Computer Networks

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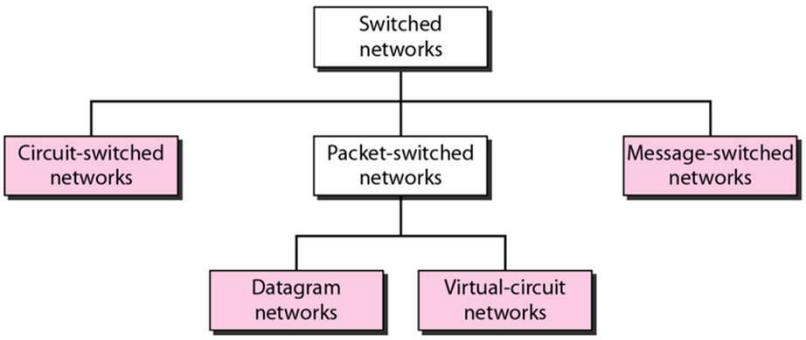
Network

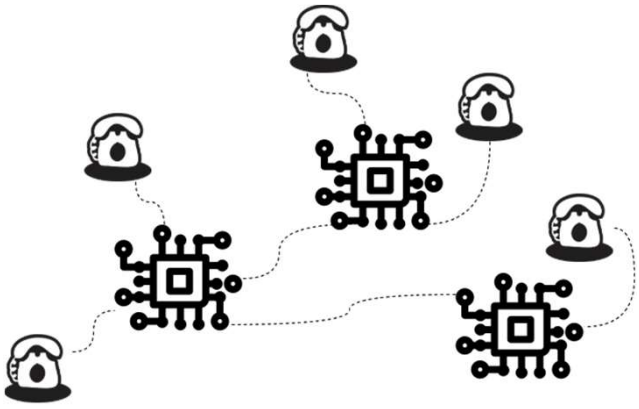
- Data Communication
- Network Topology
- LAN/MAN/WAN
- OSI Model
- TCP/IP Model

How to connect nodes to make one-to-one communication possible ?

Taxonomy of switched networks



Telephones



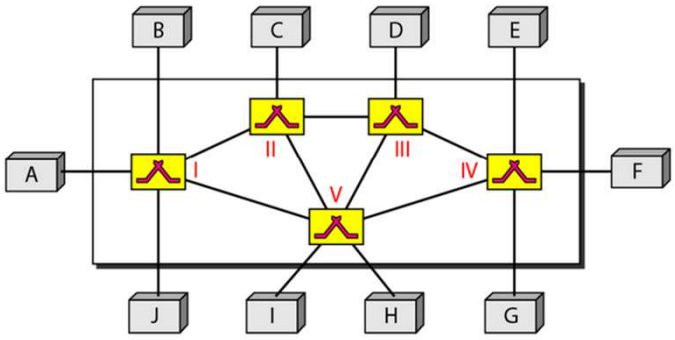
Circuit Switching

- *end-to-end circuit*
- Links and Circuits
- FDM (**frequency division multiplexing)**
- TDM (**time-division multiplexing**)

Disadvantages

- Resource Utilization
- Connection Establishment Time

Switched network



An Example

Suppose that all links in the network use TDM with 12 slots per second and have bit rate 1.536 Mbps.

An end-to-end circuit establishment time =500 msec

How long does it take to send a file of 640Kbits?

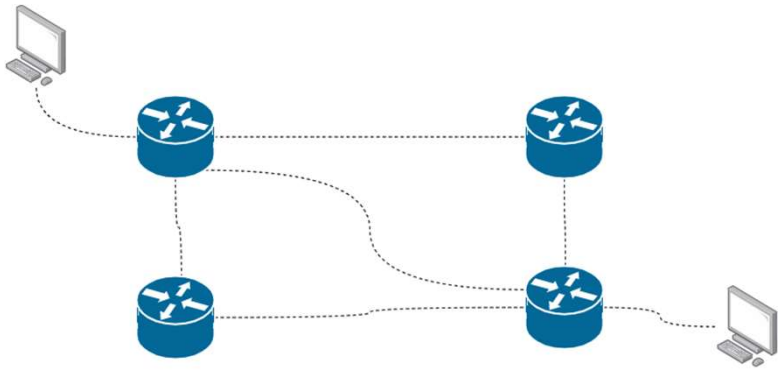
Each circuit has a transmission rate= (1.536 Mbps)/12 = 128 Kbps,

Time to transmit the file= (640 Kbits)/(128 Kbps) = 5 seconds.

Total time- 5.5sec

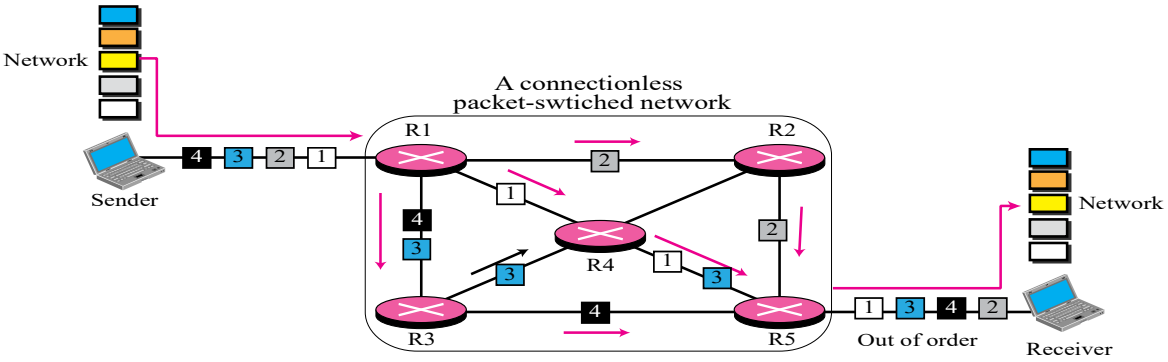
Packet Switching

- Messages → Packets
- Packets traverse through communication links and routers (**packet switches**)



- Queueing Delays
- Input Buffer
- Output Buffer

Connectionless Packet Switching Network



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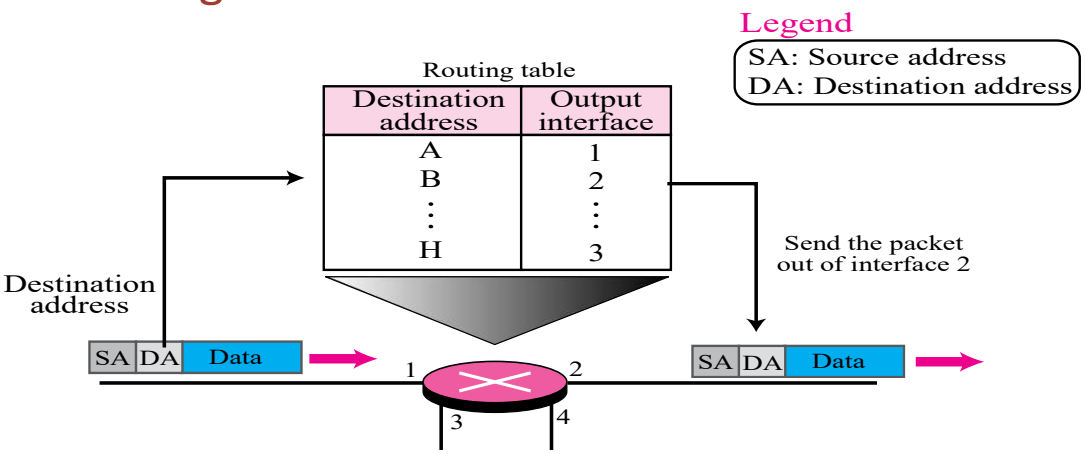
Forwarding Process in Connectionless Network



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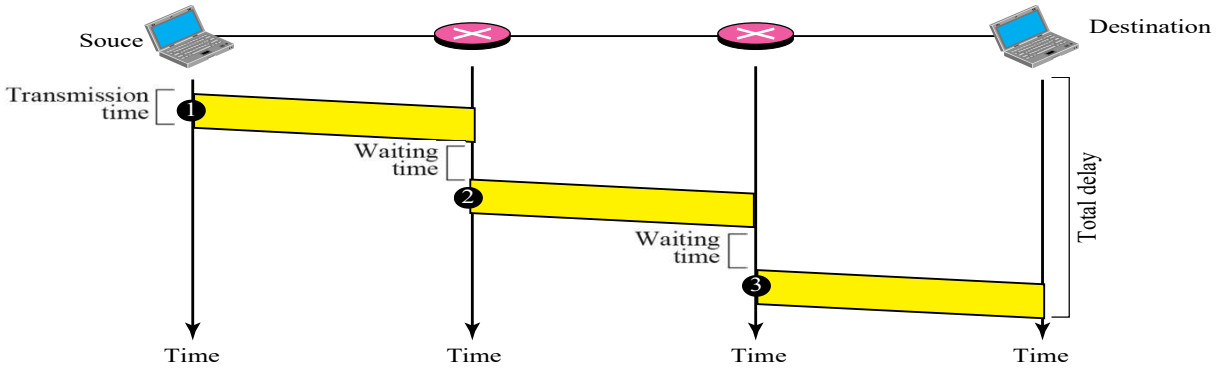
Delay in Connectionless Network



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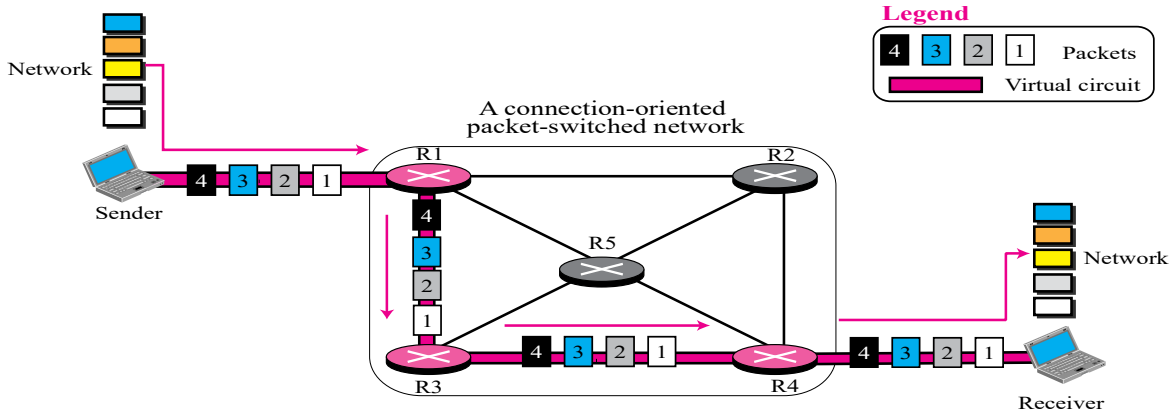
A Connection Oriented Packet Switched Network



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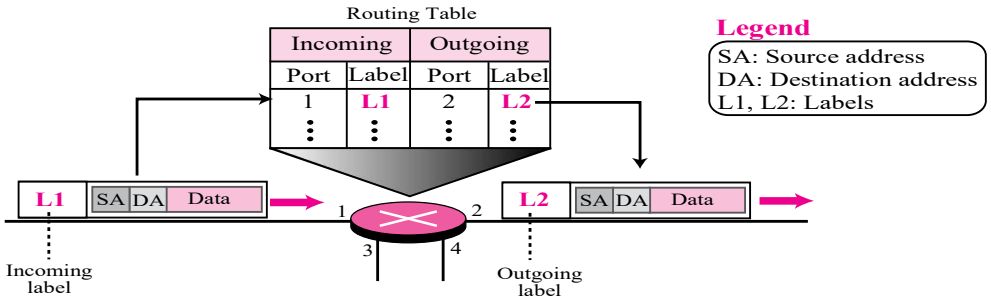
Forwarding Process in a Connection oriented Network



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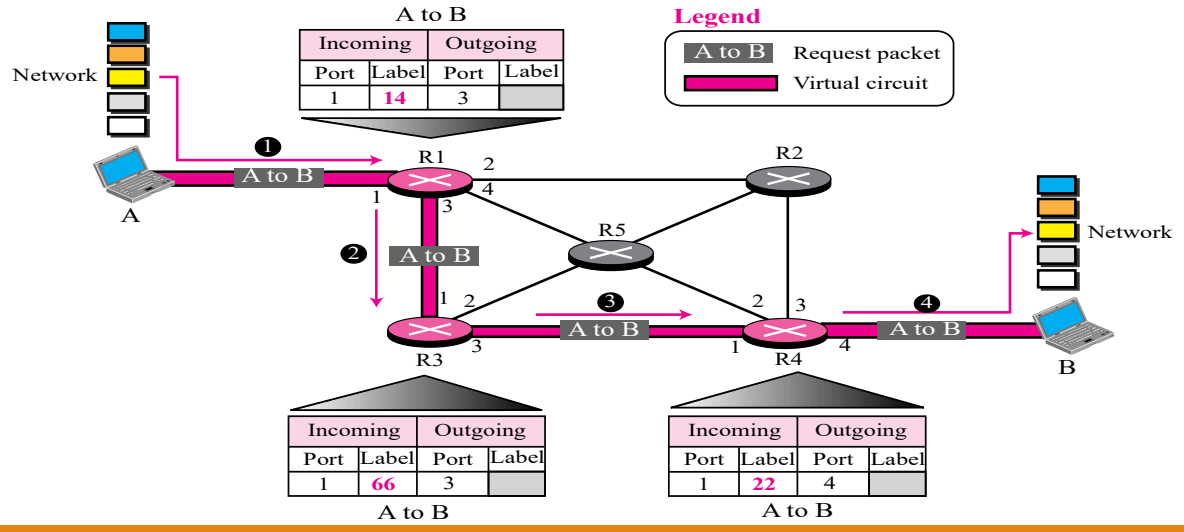
Sending request packet in a virtual-circuit network



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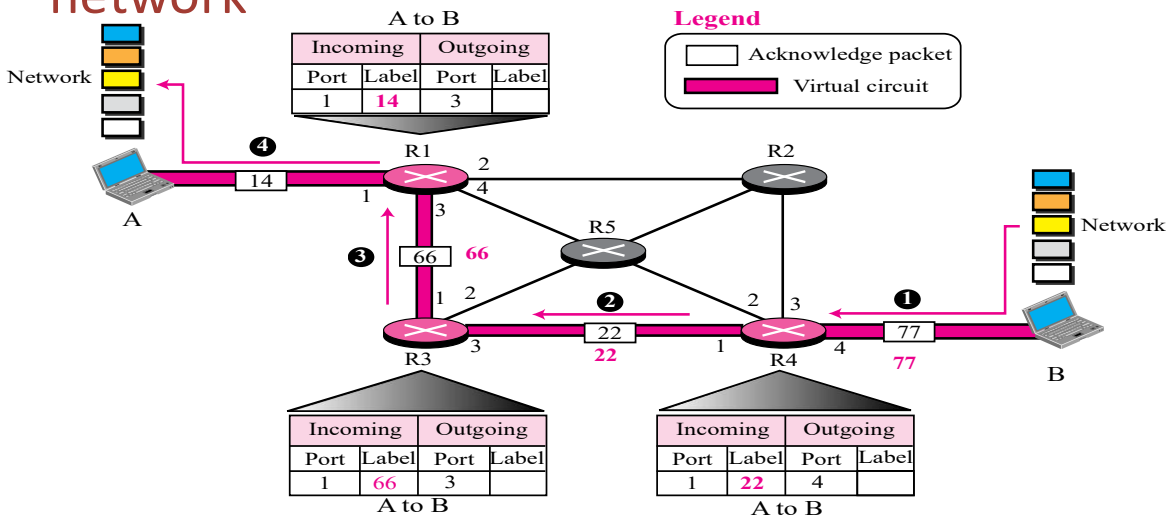
Setup acknowledgement in a virtual-circuit network



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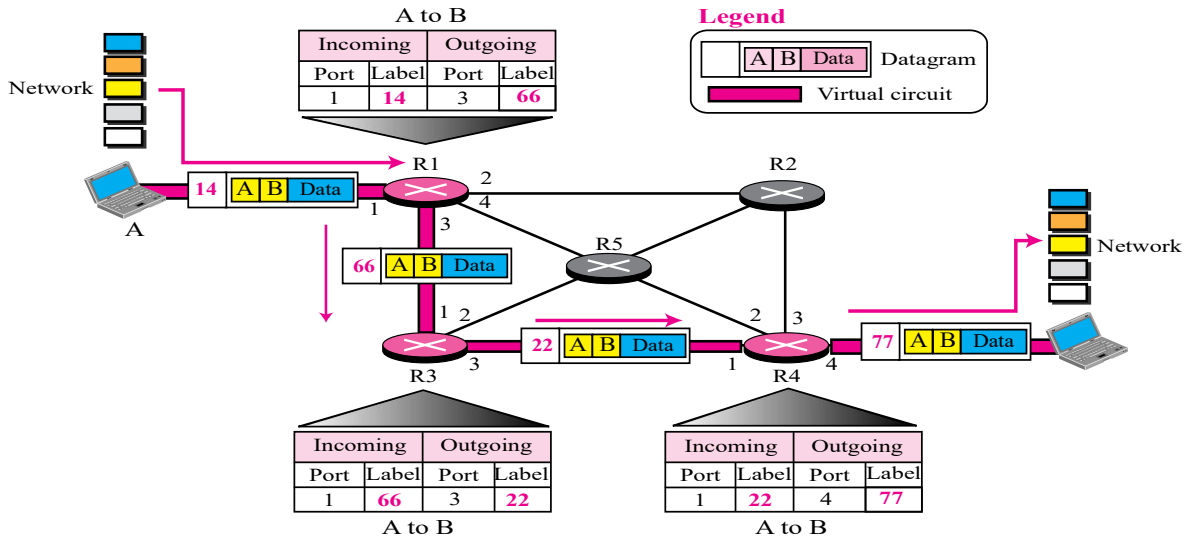
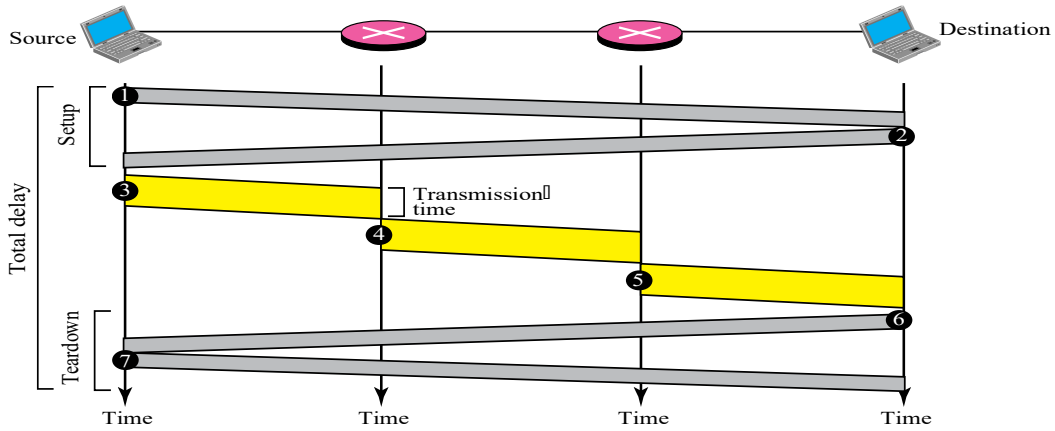
Flow of one packet in an established virtual circuit



Delay in a connection-oriented network



Comparison of Circuit Switching and Packet Switching

Parameter	Circuit Switching	Packet Switching
Routing scheme	Route selected during call setup	Each packet routed independently
Multiplexing scheme	Circuit multiplexing	Packet multiplexing shared media access networks
Addressing scheme	Hierarchical numbering plan	Hierarchical address space
Information representation	Analog voice or PCM coded voice	Binary information
End terminal	Telephone, modem	Computer
Transmission system	Analog and digital data over different transmission media	Digital data over different transmission media
Traffic	Real time interactive	Heavy traffic
Application	Telephone network for bi-directional, real time transfer of voice signals	Internet for datagram and reliable stream service between computers

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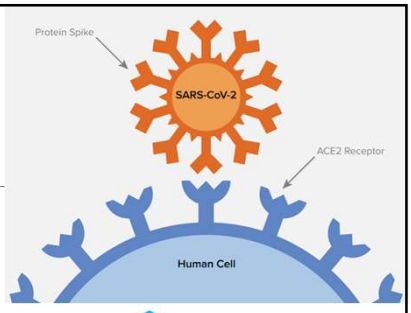
Network Programming

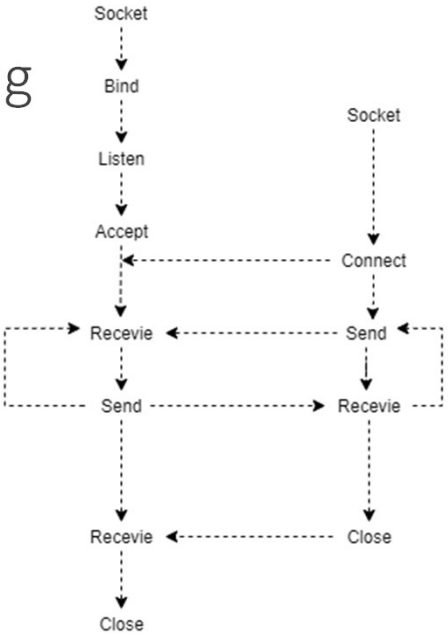
- *Client and Server*

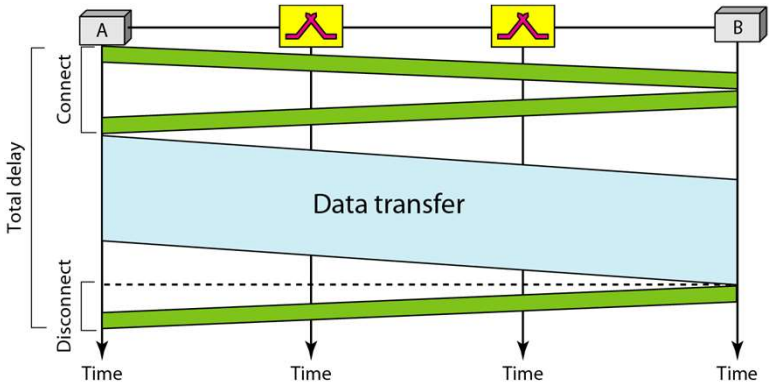
- *A socket is one end point of two way communication link between programs running on the network.*



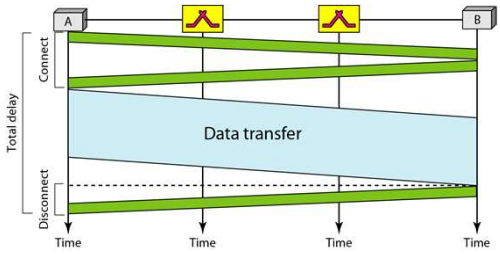
Network Socket Programming

Application Program Interface





A path in a digital circuit-switched network has a data rate of 1Mbps. The exchange of 1000 bits is required for the setup and teardown phases. The distance between two parties is 5000kms.



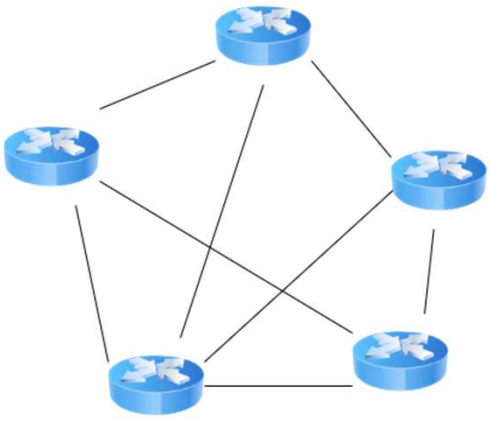
What is total delay if 1000 bits of data are exchange during data transfer phase.

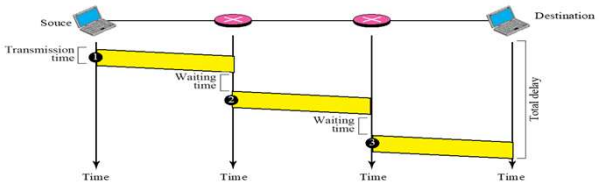
What is total delay if 100,000 bits of data are exchange during data transfer phase.

What is total delay if 1,000,000 bits of data are exchange during data transfer phase.

What is total delay if 50000 bits of data are exchange during data transfer phase

Transmission delay = Data unit size / BW
Propagation delay= Distance / speed
Waiting time=

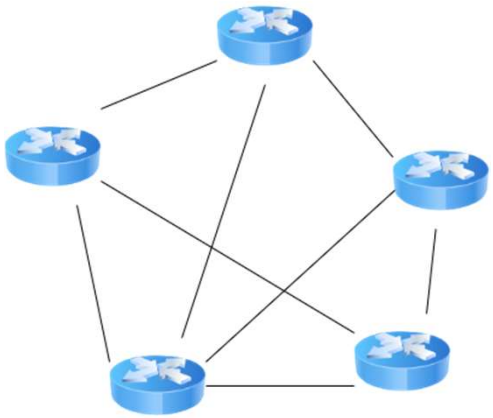




Datagram	Path Length	Visited Switches
1	3200Km	1,3,5
2	11,700 Km	1,2,5
3	12,200 Km	1,2,3,5
4	10,200 Km	1,4,5
5	10,700 Km	1,4,3,5

The delay for each switch (including waiting and processing) is 3,10, 20, 7, and 20 ms.
Assuming that the propagation speed is 2×10^8 m,

Find the order the datagram arrival



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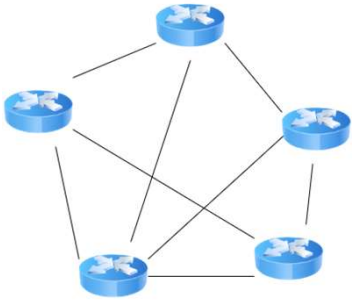

Thank you