COMPUTER COMMUNICATION NETWORKS

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NETWORK LAYER

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Internal organization of router and Functions of router

The primary role of the **network layer** is to **move packets** from a **sending host to a receiving host**.
The two important network-layer functions are

- **Forwarding**: Forwarding refers to the **router-local action** of transferring a packet from an input link interface to the appropriate output link interface. Forwarding takes place at very short timescales (typically a few nanoseconds), and is typically **implemented in hardware**.
- **Routing**: Routing refers to the **network-wide process** that determines the end-to-end paths that packets take from source to destination. Routing takes place on much longer timescales (typically seconds), and is often **implemented in software**.

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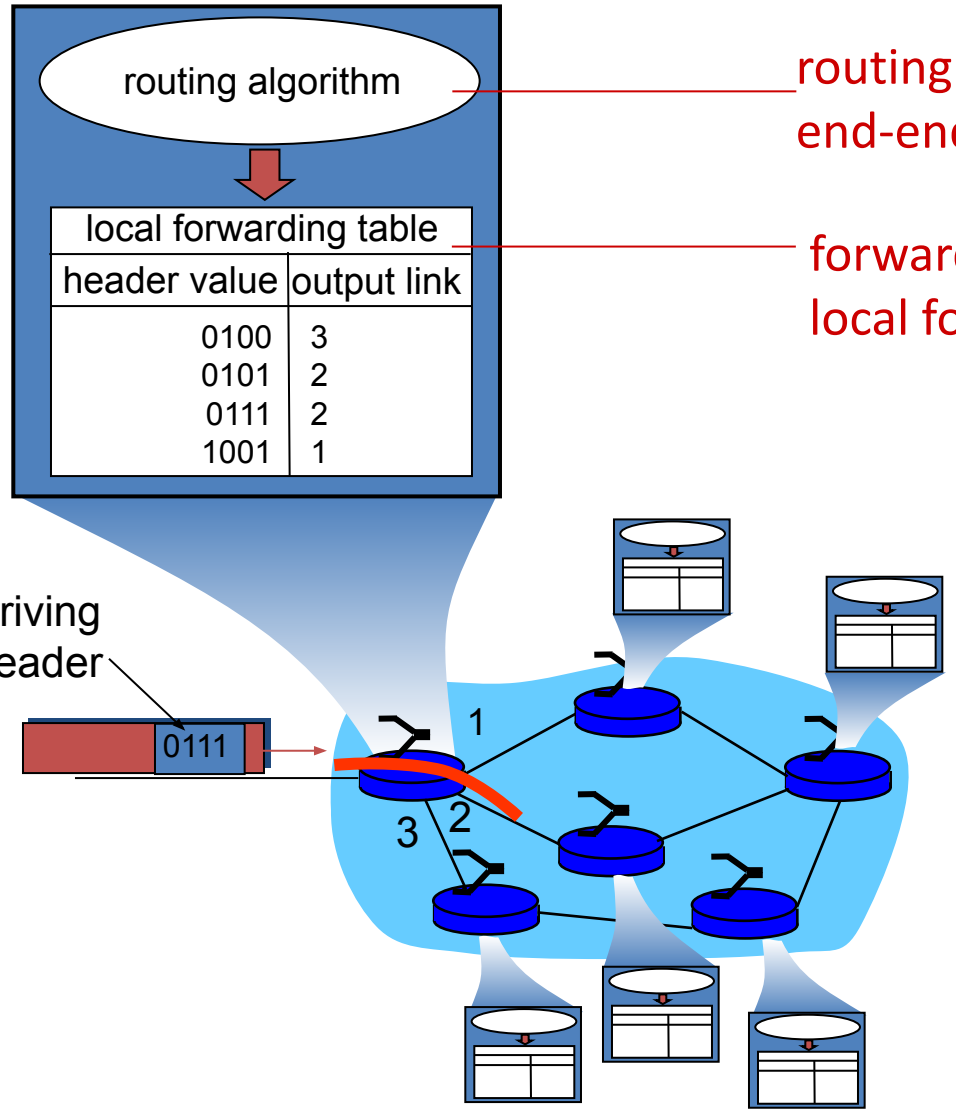

routing algorithm determines end-end-path through network

forwarding table determines local forwarding at this router

Interplay between routing and forwarding

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- Some packet switches, called **link-layer switches** transfers/forwards a packet from input link interface to output link interface according to values in a packet's header fields of the link-layer frame. So link-layer switches are referred to as **link-layer (layer 2) devices.**

- Other packet switches, called **routers**, base their forwarding decision on header field values in the network-layer datagram. Routers are thus **network-layer (layer 3) devices**.

The **network service model** defines the characteristics of end-to-end delivery of packets between sending and receiving hosts.

Services offered by Network Layer

- Guaranteed delivery: This service guarantees that a packet sent by a source host will eventually arrive at the destination host.
- Guaranteed delivery with bounded delay: This service not only guarantees delivery of the packet, but delivery within a specified host-to-host delay bound (for example, within 100 msec).
- In-order packet delivery: This service guarantees that packets arrive at the destination in the order that they were sent.

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- Guaranteed minimal bandwidth: This network-layer service emulates the behavior of a transmission link of a specified bit rate (for example, 1 Mbps) between sending and receiving hosts. As long as the sending host transmits bits (as part of packets) at a rate below the specified bit rate, then all packets are eventually delivered to the destination host.

- Security: The network layer could encrypt all datagrams at the source and decrypt them at the destination, thereby providing confidentiality to all transport-layer segments.

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Architecture of Router:

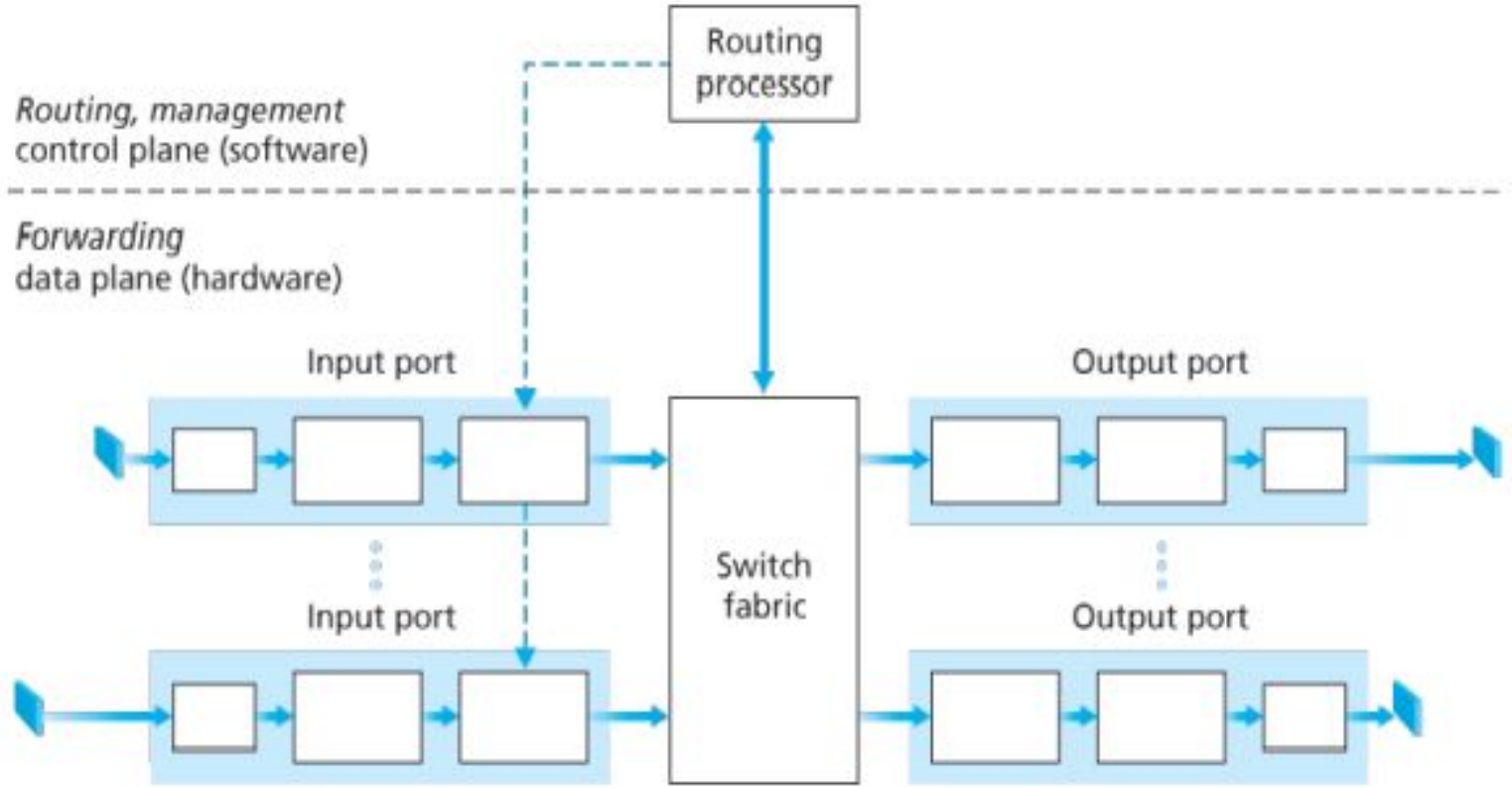

Figure 4.4 Router architecture

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- **Input ports:** An input port performs several key functions. It performs link layer decapsulation and "prefix matching" using destination IP contained in the packet. The prefix matching helps identify the output port

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

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- **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.

- **Routing processor**: The routing processor is responsible for computing the forwarding table and implementation of routing protocols.

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Input Port Processing:

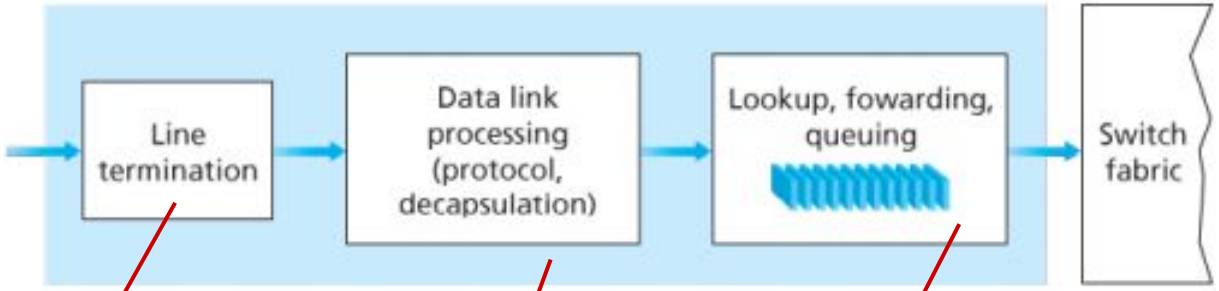

Figure 4.5 Input port processing

physical layer:
bit-level reception

data link layer:
e.g., Ethernet

decentralized switching:
Prefix matching

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Prefix Matching Example:

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

Datagram Forwarding Table

Prefix Matching Example (Contd):

When looking for forwarding table entry for given destination address, use *longest* address prefix that matches destination address.

Destination Address Range	Link interface
11001000 00010111 00010*** *********	0
11001000 00010111 00011000 *********	1
11001000 00010111 00011*** *********	2
otherwise	3

examples:

DA: 11001000 00010111 00010110 10100001 which interface?

DA: 11001000 00010111 00011000 10101010 which interface?

Numerical 1:

Consider a datagram network using 8-bit host addresses. Suppose a router uses longest-prefix matching, and has the following forwarding table:

Prefix Match	Interface
00	1
11	2
000	3
110	4
010	5
otherwise	6

1.Suppose a datagram arrives at the router, with destination address 11010111. To which interface will this datagram be forwarded using longest-prefix matching?

2. Suppose a datagram arrives at the router, with destination address 00111101. To which interface will this datagram be forwarded using longest-prefix matching?

3. Suppose a datagram arrives at the router, with destination address 00010101. To which interface will this datagram be forwarded using longest-prefix matching?

Solution:

1. Since the address is 11010111, it will go to interface 4.

2. Since the address is 00111101, it will go to interface 1.

3. Since the address is 00010101, it will go to interface 3.

Prefix Match	Interface
00	1
11	2
000	3
110	4
010	5
otherwise	6

THANK YOU

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