IP Routing

Bharat S. Chaudhari
International Institute of Information Technology
Pune, India

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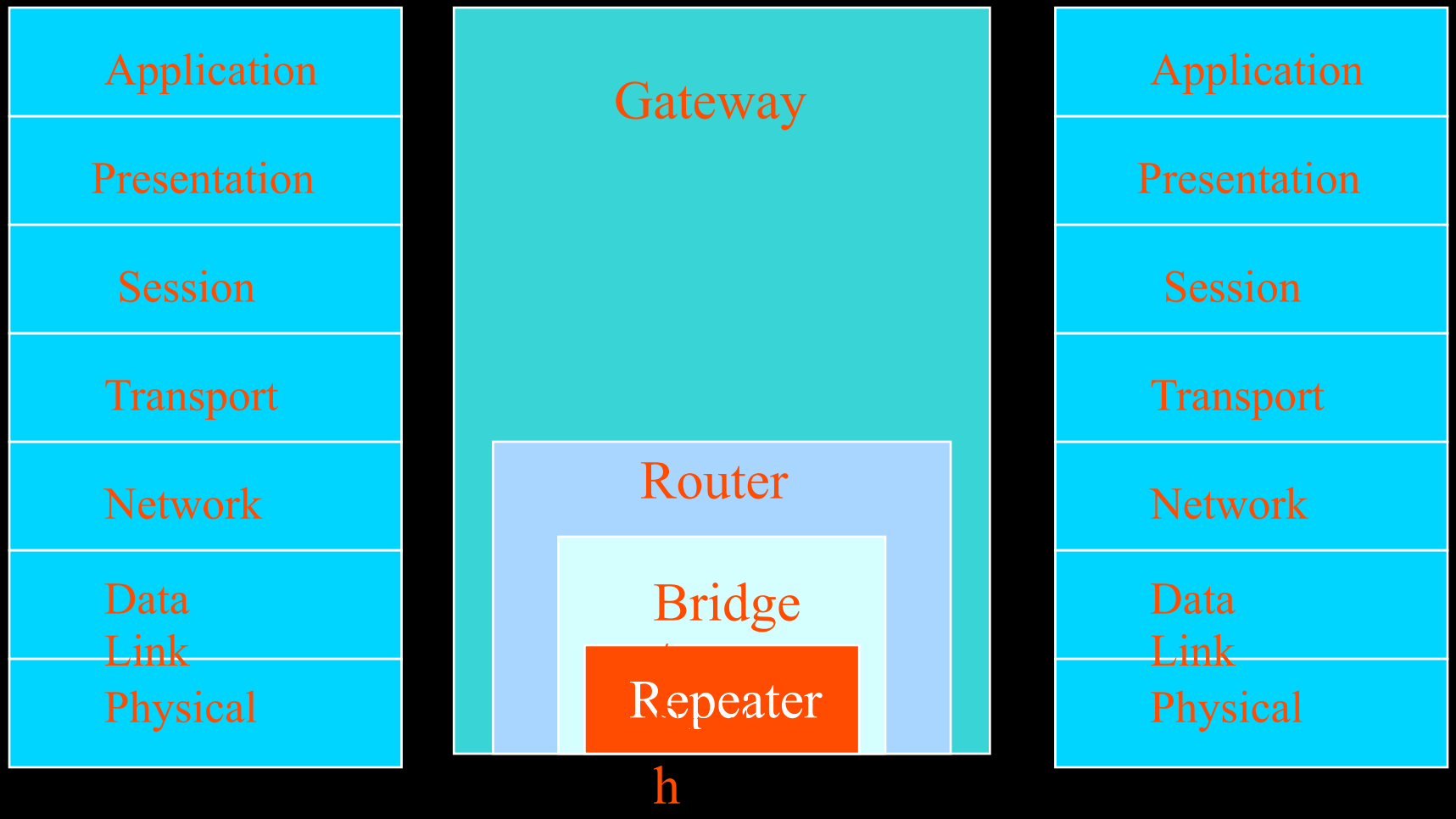
Network Devices:

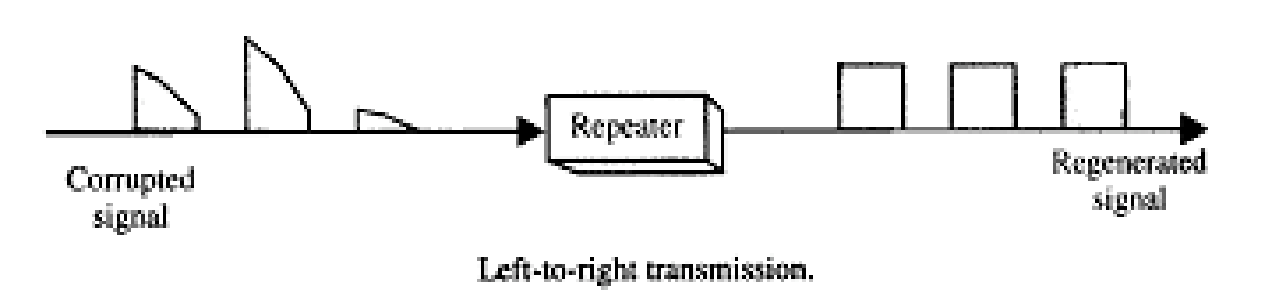
- The networking and internetworking devices are divided in the following categories:
  - **Repeaters**
  - **Hubs**
  - **Bridges**
  - **Switches**
  - **Routers**
  - **Gateways**
  - **Each of these device interacts with protocols at different layers of communication architecture**

OSI Model and Connecting Devices:



Repeaters:

- An electronic device operates at the physical layer of the OSI model
- Does the 3R functionalities
- Allows extension of the physical length of the network

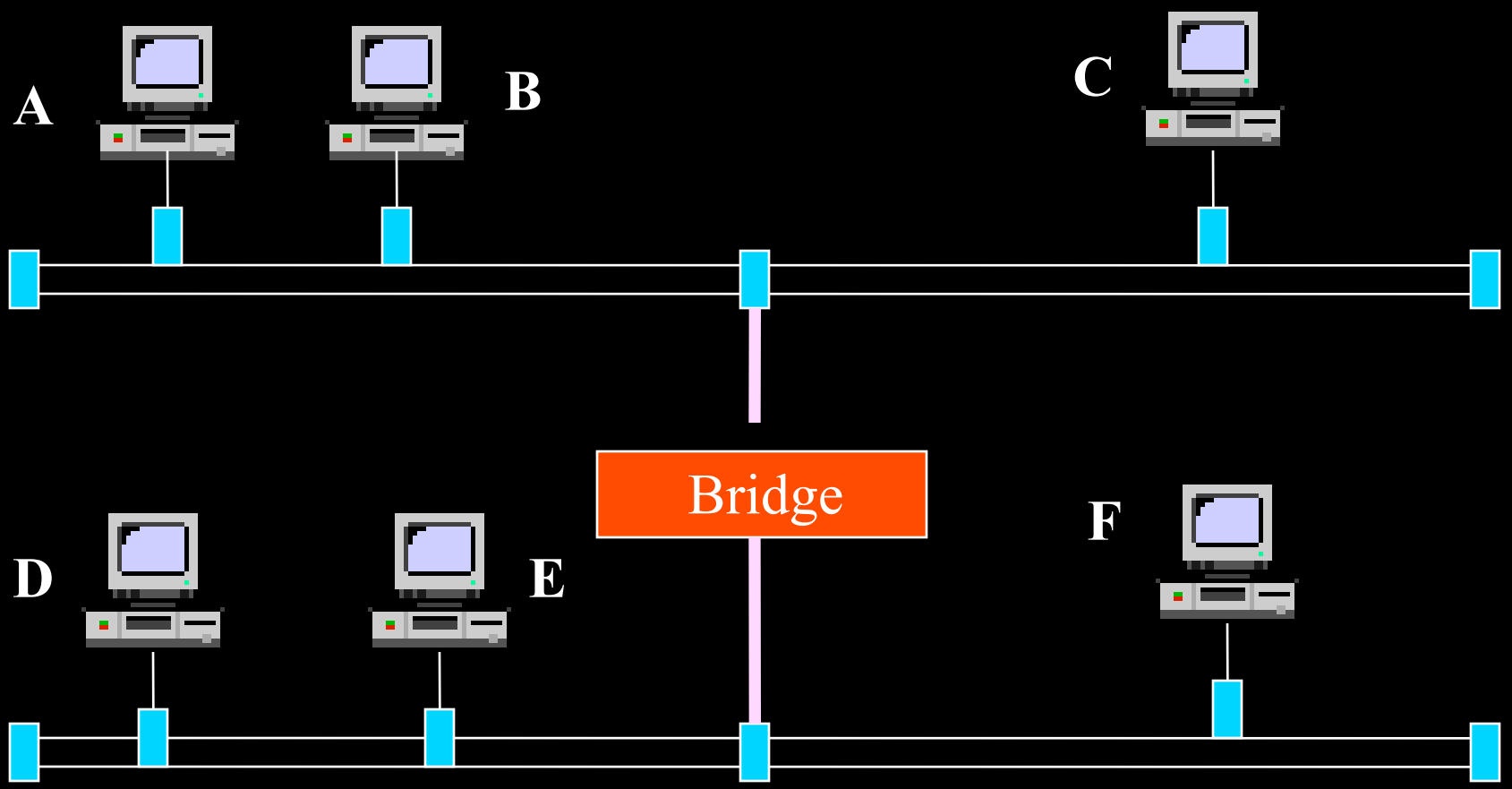


Left-to-right transmission.

Bridges:

- Operates in both the physical and data link layers of the OSI model
- Divides a large network into segments
- Relays frames between two originally separate LANs
- Keeps the traffic on each segment separate: controls congestion, isolates problem links

Bridges:



Hubs:

- Multiport devices to connect many host to a networks
- Not intelligent
- Receives the frames and forward it to all host connected

Switches:

- Provides bridging functionality with greater efficiency
- Each port has a buffer for each link to which it is connected
- A received packet is stored in the buffer
  - Checks the destination address
  - forwards the packet to outgoing link if the link is free

Routers:

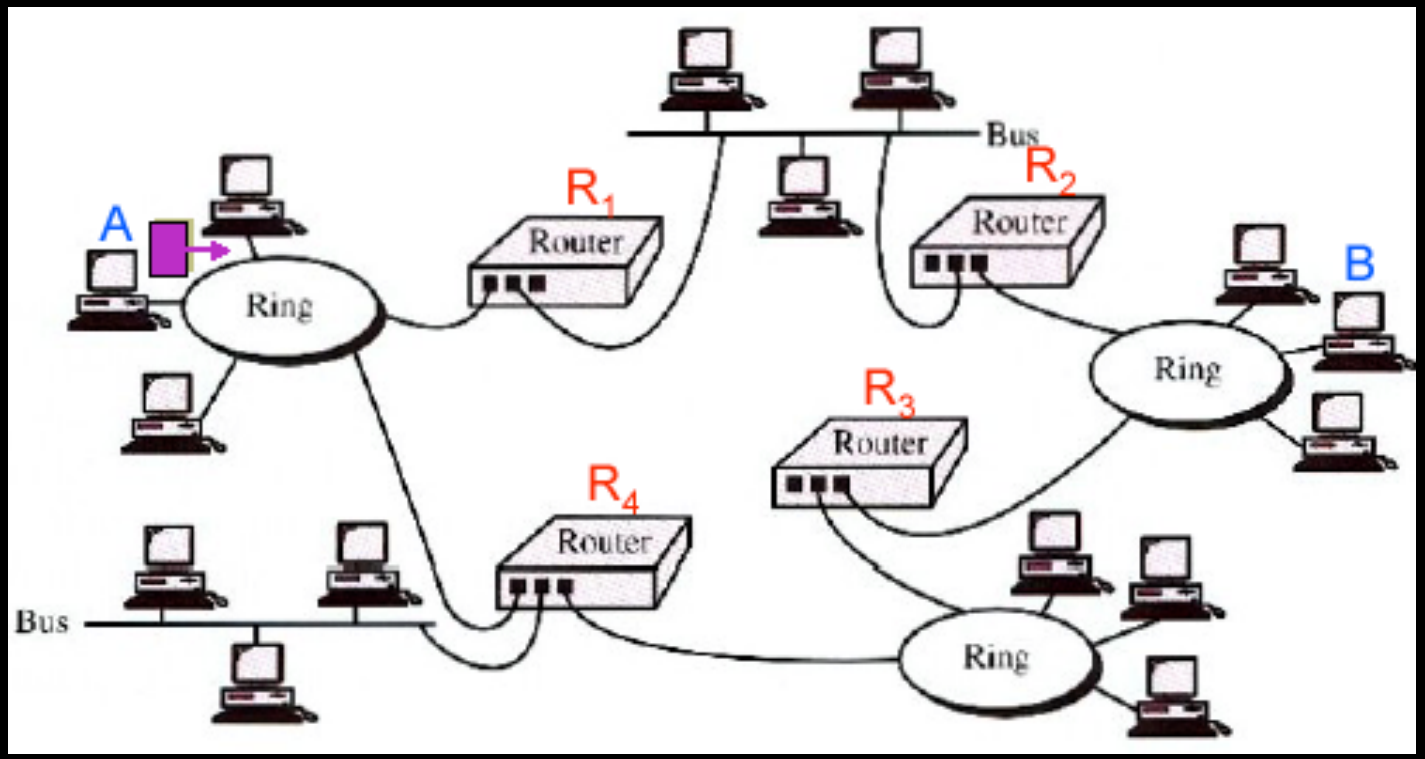
- Routers have access to network layer addresses
- They work on physical, data link and network layers
- Routes the packets over different networks
- Many other functionalities such as network management

Gateways:

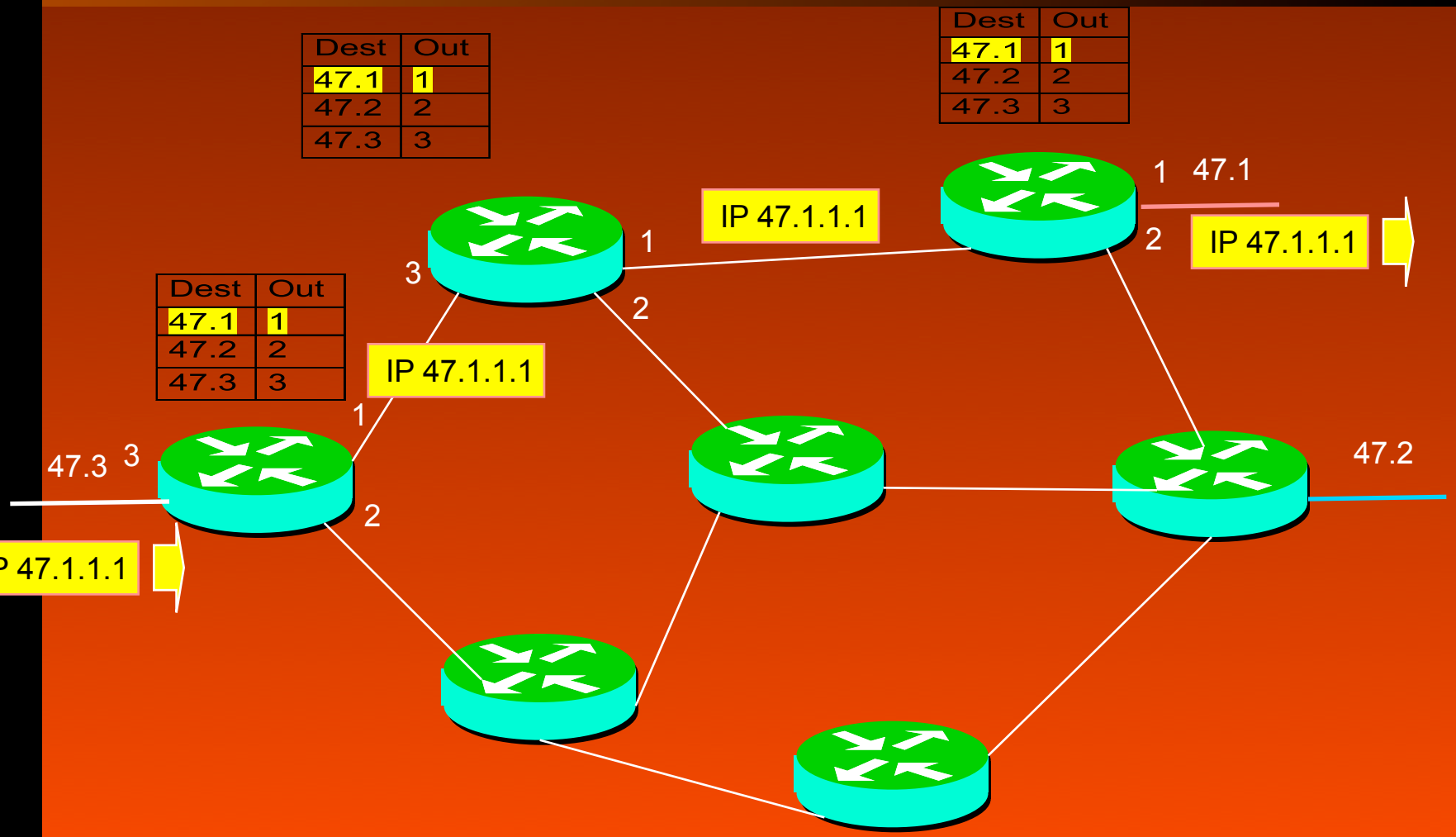
- Operate in all seven layers of the OSI model
- It's a protocol converter
  - Example – TCP/IP to AppleTalk
- Its generally a software installed in a router
- It must adjust the data rate, size, and format

Routing:

- is a process of moving packets from one network to another along the path from source to the destination.



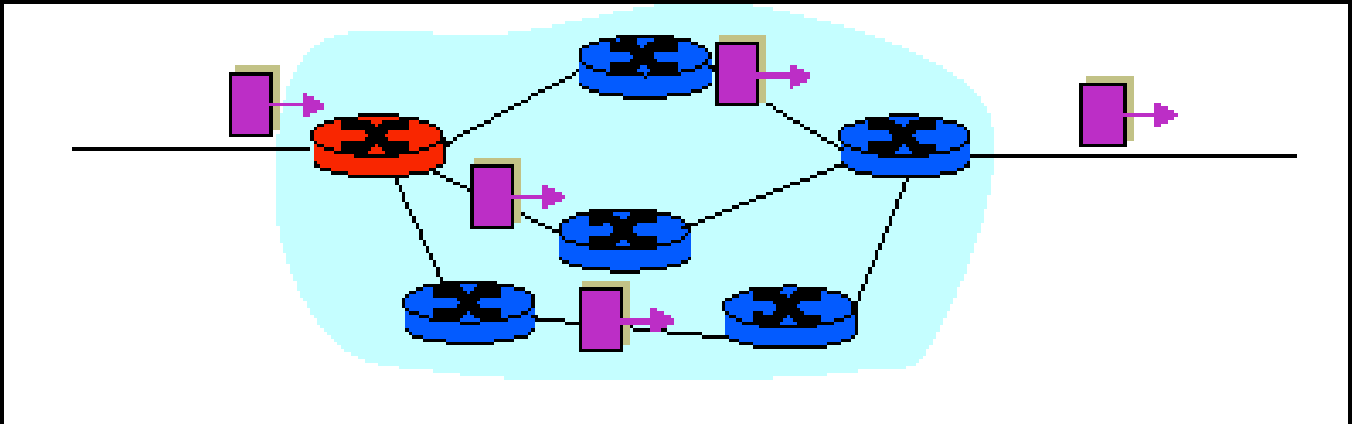
IP Routing:


Dest | Out
47.1 | 1
47.2 | 2
47.3 | 3
Dest | Out
47.1 | 1
47.2 | 2
47.3 | 3
Dest | Out
47.1 | 1
47.2 | 2
47.3 | 3
1
47.1
IP 47.1.1.1
IP 47.1.1.1
3
1
2
IP 47.1.1.1
47.3
3
1
2
47.2
IP 47.1.1.1

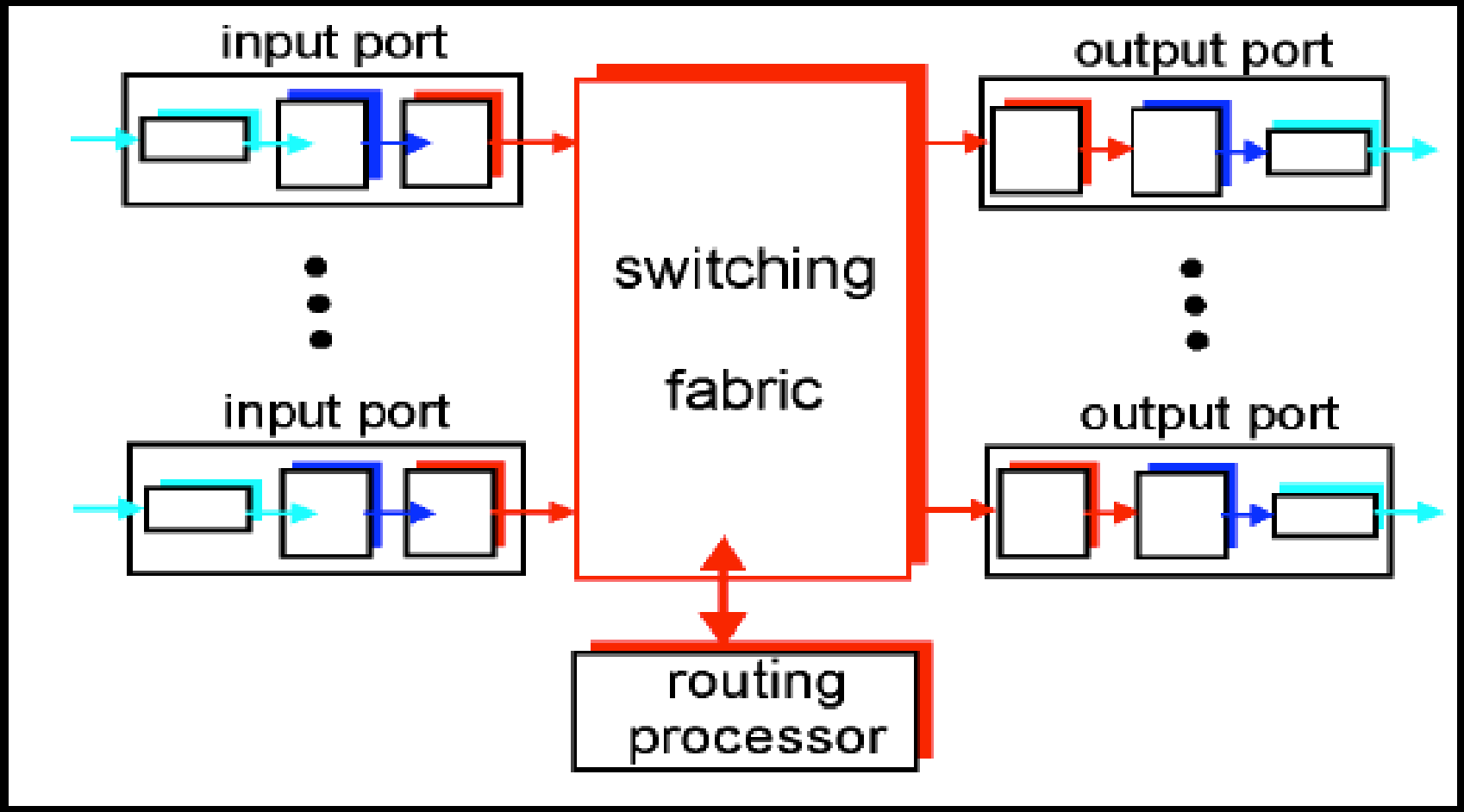
Routing:

Routing involves two activities:

- Run routing algorithm/protocol:
  - determines the optimal path for routing the packets from the source to the destination
  - can be very complex
- Switching:
  - moves packets from input of the router to appropriate output of the router
  - relatively straightforward

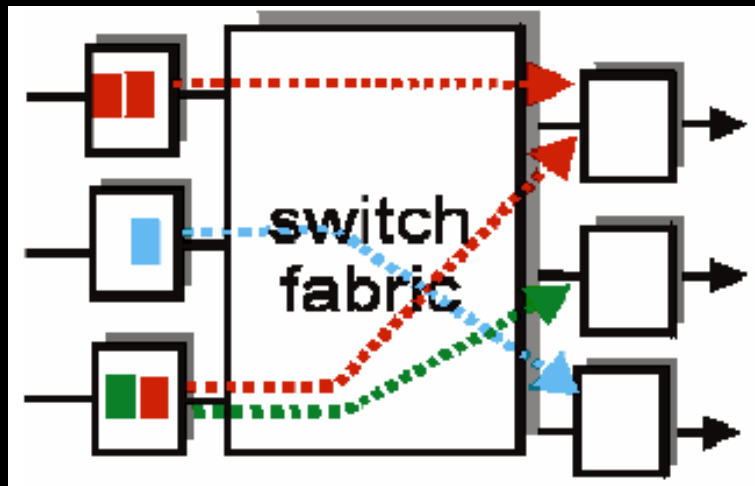


Router Architecture:



Routing Processor:

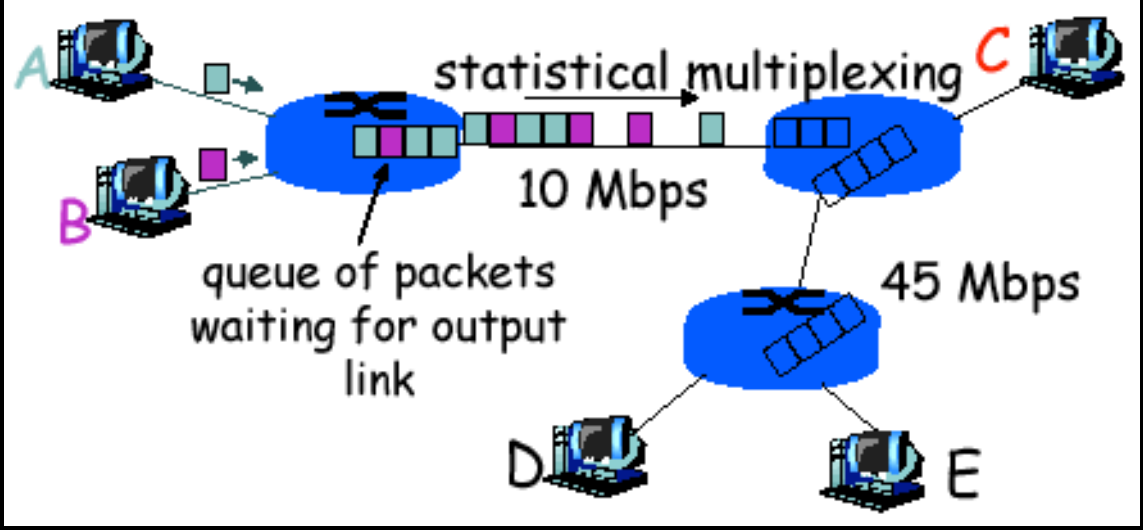
- Maintains routing table
- Moves the packets from input interface to output interface with the help of switching fabric



Destination	Next Router	IF
192.168.2.	192.168.2.5	2
193.55.114.	193.55.114.6	3
default	193.55.114.129	1

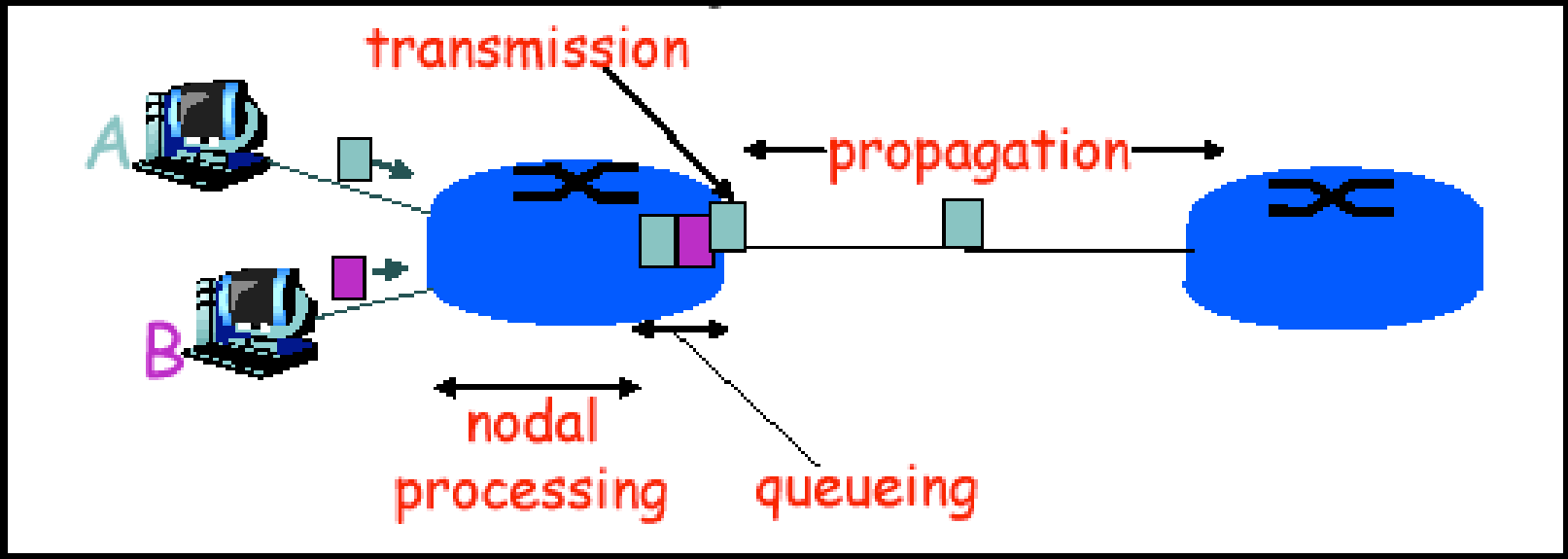
Switching:

- Uses packet switching
- Based on statistical multiplexing
  - resources are shared
  - queue for resources



Sources for Delay:

- Four Sources of delay in network:



Routing:

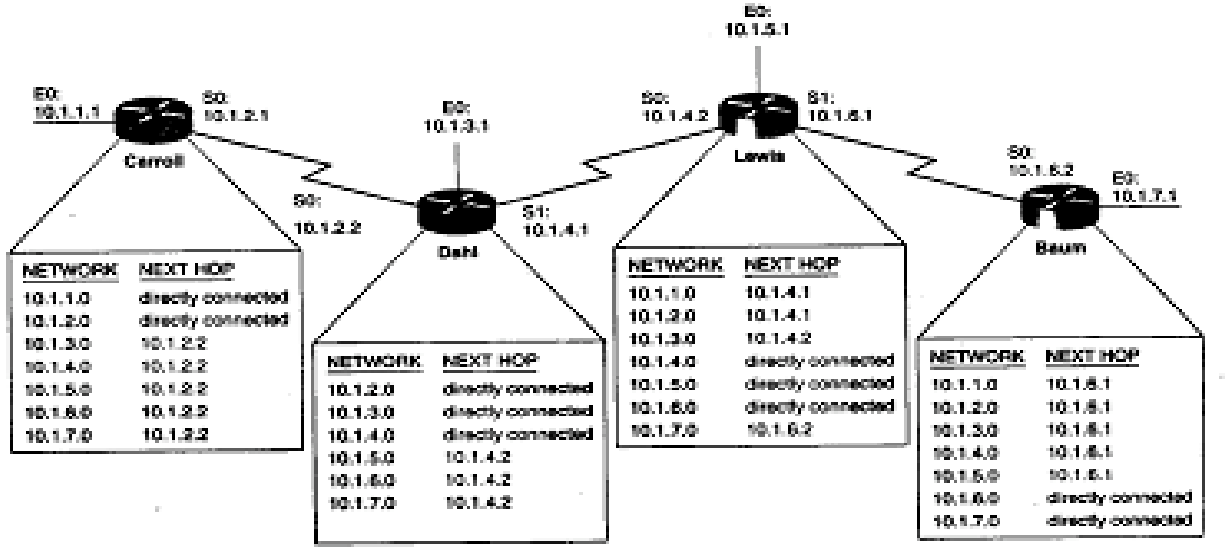
- Complex, crucial aspect of packet switched networks
- Characteristics required:
  - Correctness
  - Simplicity
  - Robustness
  - Stability
  - Fairness
  - Optimized
  - Efficiency

Types of Routing:

- Two Types: *Static* and *Dynamic*
  - *Static:*
    - routing information entered manually
    - routes are predefined and are fixed
    - Not frequent routes changes
  - *Dynamic:*
    - routes are decided (by the router) depending on availability
    - periodic update in response to link cost changes
    - routes change more quickly

Static Routing:

- A simple internetwork and route table entries required by each router are as shown in figure



Figure

The minimum information needed for each route table entry consists of the destination networks and the pointers to those networks.

Static Routing:

- Entry for network 10.1.1.0 is missing from Dahl's route table
  - **If packet comes for that destination, it is dropped and ICMP destination unreachable message is sent.**
- **Typical Routing Table for a Cisco router:**
  - **Routing Table for 3rd Router (Lewis) of diagram (next slide):**
  - **Command is show ip route**
    - **Lewis#show ip route**

Routing Table for 3rd Router (Lewis):

Lewis# show ip route

Codes: c- connected, s- static,…….R-RIP

.

Gateway of last resort is not set (Default route)

10.0.0.0/24 is subnetted, 7 subnets

S 10.1.3.0 [1/0] via 10.1.4.1

S 10.1.2.0 [1/0] via 10.1.4.1

.

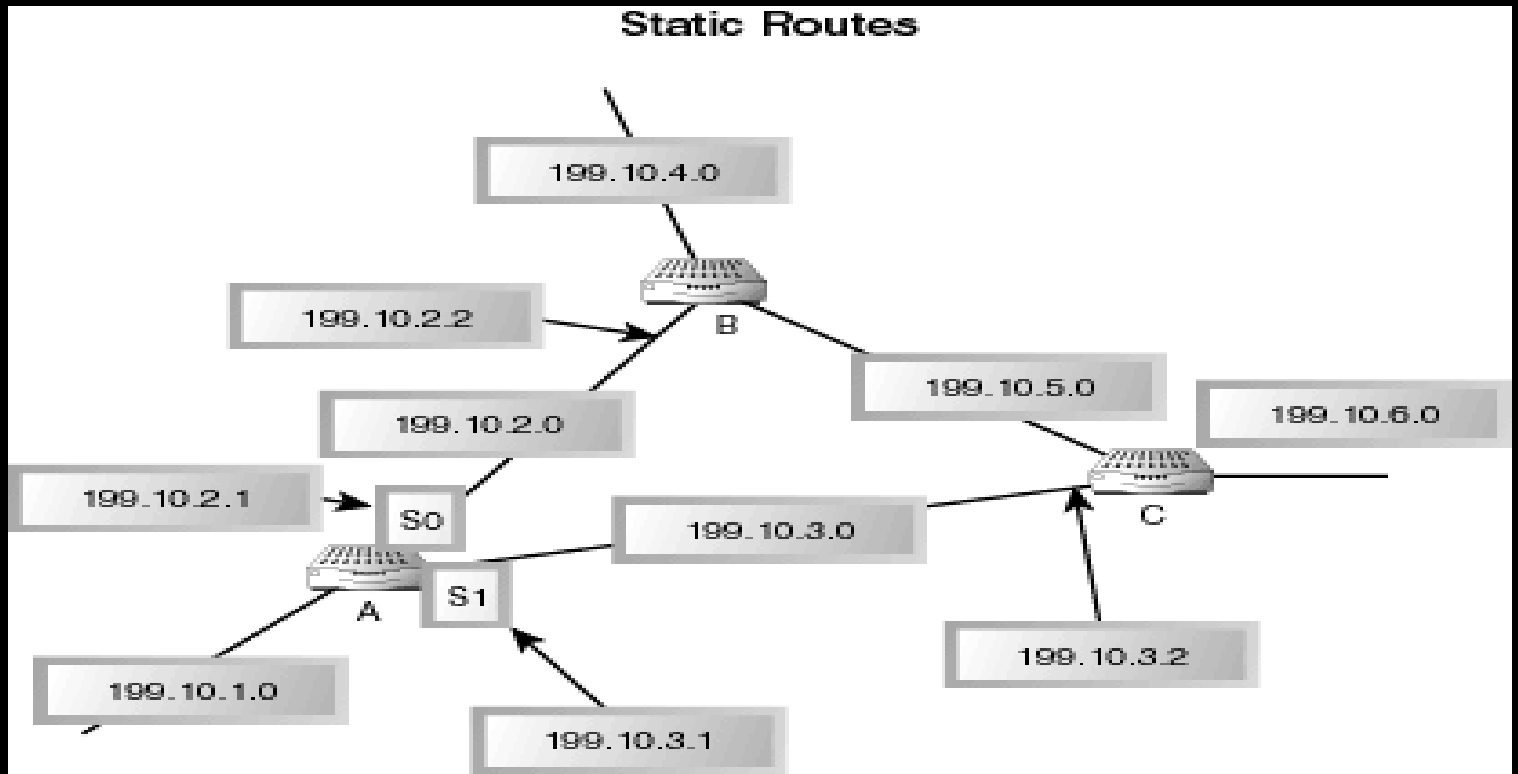
C 10.1.6.0 is directly connected, serial 1

C 10.1.5.0 is directly connected, Ethernet 0

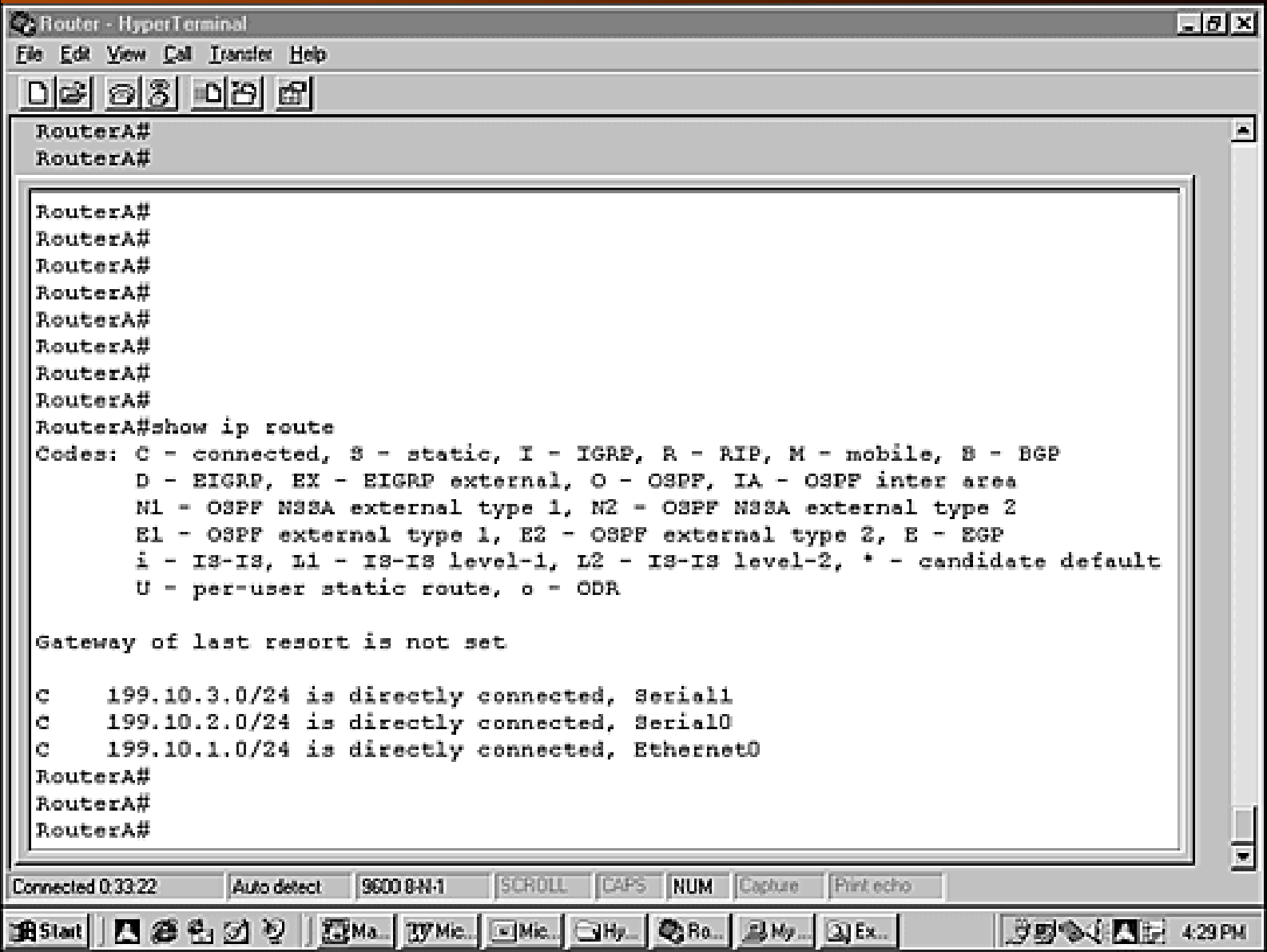
C 10.1.4.0 is directly connected, serial 0

Static Routing:

- Three Routers: A, B, and C
- Each router has three directly connected networks



Static Routing for Router A:



Dynamic Routing Protocols:

- In Static Routing, routing information is to put in the table manually
- In dynamic routing:
  - router can discover information automatically and share it with other routers via dynamic routing protocols.

Dynamic Routing Protocols:

- A routing protocols is the language a router speaks with other routers in order to share information about the reachability and status of networks.
- **It determines:**
  - **Path to the destination**
  - **Route table up date**
  - **Next best path if the best path is unusable**
  - **Capability to compensate for topology change**

Dynamic Routing Protocols:

- Broadly Speaking, there are two types of routing protocols:
  - Distance Vector: Like road signs
    - Based on *Bellman-Ford* algorithm
    - Routes are advertised as vectors of (distance, direction), where distance is defined in terms of a metric and direction is defined in terms of the next-hop router
  - Link State: Like complete map of network
    - Based on Dijkstra's Algorithm
    - The link state router can not be fooled as easily into making bad routing decisions

Distance Vector Routing Protocols:

- **Some Popular Distance Vector Protocols:**
  - **Routing Information Protocols (RIP) version I and II**
  - **Cisco's Interior Gateway routing Protocol (IGRP)**
  - **Cisco's Enhanced Interior Gateway routing Protocol (EIGRP)**

Link State Routing Protocols:

- Popular Link State Protocols:
  - Open Shortest Path First (OSPF)
  - ISO's Intermediate System - Intermediate System (IS - IS)

Metrics:

- **To determine best path, router uses:**
  - ***Hop Count:***
  - ***Bandwidth:***
  - ***Load:***
  - ***Delay:***
  - ***Reliability:***
  - ***Cost:***

- *RIP: Uses hop count as metric*
- *IGRP and EIGRP: Uses bandwidth, delay, load, and reliability for calculating metric*
- *OSPF, IS-IS uses bandwidth for calculating metric*

Convergence:

- The process of bringing all route tables to a state of consistency is called convergence
- The time it takes to share information across an internetwork and for all routers to calculate best paths is call ed as convergence time
- Faster network convergence after a topology change, its better, but…?

Exterior Gateway Protocols:

- The protocols studied so far are called as ***Interior Gateway Protocols (IGP)***
- Other types of protocols, i.e. ***Exterior Gateway Protocols (EGP)*** are used outside autonomous system routing.
  - *e.g.* EGP, BGP

Static Routing or Dynamic Routing?

- Dynamic routing protocols
  - automatically detect and adapt to topological changes in the internetwork
- The price of this 'automation' is paid in terms of:
  - bandwidth
  - Memory
  - in processing time.
- A frequent objection to static routing:
  - hard to administer.
- Static routing is best for small networks with no alternative routes
- Static routing can be used give default routes
- It is good to choose dynamic routing when static routing is not feasible practically.

Thank you!

bsc@ieee.org, bharatc@isquareit.ac.in

www.isquareit.ac.in