Computer Networks

Network Layer
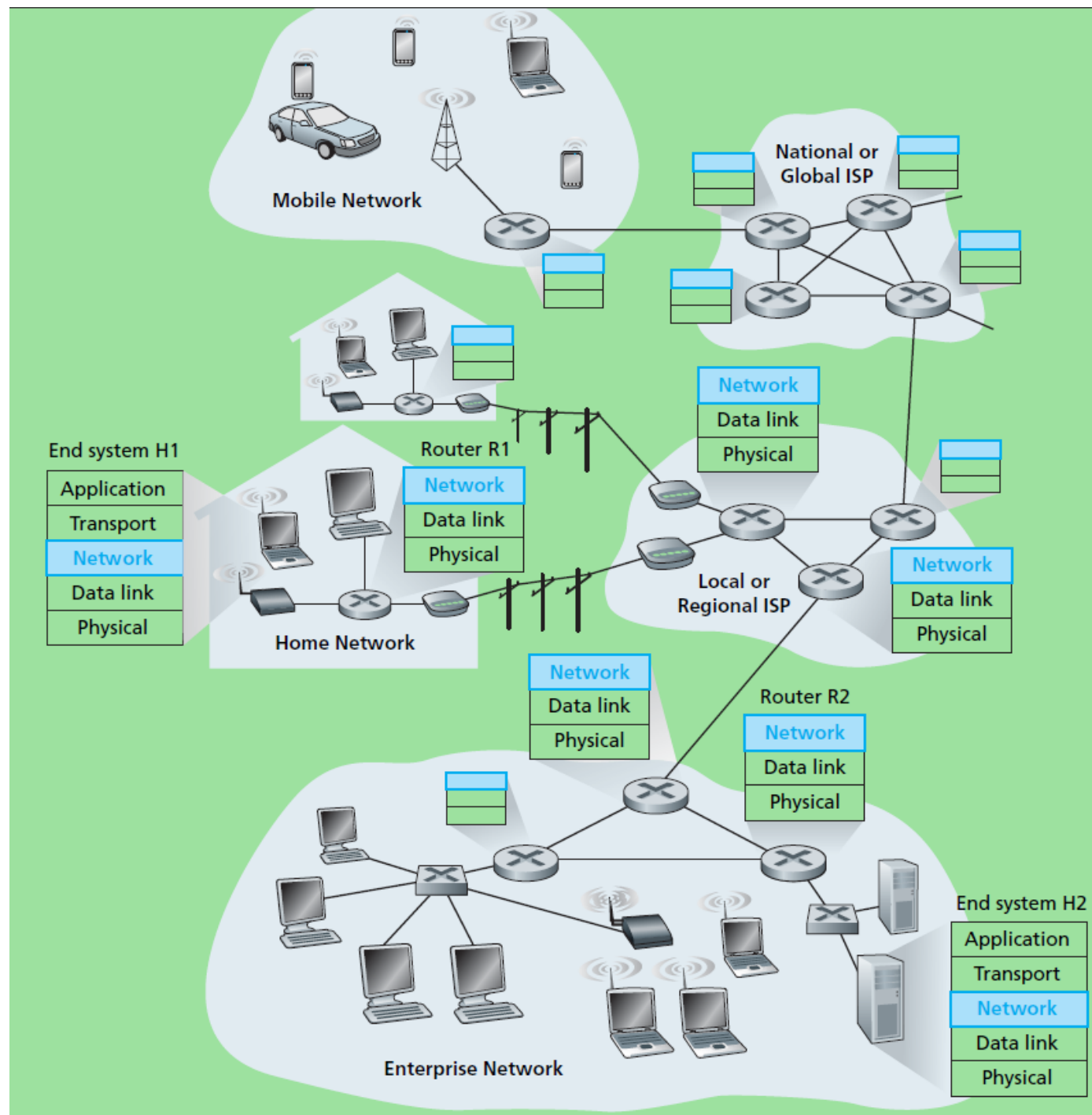
جامعة الانبار

قسم الهندسة الكهربائية

مادة شبكات الحاسوب – 2021

م.م. براء سعيد العبيدي

Network layer

- The network layer implements the host-to-host physical communication service. It is responsible for the actual communication between the sender and the receiver.

- The network layer implements forwarding and routing.
  - Forwarding: the router-local action of transferring a packet from an input link interface to the appropriate output link interface.
  - Routing: refers to the network-wide process that determines the end-to-end paths that packets take from source to destination.

- The main device in this layer is the router.

- Every router has a forwarding table.

- Routing algorithms determine values in forwarding tables.

- The main protocol in this layer is the IP (Internet Protocol).

Mobile Network

National or Global ISP

Network
Data link
Physical

End system H1

Application
Transport
Network
Data link
Physical

Router R1

Network
Data link
Physical

Home Network

Network
Data link
Physical

Local or Regional ISP

Network
Data link
Physical

Router R2

Network
Data link
Physical

Enterprise Network

End system H2

Application
Transport
Network
Data link
Physical

IP Address

- IP address is 32 bits.

- **dotted-decimal notation**: each byte of the address is written in its decimal form and is separated by a period (dot) from other bytes in the address. For example:

  11000001 00100000 11011000 00001001   ➜   193.32.216.9

- **Subnet mask:**

- The first 24 bits of the 32-bit quantity define the subnet address

  223.19.2.X   223.19.2.0/24

Ex.:

  00000000.00000000.00000000.X   ==> 0.0.0.0

  11111111.11111111.11111111.X   ==> 255.255.255.255

maximum number of subnets = 2 to power 24 = 16,777,216

maximum number of hosts = 2 to power 8 =   256

IP Address

- The first 16 bits of the 32-bit quantity define the subnet address

    244.123.100.0/16

    223.19.X.X

Ex.:

       00000000.00000000.X.X ==> 0.0.X.X

       11111111.11111111.X.X ==> 255.255.X.X

maximum number of subnets = 65,536 subnets

maximum number of hosts = 65,536 hosts

IP Address

- The first 8 bits of the 32-bit quantity define the subnet address

223.X.X.X   223.19.2.0/8

Ex.:

      00000000.X.X.X ==> 0.X.X.X

      11111111.X.X.X ==> 255.X.X.X

maximum number of subnets = 2 to power 8 = 256

maximum number of hosts= 2 to power 24 =   16,777,216

Example

Q1: Design a network that can provide **65,563** IP addresses, i.e. the network can host up to 59000 hosts) given that you need only **255 subnets**. Divide the IP address accordingly.

A1:

The IP address should be divided as follows:

8 bits (1 bytes) for the subnet part, which gives us 256 subnets.

24 bits (3 bytes) for the hosts part, which gives us 16,777, 216 hosts.

For the subnets: for the hosts:

00000000.X.X.X   X.00000000.00000000.00000000 ➜ 0.0.0.0

       through   through

11111111.X.X.X   X.11111111.11111111.11111111 ➜ 255.255.255.255
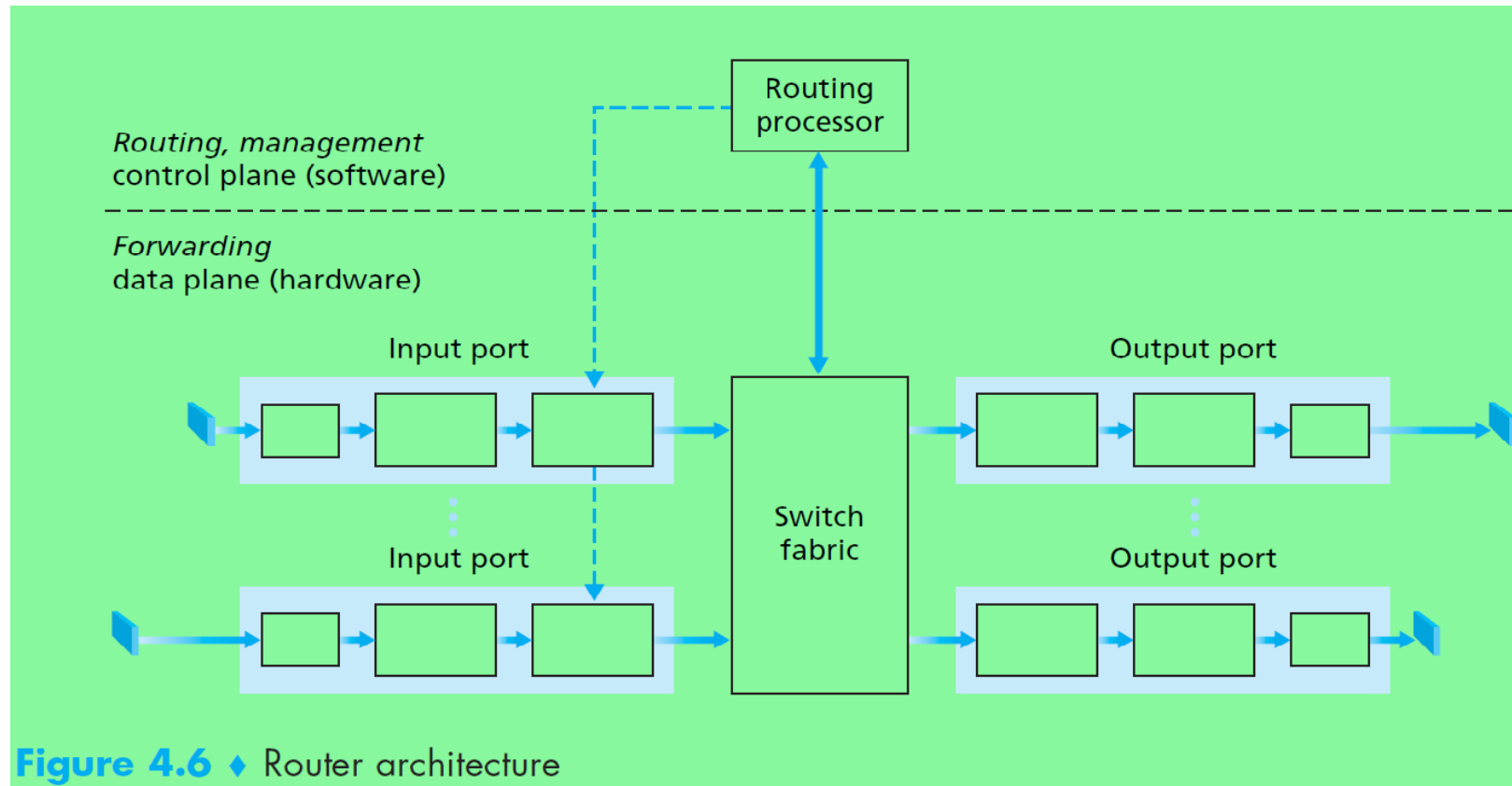
An Example of a Forwarding Table

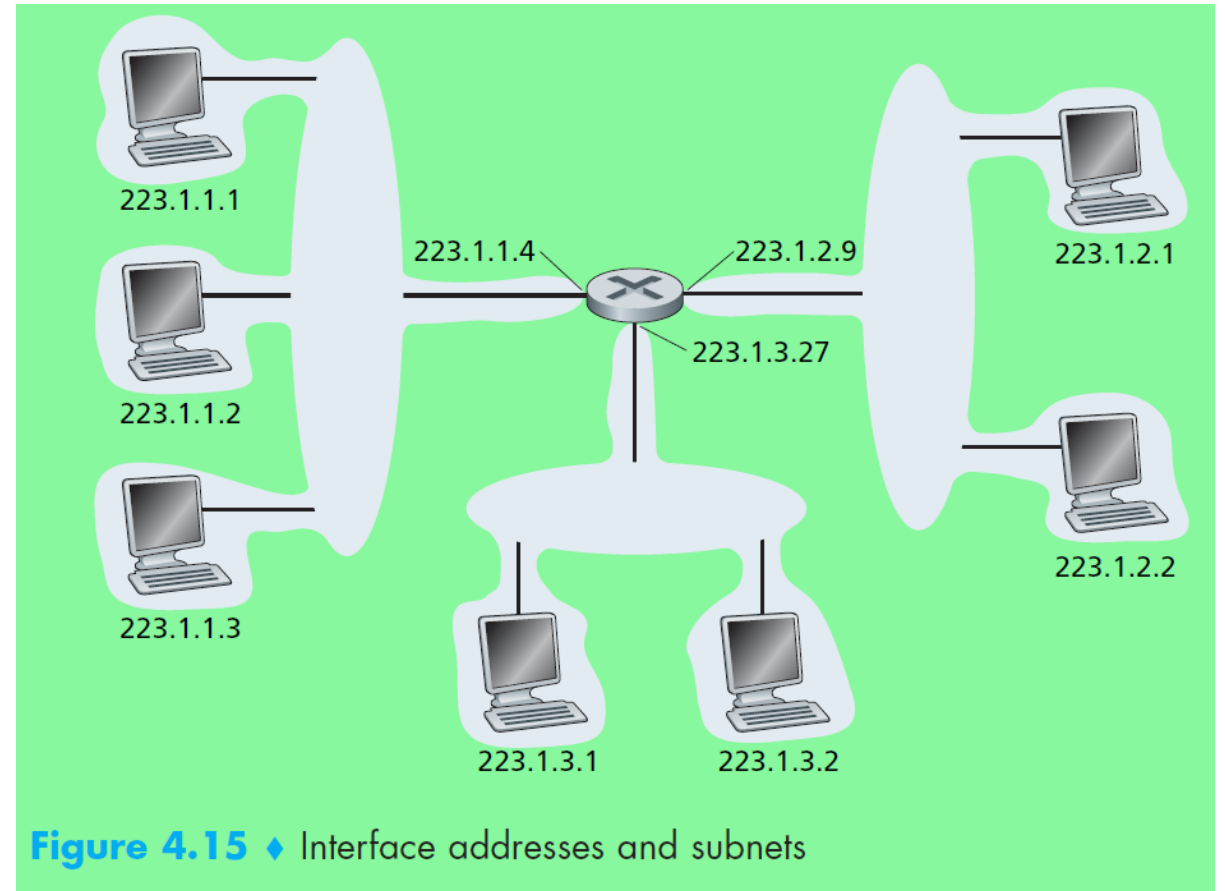| Destination Address Range	Link Interface
11001000 00010111 00010000 00000000 through 11001000 00010111 00010111 11111111	0
11001000 00010111 00011000 00000000 through 11001000 00010111 00011000 11111111	1
11001000 00010111 00011001 00000000 through 11001000 00010111 00011111 11111111	2
otherwise	3

Router Architecture

A high-level view of a generic router architecture is shown in Figure 4.6. Four router components can be identified:

- *Input ports:* An input port performs several key functions. It performs the physical layer function of terminating an incoming physical link at a router; An input port also performs link-layer functions needed to interoperate with the link layer at the other side of the incoming link. The lookup function is also performed at the input port.

- *Switching fabric:* The switching fabric connects the router's input ports to its output ports.

- *Output ports:* An output port stores packets received from the switching fabric and transmits these packets on the outgoing link by performing the necessary link-layer and physical-layer functions.

Router Architecture

Figure 4.6 ♦ Router architecture

Three subnets connected by one router

Figure 4.15 ♦ Interface addresses and subnets

How forwarding is done?

Figure 4.2 ♦ Routing algorithms determine values in forwarding tables