TITLE: Study on WANs using Routers.

PROBLEM STATEMENT:

- Demonstration and performance measurement of routing protocols in WANs - OSPF, RIP, EIGRP
- WAN realisation using two routers and performance measurement on HDLC and PPP protocols

Equipment's: Routers (Cisco Routers-Cisco 2811), PCs,

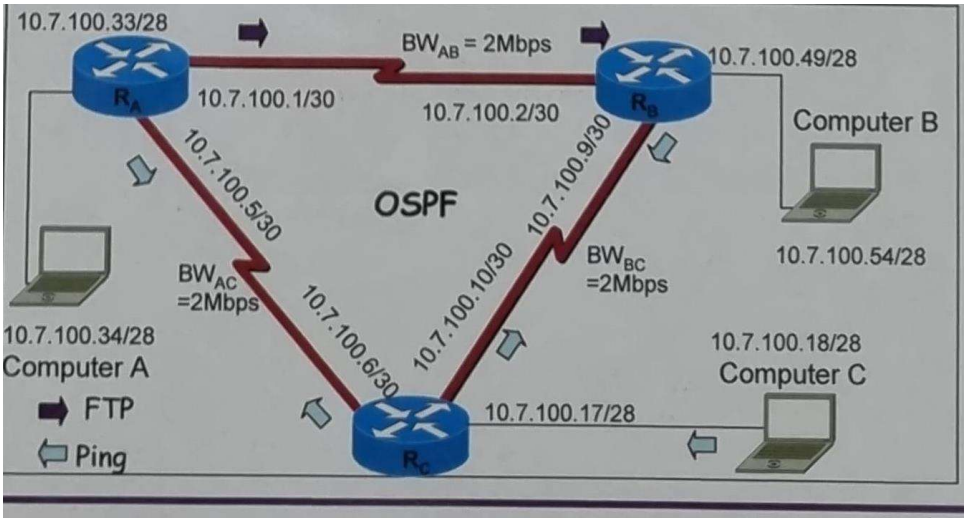
BRIFE THEORY & BACKGROUND:

- **WANs:**

A Wide Area Network (WAN) is a type of computer network that spans over a large geographical area, connecting multiple smaller networks or devices. Unlike Local Area Networks (LANs), which typically cover a smaller area such as a single building or campus**,** WANs can extend across cities, countries, or even continents.
WANs play a vital role in enabling communication and data exchange across vast distances, connecting disparate locations into a unified network infrastructure.

- **OSPF (Open shortest path first)**

Open Shortest Path First (OSPF) is a dynamic routing protocol widely used in computer networks to determine the best paths for routing IP packets.
OSPF is a link-state routing protocol, which means that routers exchange information about their directly connected links with neighbouring routers. This information, known as link-state advertisements (LSAs), is used to construct a complete topology map of the network.
OSPF calculates the shortest path to each destination network using Dijkstra's shortest path algorithm. By considering link costs (**Based on Bandwidth**), OSPF determines the most efficient routes through the network, minimizing delays and congestion.



Command for apply OSPF algorithm in network:

- Router# configure terminal
- Router(config)# router osfp 109 – To declare the ospf
- Router(config-router)#network 10.7.100.0 0.0.0.255 area 0 – To declare network to the router.
- Router(config-router)#exit

Set the bandwidth for operation:

- Router# configure terminal.
- Router(config)# interface serial 0/0/1 (For a connection between A and B)
- Router(config-if)# bandwidth 500 – Changed the bandwidth to 500 kbps from 1544 kbps.
- To increase the traffic between nodes A-C and B-C, from device C we ping both A and B on cmd prompt: Ping (IP address of device) -t -l 15000 – It will continuously send data packets of size 15000 bytes to both devices creating congestion.

Discussion:

When the bandwidth between all the connections (A-B, B-C, C-A) is same i.e. 1544 kbps, the time taken to transfer the file is 46.61 seconds at 238.79 kbps and the path taken will be A to B.

When the bandwidth of the A-B connection is reduced to 500 kbps, the transfer of the file takes 46.63 seconds at 238.71 kbps and the path taken is A-C-B.

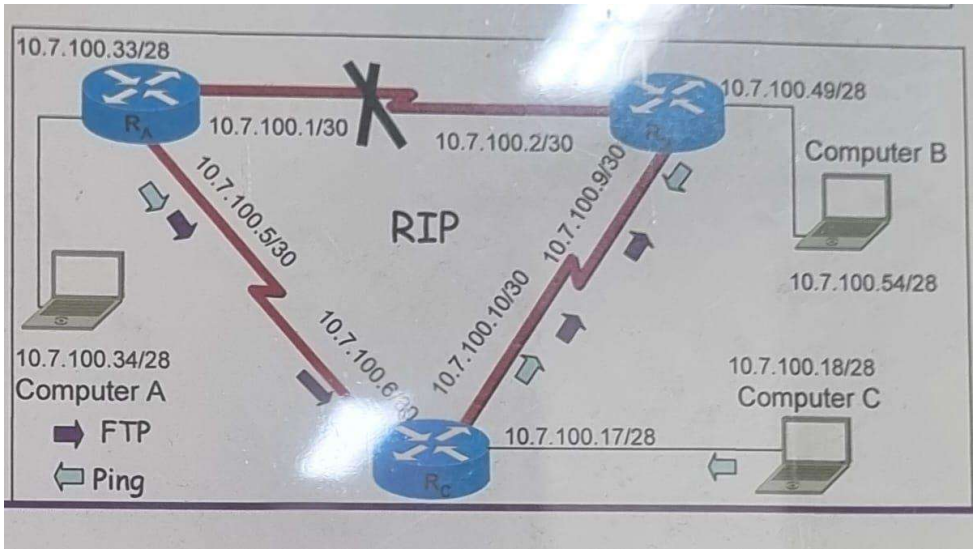
Now, if we increase the traffic of the route A-C and C-B to 15000 bytes, the time taken to transfer the file will increase to 48.86 seconds at 227.79 kbps but it will take the same path as path taken is dependent only on the bandwidth and not any other constraints.

SOURCE	DESTINATION	TRAFFIC	PATH	BW(A-B)	THROUGHPUT (kbps)
A	B	32	A-B	1544	238.79
A	B	32	A-C-B	500	238.71
A	B	15000	A-C-B	500	227.79

- **RIP Routing information protocol (Based on HOP count)**

The messages should include information about network topology, such as the hop count to reach various destinations. Each router maintains a routing table containing information about reachable destinations and their corresponding hop counts. Develop algorithms for updating and maintaining these tables based on information received

from neighbouring routers. RIP has a maximum hop count limit of 15. If a route's hop count exceeds this limit, it is considered unreachable. This limitation restricts the size of networks that RIP can effectively support and makes it unsuitable for larger networks or networks with complex topologies.



Command for apply RIP algorithm in network:

- Router# configure terminal
- Router(config)# no router ospf 109
- Router(config)# router rip – To declare the rip
- Router(config-router)# version 2
- Router(config-router)# net 10.0.0.0
- Router(config-router)#exit

Shut down Link:

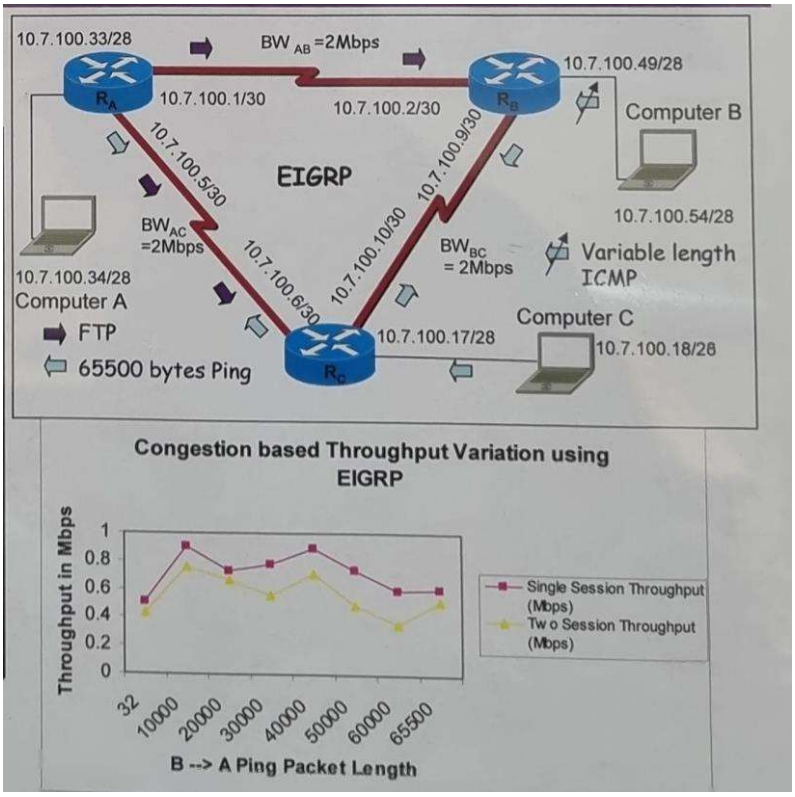
- In config mode:
  #interface serial 0/0/1
  #shutdown
  #sh interface serial 0/0/1 - To check if serial is disconnected or Not.

Discussion: When all links are open, the routing path will be direct from A to B irrespective of the bandwidth of the link. The RIP algorithm only checks the number of hops required to reach the destination.
When A-B link is closed, it only has A-C-B path to transfer the file. But in a WAN with a greater number of connections, it chooses the path with 2nd least number of hops. The maximum number of hops this algorithm allows is 15. After that, the destination is marked as unreachable.

- **EIGRP (Based on BW and congestion):** EIGRP stands for Enhanced Interior Gateway Routing Protocol. It is an advanced distance-vector routing protocol used in computer networks, particularly in enterprise environments. EIGRP incorporates features such as support for variable-length subnet masking (VLSM), rapid convergence, and scalability enhancements compared to traditional distance-vector protocols like RIP. Enhanced Interior Gateway Routing Protocol (EIGRP) is a Cisco-proprietary routing protocol used for routing within an autonomous system (AS).

  Commands to Configure router from RIP to EIGRP:

  - Router# configure terminal
  - Router(config)# no router rip
  - Router(config)# router eigrp 200 – To declare eigrp
  - Router(configuration)# variance 100
  - Router(config-router)# net 10.0.0.0
  - Router(config-router)#exit
  - #sh eigrp topology all-links



Discussion:

It considers so many factors, so routing table gives details about the connection and its cost.

Cost of any connection can be changed by changing the bandwidth of the link.

11130048 bytes of data received in 46.61 seconds at 238.79 kbps.

- **WAN realisation using two routers and performance measurement on HDLC and PPP protocols.**

Theory and Background:

Encapsulation:

- Encapsulation is like putting a letter in an envelope before sending it. When data travels through different parts of a network, it's wrapped in a special cover called a "protocol header and trailer," just like how a letter is put in an envelope for protection. This wrapping helps ensure that the data gets to its destination properly and securely, even as it moves through different layers of the network.
- Think of each layer in a network like a person adding their own cover page and maybe a footer to a document. So, as the data moves through the network, each layer adds its own cover page and footer to the original data, making a new "wrapped-up" packet. This wrapping-up process is really important for sending data across networks and helps different devices in the network talk to each other.
- Encapsulation ensures that data can traverse different network segments and devices while preserving necessary routing and control information at each layer of the network stack.
- It allows for interoperability between devices and facilitates communication across diverse network environments.

HDLC Protocol:

- HDLC (High-Level Data Link Control) is a communication protocol used for transmitting data between devices over a network. It operates at the data link layer of the OSI model, which is responsible for the reliable transmission of data across a physical link.
- HDLC organizes data into frames for transmission. Each frame typically consists of a header, data field, and trailer. The header contains control information for frame synchronization and error detection, while the data field carries the actual payload to be transmitted. The trailer usually contains error detection information.

- HDLC can be used in both point-to-point and multipoint configurations. In a point-to-point configuration, data is transmitted between two devices. In a multipoint configuration, multiple devices can communicate over a shared medium, with one device acting as the primary controller.
- HDLC has been widely adopted in various networking technologies, including synchronous serial interfaces, WAN connections, and link-layer protocols such as PPP (Point-to-Point Protocol) and LAPB (Link Access Procedure, Balanced).

PPP Protocol:

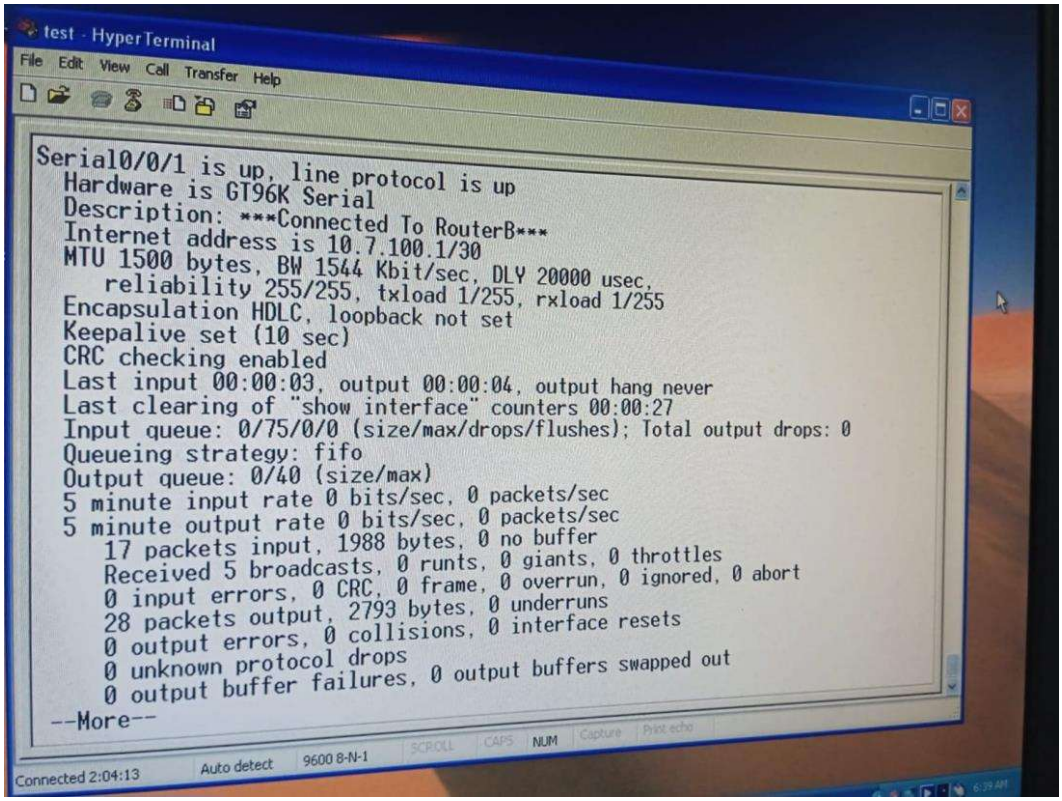
- Point-to-Point Protocol, is a data link layer protocol used to establish a direct connection between two nodes over a serial link.
- It is commonly used in dial-up connections, DSL (Digital Subscriber Line) connections, and other point-to-point links. PPP provides a method for encapsulating packets and negotiating various parameters for data transmission.
- PPP encapsulates network layer packets, such as those using the Internet Protocol (IP), allowing them to be transmitted over a point-to-point link.
- PPP can encapsulate packets from multiple network layer protocols, including IPv4, IPv6, IPX (Internetwork Packet Exchange).

Commands for changing encapsulation:

- Router# configure terminal
- Router(configure)# interface serial 0/0/0
- Router(configure-if)# encapsulation PPP
- Router(configure-if)# encapsulation HDLC

To view the encapsulation:

Router# sh interface serial 0/0/0


test - HyperTerminal
File Edit View Call Transfer Help
Serial0/0/1 is up, line protocol is up
Hardware is GT96K Serial
Description: ***Connected To RouterB***
Internet address is 10.7.100.1/30
MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
CRC checking enabled
Last input 00:00:03, output 00:00:04, output hang never
Last clearing of "show interface" counters 00:00:27
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
17 packets input, 1988 bytes, 0 no buffer
Received 5 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
28 packets output, 2793 bytes, 0 underruns
0 output errors, 0 collisions, 0 interface resets
0 unknown protocol drops
0 output buffer failures, 0 output buffers swapped out
--More--
Connected 2:04:13
Auto detect
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo