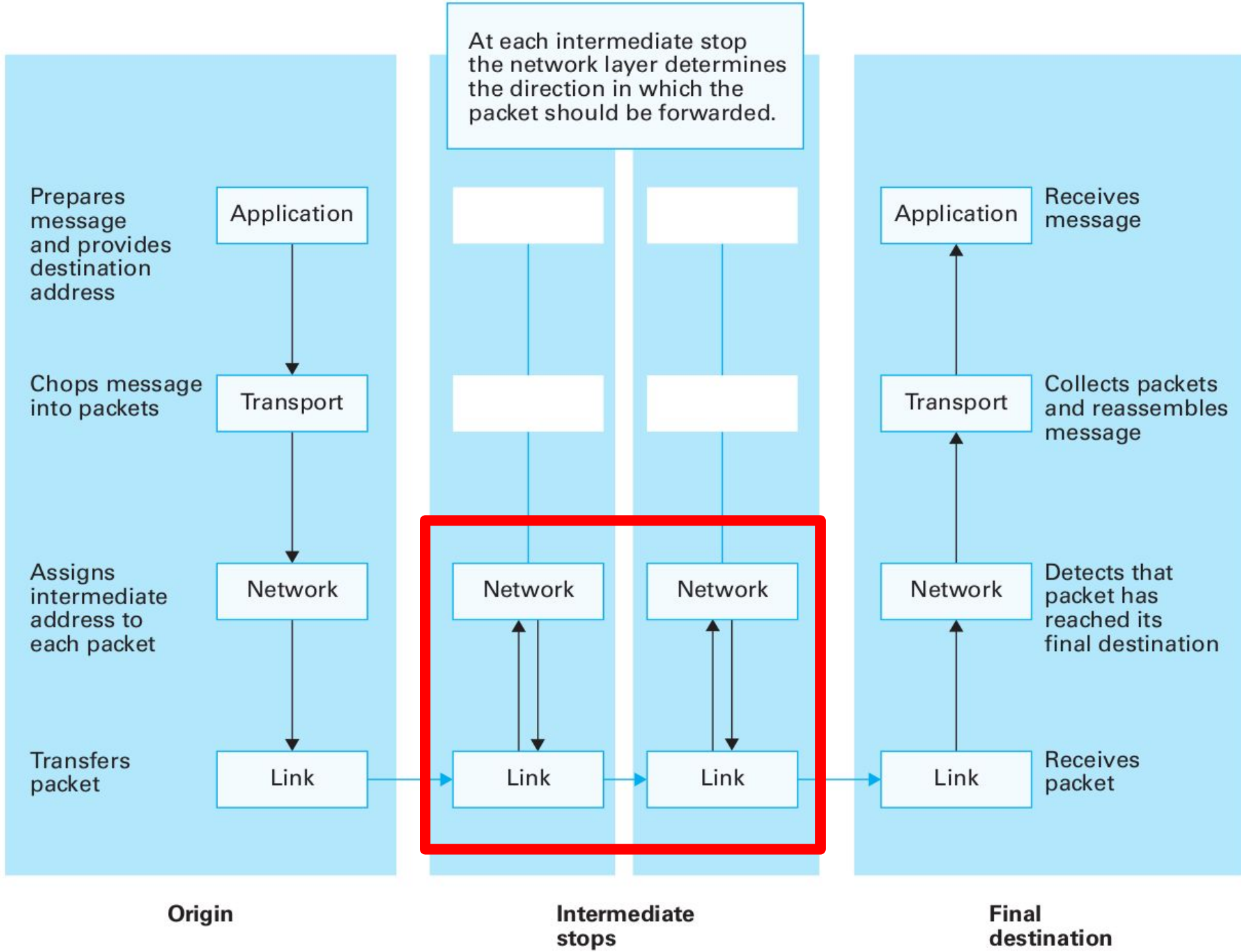
Detects that  
packet has  
reached its  
final destination

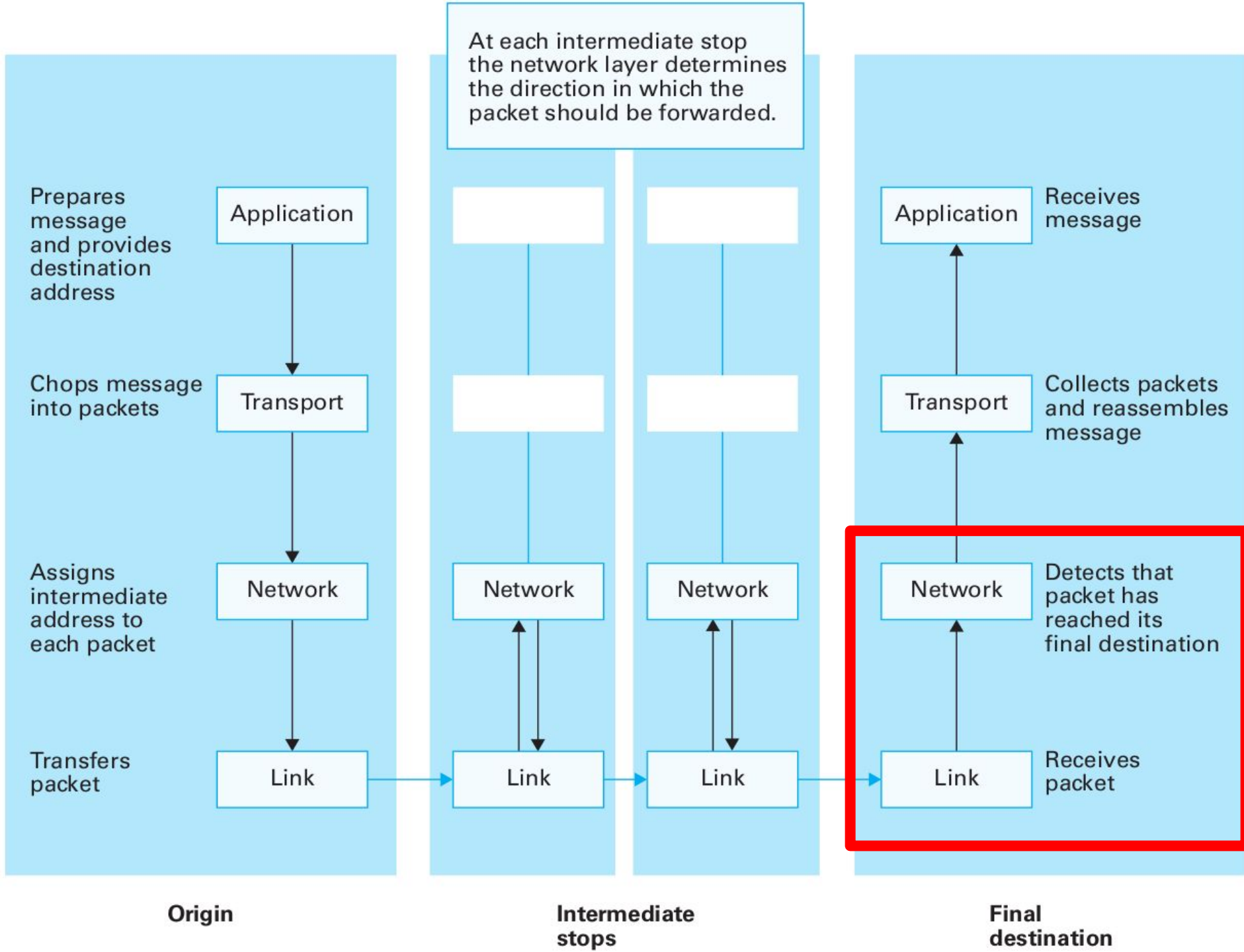
Link

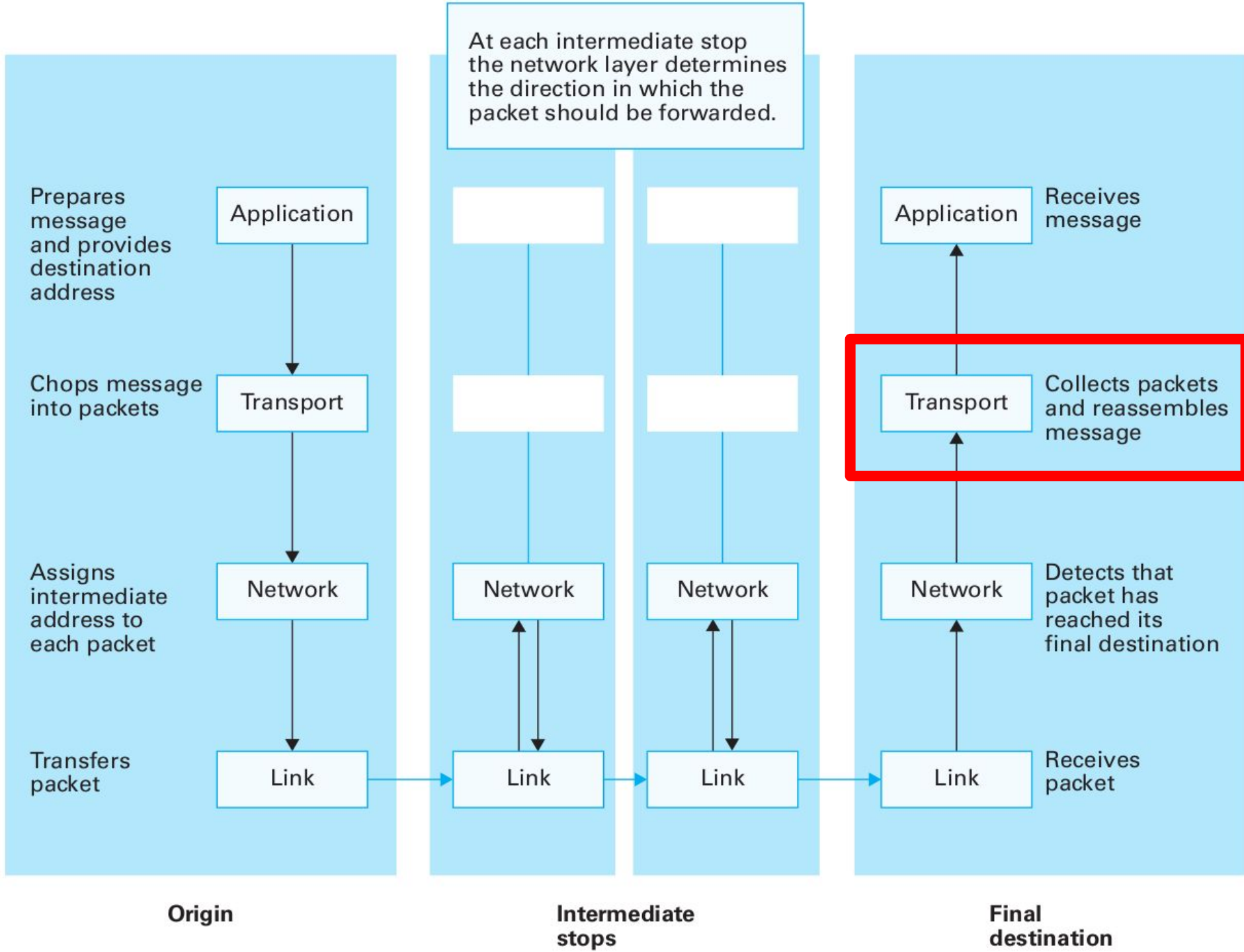
Receives  
packet

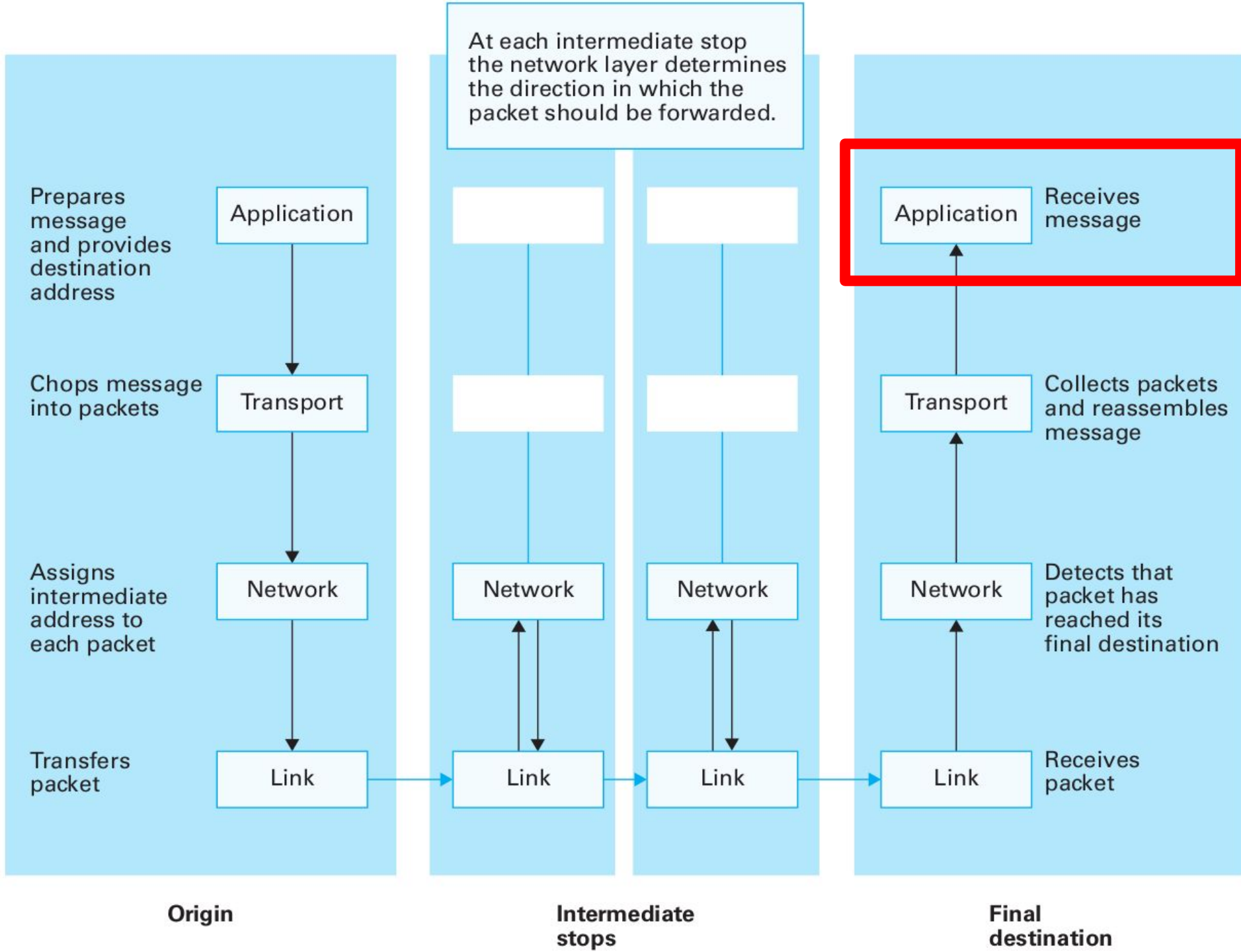
Final  
destination











# 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.

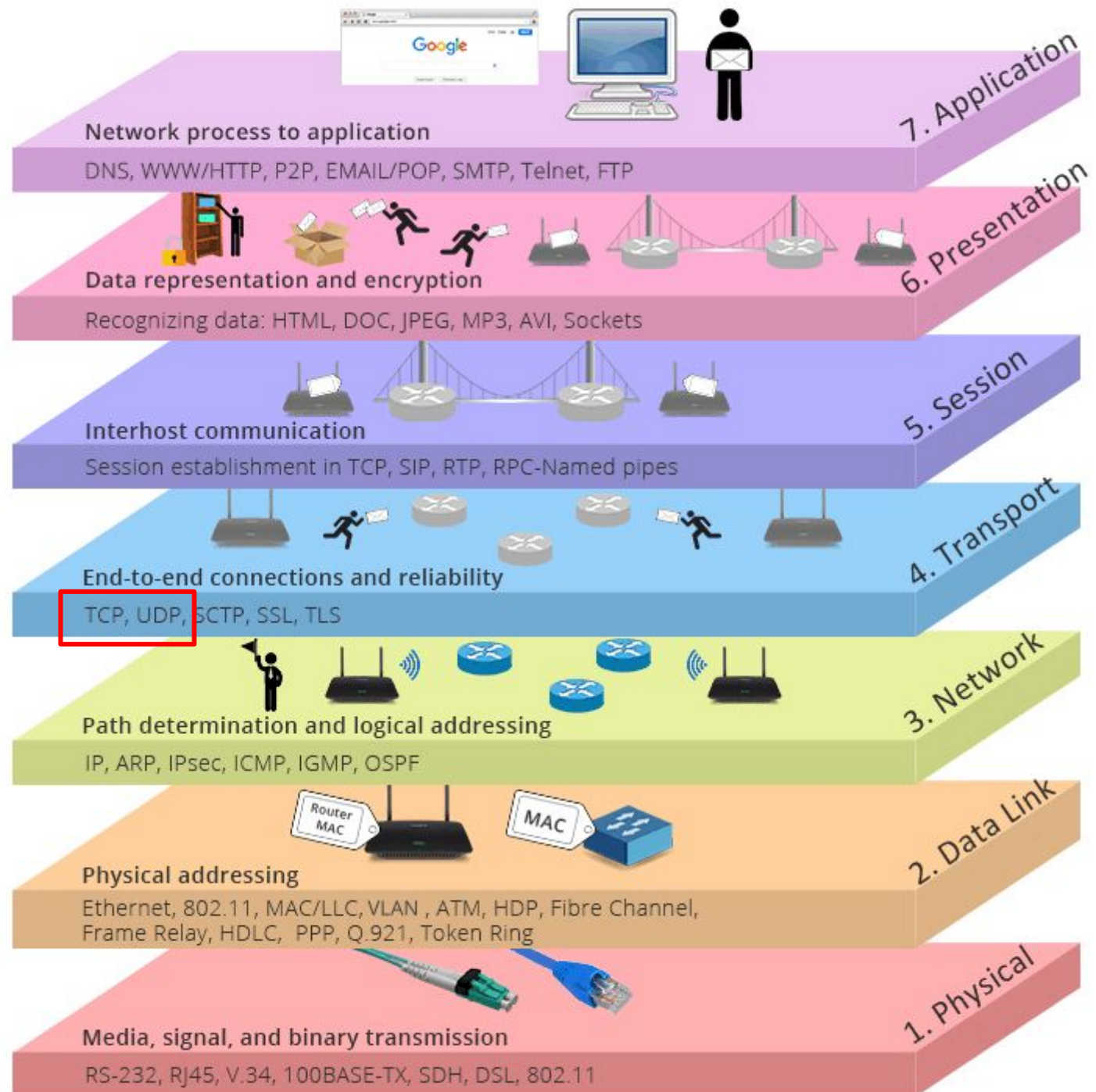
# The TCP/IP Protocol Suite

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



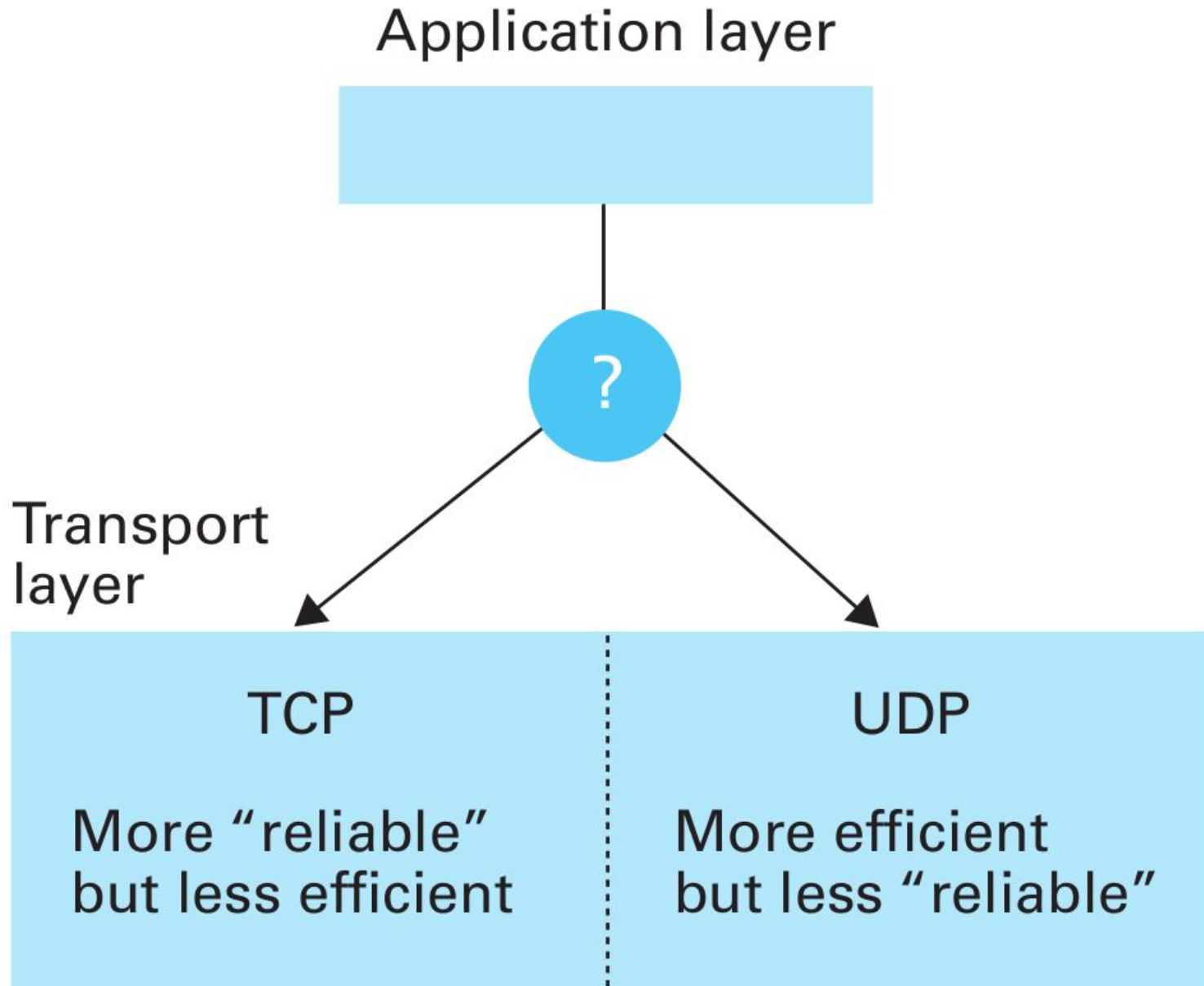
# The TCP/IP Protocol Suite

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.

# The TCP/IP Protocol Suite



# 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/1i1tU3AdlvPgRxqzGmXrsnVVCRXws5V3caDTCPMbPJ\\_0/edit?usp=sharing](https://docs.google.com/document/d/1i1tU3AdlvPgRxqzGmXrsnVVCRXws5V3caDTCPMbPJ_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

# COM1013

# INTRODUCTION TO COMPUTER SCIENCE

Lecturer: Begüm MUTLU BİLGE, PhD

[begummutlubilge+com1013@gmail.com](mailto:begummutlubilge+com1013@gmail.com) (recommended)  
[bmbilge@ankara.edu.tr](mailto:bmbilge@ankara.edu.tr)