Distributed and Parallel Computer Systems

CSC 423

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Lecture 6

Principles of Networking

INSTRUCTOR

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➢ Contents

➢ Principles of Networking

1. Mode of transmission
2. Switching schemes
3. Protocol suites
4. Routing
5. Congestion control

❑ 1-Mode of transmission

- Packets
  - messages divided into packets
  - packets queued in buffers before sent onto link
  - The simplest form of packet is a sequence of binary data (an array of bits or bytes) of restricted length, together with addressing information sufficient to identify the source and destination computers.
- Data streaming
  - links guarantee QoS (rate of delivery)
  - for multimedia traffic
  - higher bandwidth

❑ 2-Switching schemes

- A network consists of a set of nodes connected together by circuits.
  - Broadcasts : Broadcasting is a transmission technique that involves no switching
    - send messages to all nodes
    - nodes listen for own messages (carrier sensing)
  - Circuit switching (phone networks): At one time telephone networks were the only telecommunication networks.
  - Packet switching (TCP/IP): data packets in a computer network can be stored and processed at the nodes fast enough to give the illusion of instantaneous transmission.
    - store-and-forward → packets that arrive at a node are first stored at the node and then forwarded toward their destinations.
    - unpredictable delays

❑ 2-Switching schemes

- Frame relay (another switching method) which brings some of the advantages of circuit switching to packet-switching networks.

- ATM networks are the result. They overcome the delay problems by switching small packets (called frames) on the fly.

- Frames as a whole are not stored at nodes but pass through them as short streams of bits.

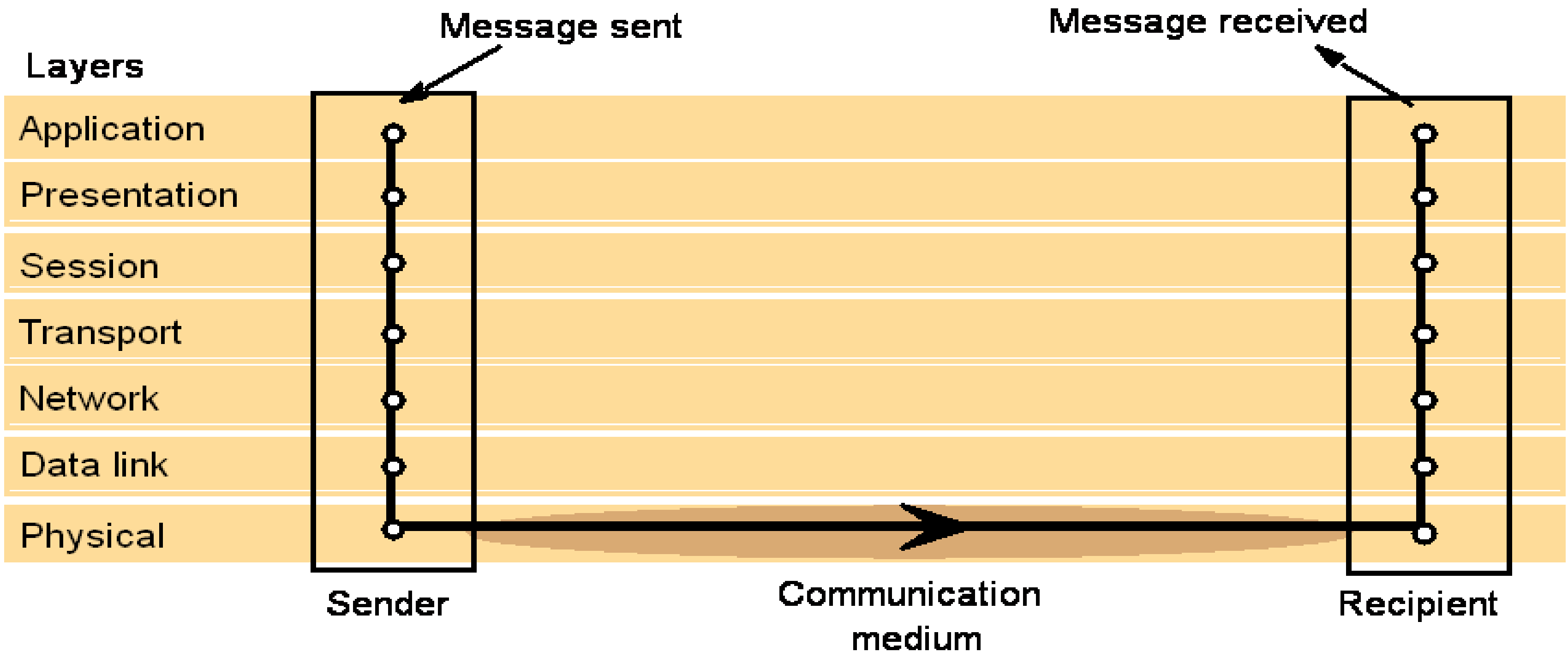
❑ 3-Protocols

- Protocol is used to refer to a well-known set of rules and formats to the user for communication between processes in order to perform a given task.

- A protocol is implemented by a pair of software modules located in the sending and receiving computers.

❑ Protocol layers

- Network software is arranged in a hierarchy of layers. Each layer presents an interface to the layers above it that extends the properties of the underlying communication system.



❑ Why such a Layering?

- Three main reasons
  - Conceptual Simplicity
  - Modularity of code (facilitates writing software for each layer independent of other layers)
  - Packet processing well organized

- The OSI (Open Systems Interconnection)
  - a protocol stack that conforms to the seven-layer Reference Model adopted by ISO.

❑ OSI Model

- Each layer performs a well-defined function and provides a well-defined service to the next higher layer.

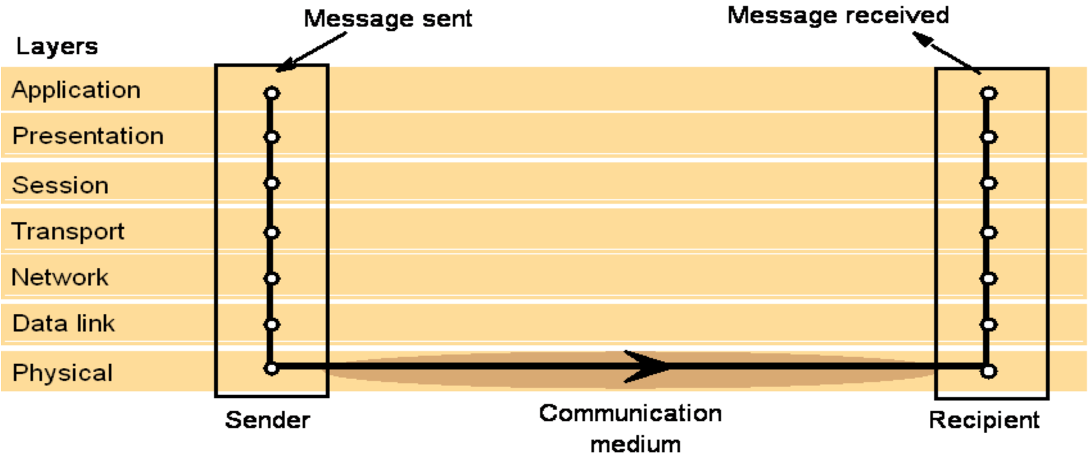
- The interface between layer n module and lower layer n-1 module at a node is precisely defined.

- A layer n module at one end communicates with its peer layer n module at the other end by passing a message into the layer n-1 module

❑ Physical Layer

- **Function:** Provides a physical link for transmitting a sequence of bits between any pair of connected nodes.

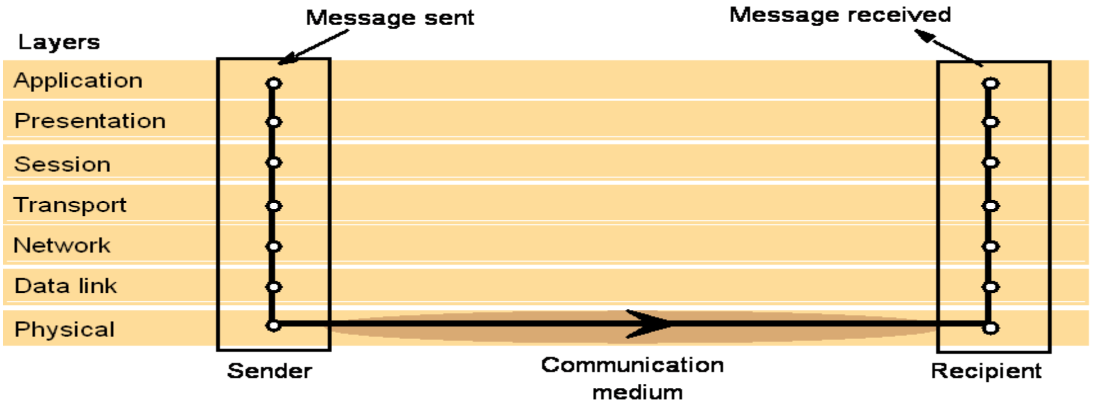
- Maps the incoming bits from the data link layer into signals appropriate for the channel, and at the receiving end, maps the signals back into bits.



❑ Data Link Layer

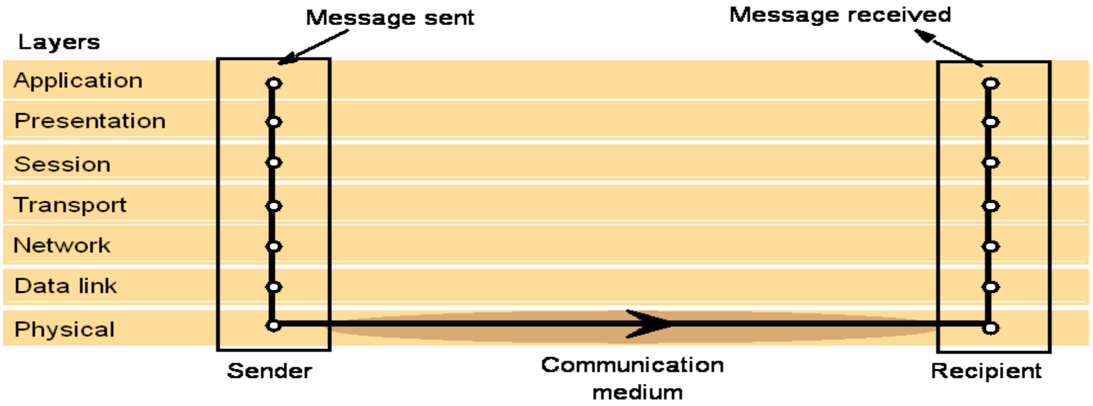
- ➢ The sending DL module places some control bits called header at the beginning of each packet and some more overhead bits called trailer at the end of each packet, resulting in a longer string of bits called a frame.

- ➢ Some of these overhead bits perform error detection/correction, and some request retransmissions when error occurs.



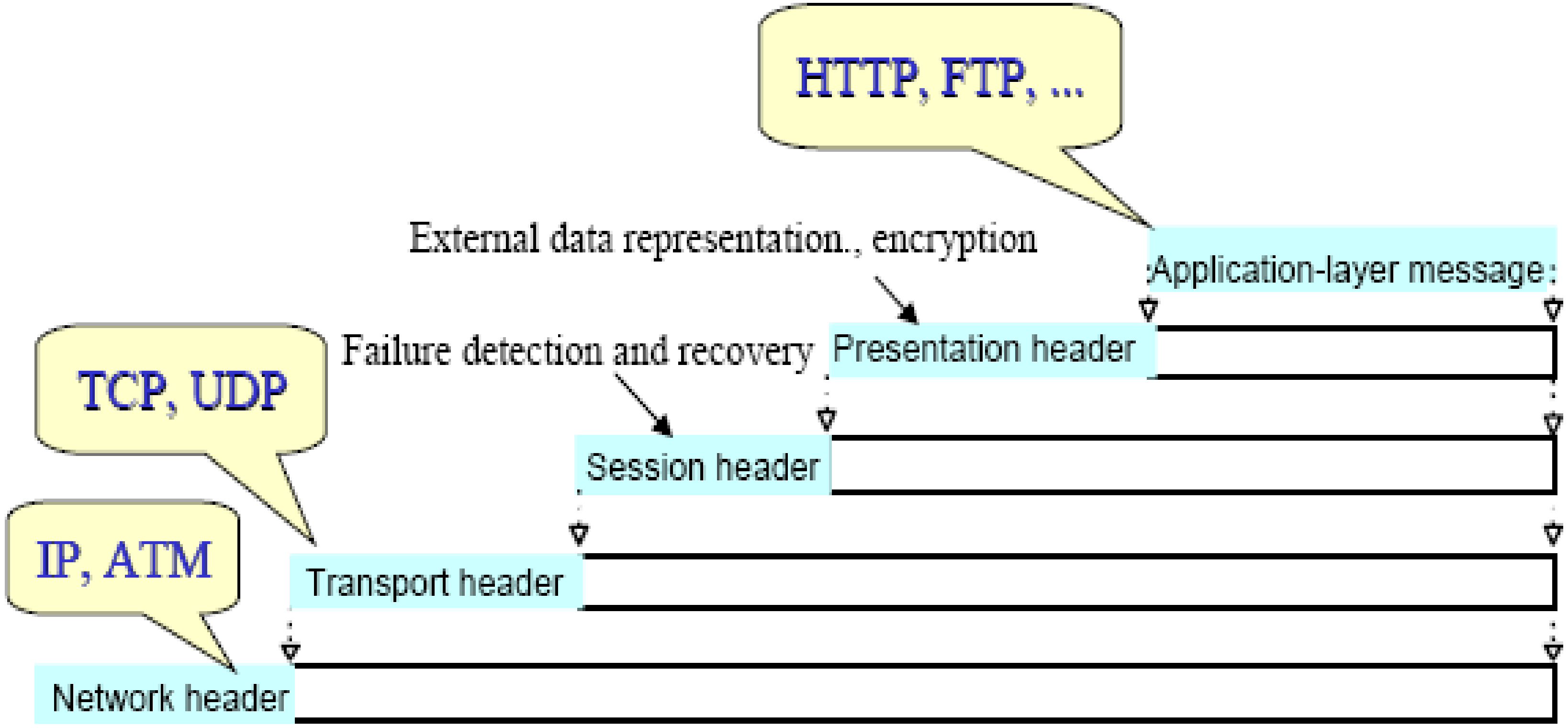
❑ Network Layer

- to transmit packet
  - Function 1: Addressing
  - Function 2: Routes packets from their sources through the network to their destinations
  - Function 3: Deals with different types of networks



❑ Network Layer

- The structure and the flow of data when a message is transmitted using top four layered protocol

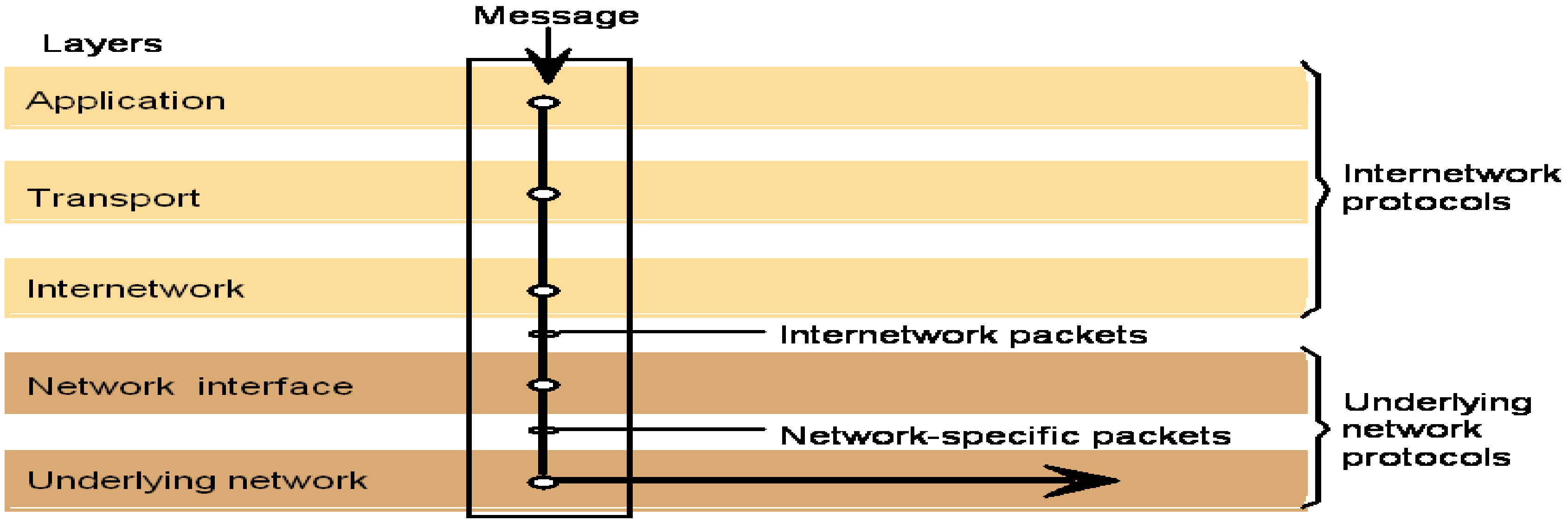

HTTP, FTP, ...
External data representation., encryption
Application-layer message
Presentation header
Failure detection and recovery
TCP, UDP
Session header
IP, ATM
Transport header
Network header

❑ Examples from protocols used on the Internet

Layer	Description	Example
Application	Protocols for specific applications	HTTP, FTP, SMTP
Presentation	Protocols for independent data representation and encryption if required.	Secure Sockets, COBRA CDR
Session	Protocols for failure detection and recovery.	
Transport	Message-level communication between ports attached to processes. Connection-oriented or connectionless.	TCP, UDP
Network	Packet-level transmission on a given network Requires routing in WANs and internet.	IP, ATM, ATM cell transfer
Data link	Packet-level transmission between nodes connected by a physical link.	Ethernet MAC, ATM cell transfer.

❑ Internetwork protocols

- ➢ Internetwork protocols are overlaid on underlying networks protocols.
- ➢ The network interface layer accepts internetwork packets and converts them into packets suitable for transmission by the network layers of each underlying network.



❑ Ports and Addressing

- The transport layer's task is to provide a network-independent message transport service between pairs of network ports.

- Ports are software-definable destination points for communication within a host computer.

- Addressing The transport layer is responsible for delivering messages to destinations with transport addresses that are composed of the network address of a host computer and a port number.

❑ 4-Routing

- Routing is a function that is required in all networks that provide direct connections between all pairs of attached hosts.

- The delivery of packets to their destinations is the responsibility of the routers located at connection points.

❑ Routing algorithm

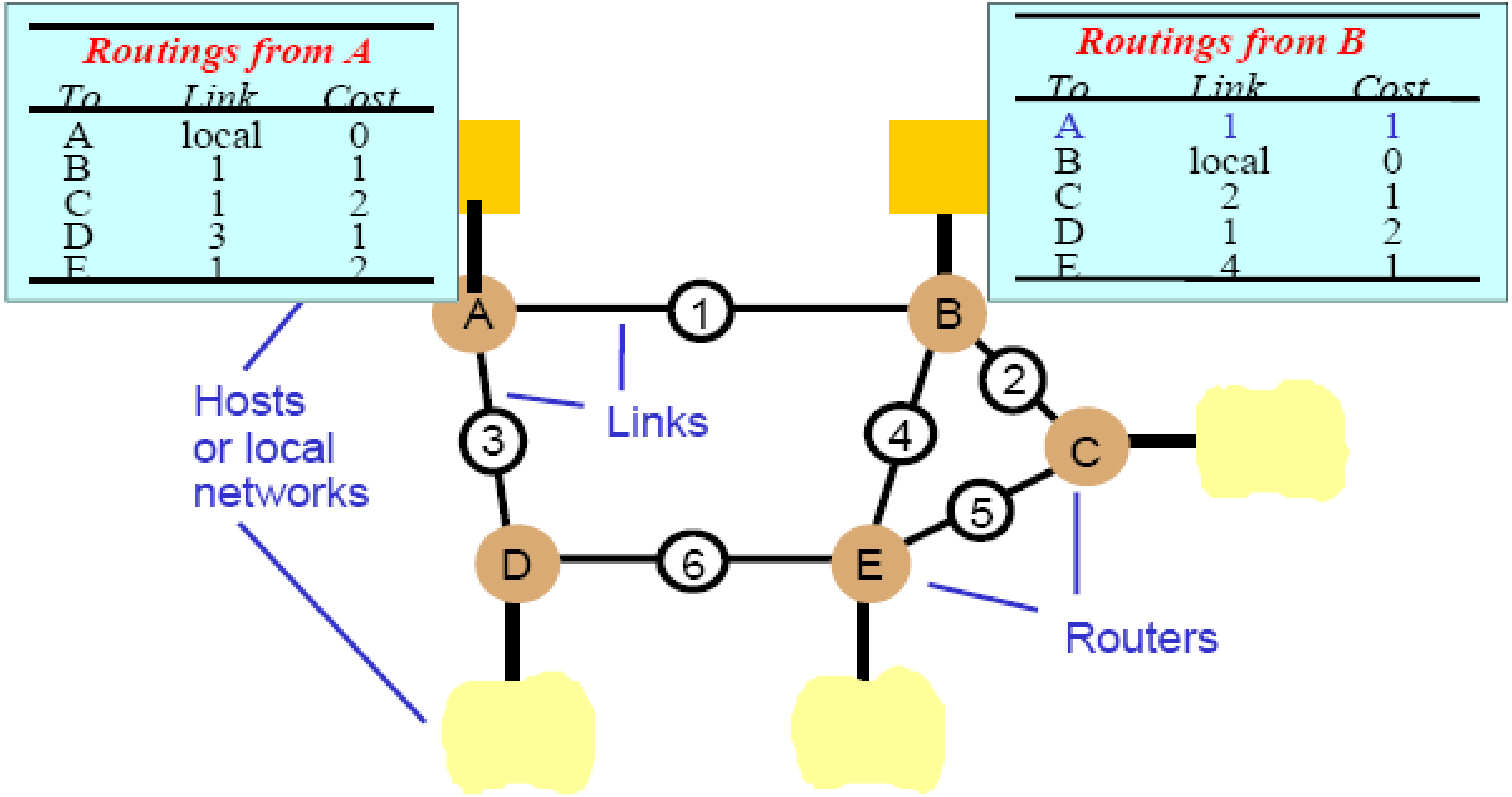
- The packet must be transmitted in a series of hops, passing through router nodes.

- The determination of routes for the transmission of packets to their destinations is the responsibility of a routing algorithm.

- Distance-vector algorithm: each node
  - stores table of links & cost info of links, cost infinity for faulty links

  - periodically updates the table and sends to neighbors (its knowledge of the network based on traffic monitoring and the detection of configuration changes or failures).

❑ Routing Figure



Routings from A

To	Link	Cost
A	local	0
B	1	1
C	1	2
D	3	1
E	1	2

Routings from B

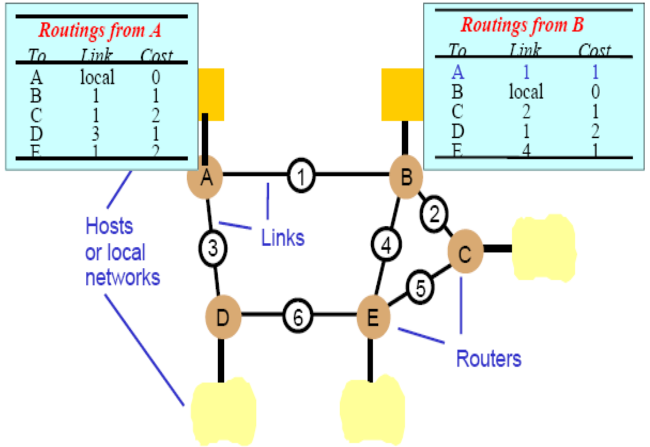
To	Link	Cost
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

❑ Routing tables for the network

Routings from A		
To	*Link*	*Cost*
A	local	0
B	1	1
C	1	2
D	3	1
E	1	2

Routings from B		
To	*Link*	*Cost*
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

Routings from C		
To	*Link*	*Cost*
A	2	2
B	2	1
C	local	0
D	5	2
E	5	1



Routings from A		
To	*Link*	*Cost*
A	local	0
B	1	1
C	1	2
D	3	1
E	1	2

Routings from B		
To	*Link*	*Cost*
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

Routings from D		
To	*Link*	*Cost*
A	3	1
B	3	2
C	6	2
D	local	0
E	6	1

Routings from E		
To	*Link*	*Cost*
A	4	2
B	4	1
C	5	1
D	6	1
E	local	0

❑ RIP routing algorithm

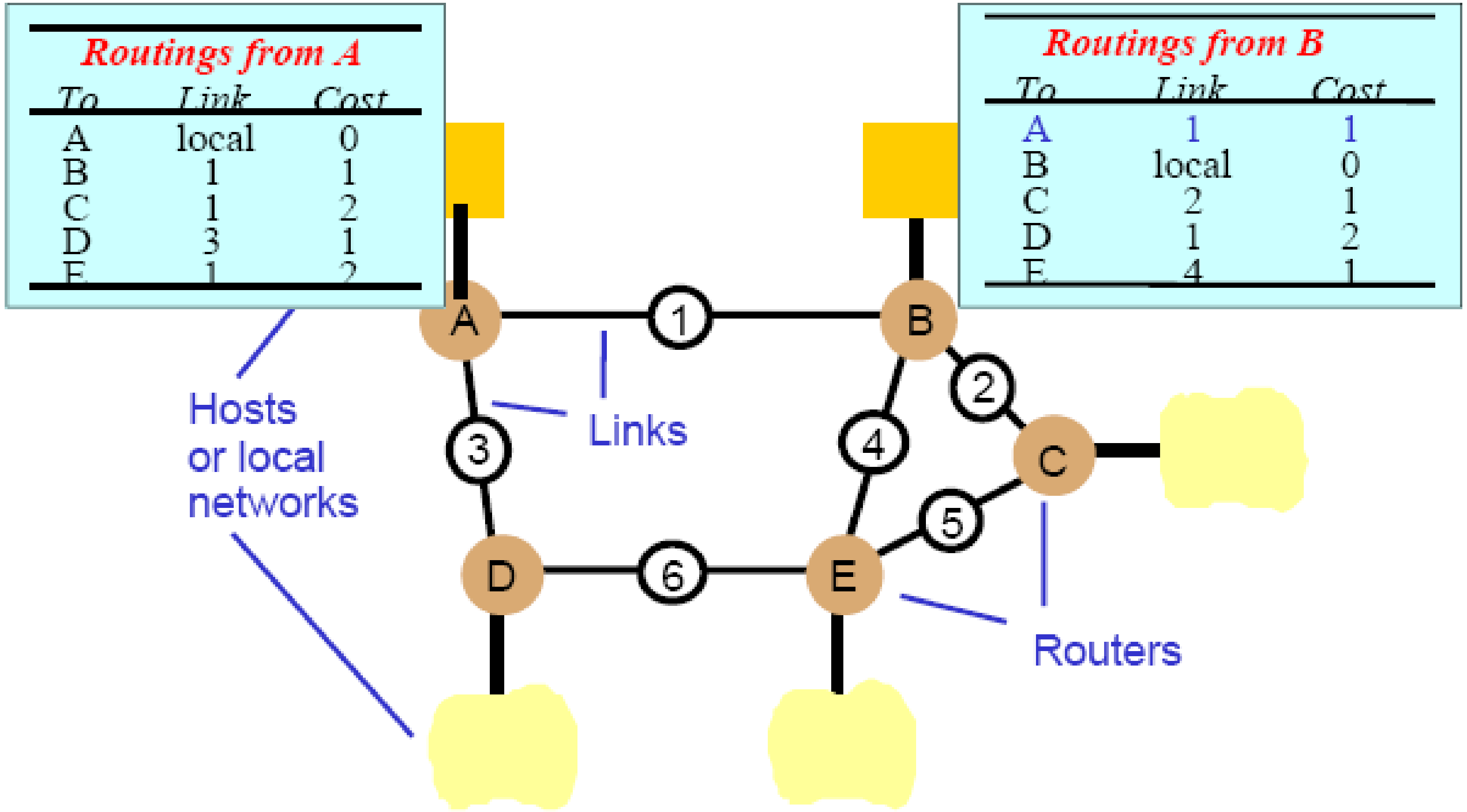
- A router exchanges information about the network with its neighboring nodes by sending a summary of its routing table using a router information protocol (RIP).

- Update: Each 30 seconds or when local table changes. send an RIP packet containing a copy of the table on each non-faulty outgoing link

- Propagation: When router X finds that router Y has a shorter and faster path to router Z, then it will update its local table to indicate this fact.

❑ Sequence of changes to the routing tables

➢ after the link labelled 3 in Figure is broken



Routings from A

To	Link	Cost
A	local	0
B	1	1
C	1	2
D	3	1
E	1	2

Routings from B

To	Link	Cost
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

- ❑ Step 1: costs for routes that use Link 3 have been set to ∞ at A, D

Routings from A

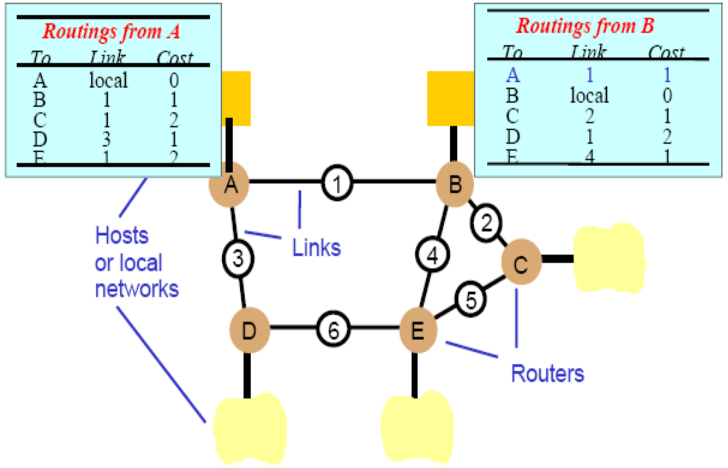
To	Link	Cost
A	local	0
B	1	1
C	1	2
D	3	∞
E	1	2

Routings from B

To	Link	Cost
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

Routings from C

To	Link	Cost
A	2	2
B	2	1
C	local	0
D	5	2
E	5	1



Routings from A

To	Link	Cost
A	local	0
B	1	1
C	1	2
D	3	1
E	1	2

Routings from B

To	Link	Cost
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

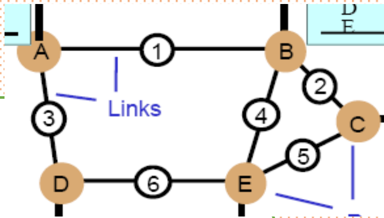
Routings from D

To	Link	Cost
A	3	∞
B	3	∞
C	6	2
D	local	0
E	6	1

Routings from E

To	Link	Cost
A	4	2
B	4	1
C	5	1
D	6	1
E	local	0

❑ Step 2: after first exchange of routing tables



Routings from A

To	*Link*	*Cost*
A	local	0
B	1	1
C	1	2
D	3	∞
E	1	2

Routings from B

To	*Link*	*Cost*
A	1	1
B	local	0
C	2	1
D	1	∞
E	4	1

Routings from C

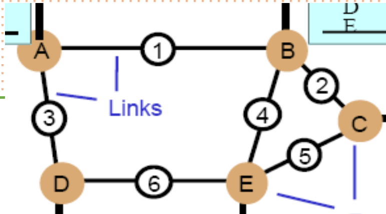
To	*Link*	*Cost*
A	2	2
B	2	1
C	local	0
D	5	2
E	5	1

Routings from D

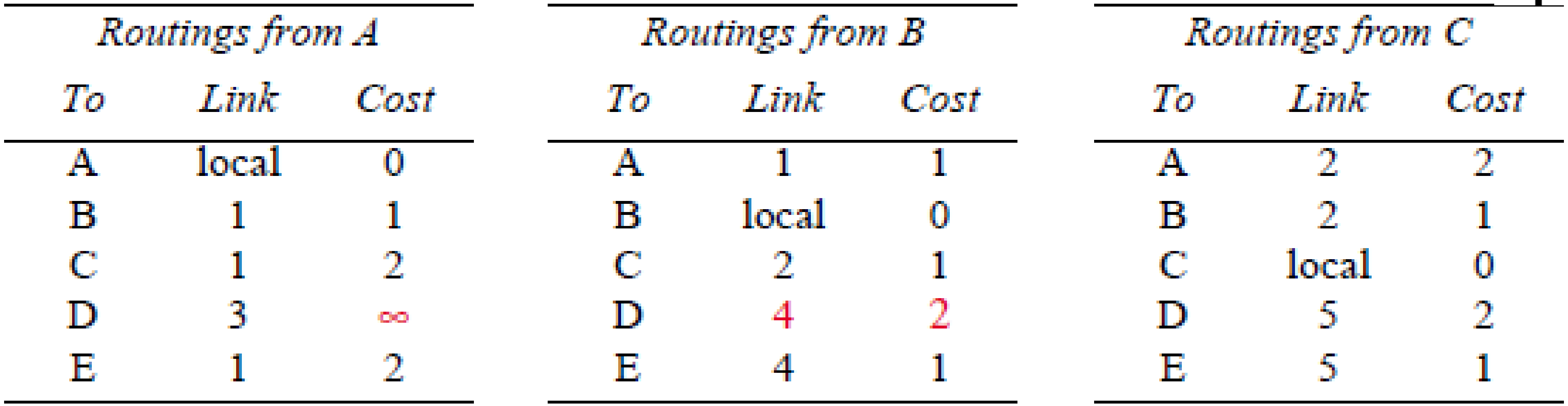
To	*Link*	*Cost*
A	3	∞
B	3	∞
C	6	2
D	local	0
E	6	1

Routings from E

To	*Link*	*Cost*
A	4	2
B	4	1
C	5	1
D	6	1
E	local	0



❑ Step 3: after second exchange of routing tables



Routings from A

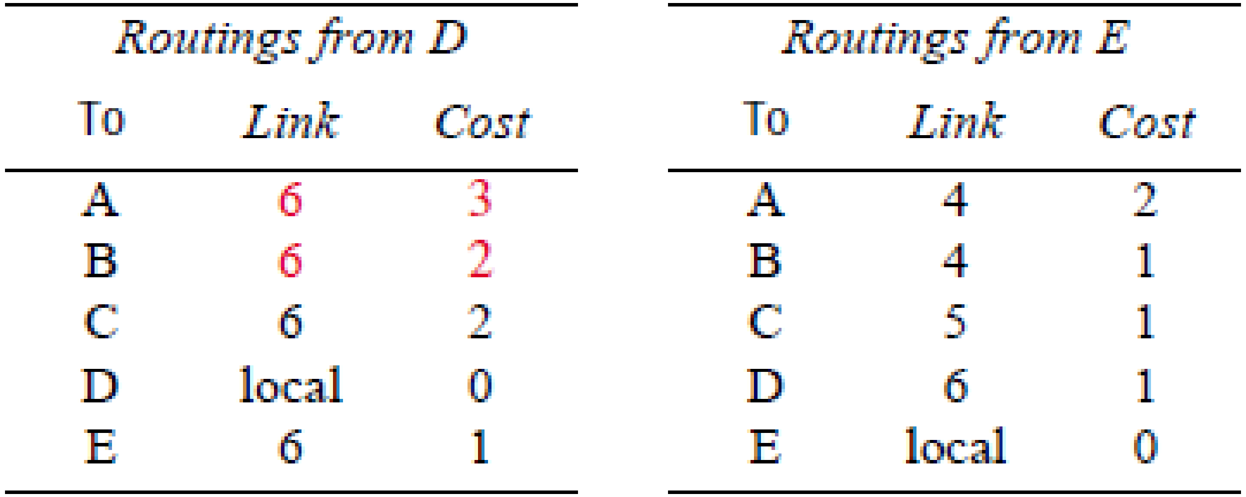
To	*Link*	*Cost*
A	local	0
B	1	1
C	1	2
D	3	∞
E	1	2

Routings from B

To	*Link*	*Cost*
A	1	1
B	local	0
C	2	1
D	4	2
E	4	1

Routings from C

To	*Link*	*Cost*
A	2	2
B	2	1
C	local	0
D	5	2
E	5	1



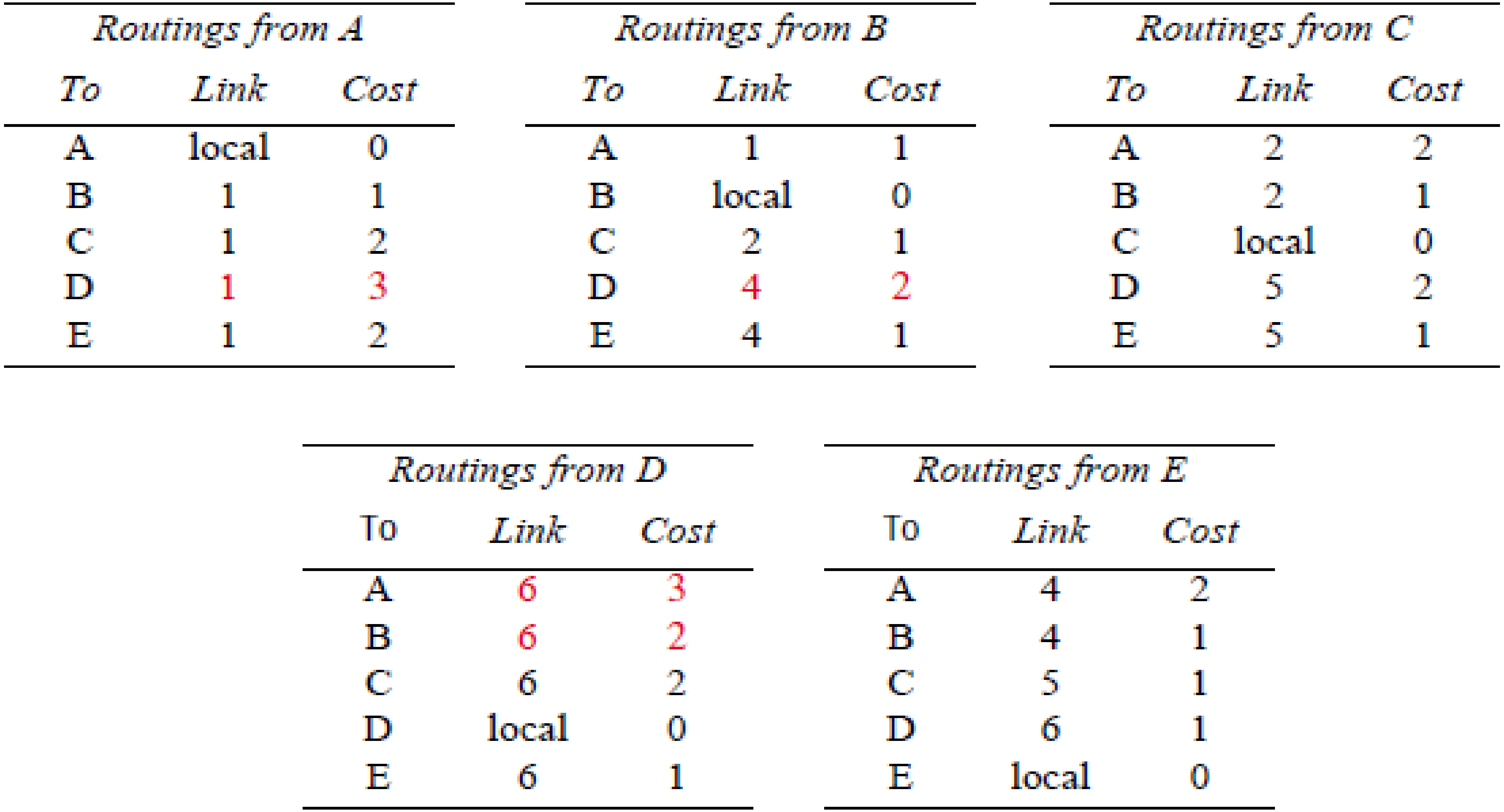
Routings from D

To	*Link*	*Cost*
A	6	3
B	6	2
C	6	2
D	local	0
E	6	1

Routings from E

To	*Link*	*Cost*
A	4	2
B	4	1
C	5	1
D	6	1
E	local	0

- Step 4: after third exchange of routing tables.



Routings from A		
To	*Link*	*Cost*
A	local	0
B	1	1
C	1	2
D	1	3
E	1	2

Routings from B		
To	*Link*	*Cost*
A	1	1
B	local	0
C	2	1
D	4	2
E	4	1

Routings from C		
To	*Link*	*Cost*
A	2	2
B	2	1
C	local	0
D	5	2
E	5	1

Routings from D		
To	*Link*	*Cost*
A	6	3
B	6	2
C	6	2
D	local	0
E	6	1

Routings from E		
To	*Link*	*Cost*
A	4	2
B	4	1
C	5	1
D	6	1
E	local	0

❑ 5-Congestion control

- ➢ The capacity of a network is limited by the performance of its communication links and switching nodes.

- ➢ When the load at any particular link or node approaches its capacity, queues will build up at hosts

- ➢ If the load continues at the same high level, the queues will continue to grow until they reach the limit of available buffer space.

- ➢ when the load on a network exceeds 80% of its capacity, the total throughput tends to drop as a result of packet losses unless usage of heavily loaded links is controlled.

❑ Congestion control

- Congestion control is achieved by informing nodes along a route that congestion has occurred, and their rate of packet transmission should therefore be reduced.

- Congestion information may be supplied to the sending node by explicit transmission of special messages requesting a reduction in transmission rate.

Thank
you