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Review of Switching Mechanism and Routing Algorithms for The Design of 1*3 Router Using Verilog

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Abstract
*A key idea in networking is routing, which is figuring out the best way for data to move between two or more computer network devices. The devices responsible for making these decisions are called routers. İt is a network device that connects different networks. İt works at 3rd layer Routers examine the destination address of incoming data packets and decide where to forward them based on routing tables. This paper offers a thorough review of various routing algorithm techniques and switching mechanism employed in computer networks and compare the results and find the best way to implement the 1*3 router Three output ports and one input port make up the router 1x3. Top-level architecture created in Verilog employing sub-modules such as FIFO, FSM, Synchronizer, and Register. Xilinx 14.5 is used to examine and verify the RTL design of routers. This research provides an extensive review of the latest technology in routing by combining traditional methods, modern approaches, and conventional algorithms.*
***Keywords:** Routing Algorithm, Switching Mechnism, Router, Verilog.*

1. Introduction
Selecting a traffic path is the process of routing in a network or communication system. It involves determining the optimal path for data to travel across a network to get from a source to a destination. Ensuring the efficient and reliable delivery of data packets is a critical role in networking. Routers are devices that are crucial to the routing process in computer networks [1]. Routing tables are used by routers to analyze the destination addresses of data packets and determine the optimal forwarding strategy. The network topology and the most efficient routes to particular locations are detailed in these tables. In a network, the routing protocol makes ensuring that information flows between machines correctly. A router uses a routing table to forward packets. Routing protocols are those that are able to learn about all networks, Determine the optimum route to each network and select the most direct route to every connection. Routing protocols are used to create routes between routers and maintain routing the design, and the synthesis, simulation, and the design, and the synthesis, simulation, and coupling of several router sub-modules, including Register, FIFO, FSM, and Synchronizer, to the top module. With System on Chip, a million transistors can be integrated on a single chip. In paper [19] author grouped the existing algorithms into three categories: (a) Routing Algorithms with Static Link Cost (RA-SLC) compute paths by using hop count, distance and/or link capacity which are static link costs that do not change during network traffic. Probe-based methodology outperforms EEGPR and RECIF+PIF. author JP Tsai delivers more dependable interest packet routing while taking router failures into consideration since probes speed up FIB updating. He shows probe-based routing technique leads to efficient routing by reducing network congestion and response time, raising FIB accuracy, and lowering

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reaction time as compared to basic CCN [3] The ratio of the highest congestion to the optimum possible congestion, also known as the competitive ratio, must be small for the static algorithm known as "oblivious routing" to be effective in routing arbitrary user demands. One more routing technique is implemented by author Nemeth shown examination of two performance metrics that emerge naturally in this situation: the expected value of congestion and the probability of congestion [6]. In recent times, programmable routers, or software-defined routers, have become a feasible option for offering an affordable packet processing platform that is simple to extend and program. demonstrate how our uniquely defined input and output traffic patterns can enhance the deep learning-based SDRs' route calculation both analytically and through large-scale computer simulations. According to the simulation results, our solution outperforms the benchmark method, especially when it comes to signaling overhead, throughput, and delay [15].

2. Classification of Routing Protocols

Routing protocols help to ensure that your data travels as smoothly as possible to its destination by determining how it gets there. Routing algorithms help to ensure a seamless routing procedure by determining how your data is routed to its destination. The varieties of routing protocols are endless. Each routing pro-tocol belongs to one of the following groups:

2.1 Distance Vector or Link State Protocols

Protocols with periodic updates are known as distance vector routing protocols. No update is sent for the entire routing table. Not the entire network receives updates; only neighbors who are directly connected receive them. Protocols for distance vector routing are not end-to-end The worlds are the directly connected neighbors and the visibility of the entire network. [1] Due to periodic updates, the convergence of distance vector routing protocols is sluggish, which increases the risk of incorrect information being transmitted in a patch that is made for the network. Distance vector protocols typically transmit nearby devices a routing table chock-full of data. Because they may be installed with little management required, this technique reduces the investment for administrators. **Example:** RIPV2, RIP, Routera

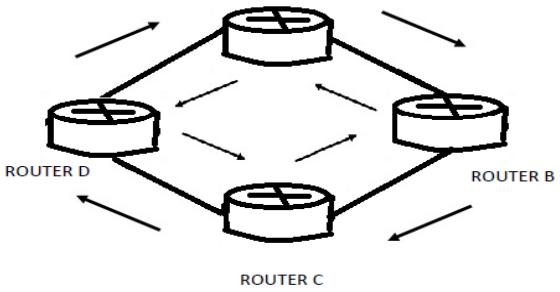

Figure 1 Architecture of Distance Vector Routing Protocol

2.2 Link State Routing Protocols

By exchanging data with nearby routers, link state protocols employ an alternative method for determining the optimal routing path. When determin-ing the route, the speed to the destination and the expense of resources are tak-en into consideration. Link state routing systems utilize an algorithm to ascertain this. Link state protocols differ significantly from distance vector protocols in that routers communicate with one another when they notice changes in a route rather than transmitting routing tables. When determining the route, the speed to the destination and the expense of re-sources are taken into consideration[2]. The routing table keeps the most effective routes, the link state routing protocol to record information about nearby routers.

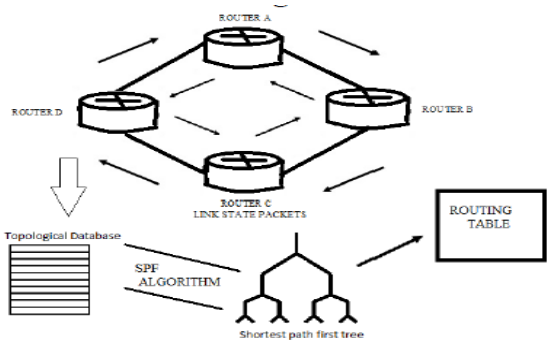

Figure 2 Architecture of Link State Routing Protocol

Updates are not broadcast, but rather multicast. Link State Routing Protocols enable routers create end-to-end network visibility by sending information such

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as OSPF cost and SPF tree table as part of their updates. There are two reasons why convergence is quicker than a distance vector:

1. There is an update trigger.
2. In the form of a topology table, routers have end-to-end network visibility.

Example: OSPF, ISIS [2]

2.3 Interior Gateway

IGPs are routing protocols that provide routing data communication between routers inside an autonomous system (AS). A sole network or a cluster of net-work managed by a sole association is referred to as an AS. Resultant, the firm AS and the ISP AS are distinct. [1] An autonomous system (AS) is a collection of routers and IP networks run by a single organization that provides the inter-net with a single routing policy, uses the Interior Gateway Protocol (IGP) as one of its routing protocols. IGPs are made to help with communication and to figure out the optimal routes for traffic routing inside an autonomous system.

2.4 Exterior Gateway Protocols (EGPs)

This algorithm employed to communicate routing data amongst routers in various autonomous systems. The only EGP protocol is likely to run into is BGP; the other protocols are more complicated. Exterior Gateway Protocol, or EGP for short, is a class of routing protocols that allows autonomous systems (AS) at a network's edges to share routing information.[2] EGP is used to provide routing between many autonomous systems, in contrast to Interior Gateway Protocols (IGP), which function within a single autonomous system. The Bor-der Gateway Protocol (BGP) is the most often utilized EGP.

2.5 Classful Routing Protocol

Protocols with a default mask of (/8, /16, or /24) are considered classful routing protocols. All we have due to setup them for a network is type the address; the mask is automatically applied since the default mask is used.

2.6 Classless Routing Protocol

Any mask other than the default mask is referred to as classless routing proto-col. We must provide them a mask when configuring them for networking since a mask can be anything.

3. Types of Routing Protocols

3.1 Routing Information Protocol

RIP is available in several versions, such as RIPv1 and RIPv2. Network path-ways are determined by the initial version of RIPv1, or RIPv1, depending on the IP destination and number of hops made during the journey. RIP's primary characteristics include being a distance-vector routing protocol, which gauges a destination's distance (or metric) by counting the number of hops required to get there. The RIP measures the total number of hops, or routers, that separate the source and the destination. To keep the network informed of any changes, RIP routers periodically communicate routing information, usually every 30 seconds. RIP uses the split horizon mechanism to prevent routing loops. If a router learns a route from a neighbor, it does not advertise that route back to the same neighbor. Routine poisoning is used by RIP to further prevent rout-ing loops. When a route becomes unreachable, the router advertises it with an infinite metric (16 in RIP) to inform other routers about the unavailability. By broadcasting its IP table to every router on the network, RIPv1 establishes a connection with it. A slightly more advanced version of this, called RIPv2, broadcasts its routing table to a multicast address [5]. Incoming traffic's subnet mask and gateway are chosen by RIPv2 to better safeguard data.

Table 1 Difference Between RIPV1 and RIPV2

Feature	RIPv1	RIPv2
class	distance vector	distance vector
hop count	15	15
addressing	classful	classless
authentication	none	none / text / MD5
routing updates	255.255.255.255	224.0.0.9

3.2 Interior Gateway Protocol (IGRP)

Cisco Systems created the private routing system known as IGRP. As an Interior Gateway Protocol (IGP), IGRP was created to make routing within an autonomous system (AS) easier. However, it is essential to note that IGRP is an outdated protocol

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that has largely been replaced by more modern and widely adopted routing protocols. Cisco Systems created the IGRP protocol in the middle of the 1980s. Although the hop count limit of 16 limited the size of the network and prevented flexibility in complicated contexts, RIP was a viable routing mechanism for small and moderately sized interconnecting networks. IP networks are suitable for IGRP deployments. IGRP is intended to function in all types of network setups. A distance measurement is used by the distance vector routing protocol, or IGRP, to compare the routes. Features like hold downs, split horizons, and reverse updates are offered by IGRP, Because IGRP has a maximum hop count of 255 and broadcasts updates every 90 seconds, it is perfect for bigger networks.[2] It can support bigger networks than a proto-col like RIP because of this. Because IGRP automatically updates itself as a network's path changes, it is also frequently utilized despite its resistance to routing loops.

3.3 Open Shortest Path First (OSPF)

It is specifically designed to function with IP networks by utilizing this meth-od. The least path spanning-tree is found using this routing technique ensuring efficient packet transfer. The surrounding network topology is extensively documented in databases that are maintained by OSPF routers. This database holds information received from other routers' Link State Advertisements (LSAs). LSAs are packets that include information about how much resources are needed for a particular path. Additionally, OSPF uses the Dijkstra algorithm to update network pathways when the topology changes. Because it can authenticate protocol changes to protect data, this protocol is also comparative-ly secure Several companies use it because it can be scaled to large areas. OSPF can recalculate compromised packet pathways if a previously utilized route is blocked, and it also maintains track of topology changes. [3]

3.4 Enhanced Interior Gateway Routing Protocol (EIGRP)

The initial IGRP was intended to be followed by the Cisco-only EIGRP proto-col. A router uses EIGRP to record information from the routing tables of its neighbors. When a change happens, the router alerts the neighbors about it. Neighbor are asked for a route. In the end, this causes the routers in the vi-cinity to learn about what is happening in other devices. but includes addition-al features to enhance performance and stability. This provides more flexibility in designing and managing IP addressing schemes [2]. To determine the opti-mal route to a destination. EIGRP is known for its fast convergence capabili-ties. It reacts quickly to network topology changes by recalculating routes. EIGRP can operate with multiple network layer protocols, although it is com-monly associated with IPv4. Cisco has also introduced EIGRP for IPv6 to sup-port the next generation of the Internet Protocol.

3.5 Border Gateway Protocol (BGP)

BGP, the internet's routing protocol, which belongs to the distance path vector group, is called BGP, or the Border Gateway Protocol. BGP was created as a decentralized routing protocol to take the place of EGP. For data packet trans-fers, the optimal routes are chosen using the BGP Best Path Selection Algo-rithm. In the absence of any specific parameters, BGP will select routes that take the quickest way to the destination. By altering the BGP cost community characteristic, one can modify the optimal routing path selection algorithm. Updated router table data is only transmitted by BGP in response to events. As a result, changes in topology are not automatically detected, necessitating ex-plicit BGP configuration by the user. BGP can be authenticated to limit data exchange between authorized routers in terms of security. .

3.6 Intermediate System-to-Intermediate System (IS-IS)

IP routing information is sent over the internet using the link-state Intermediate System-to-Intermediate System (IS-IS) and IGPP protocols. IS-IS uses an al-tered version of the Dijkstra algorithm. A variety of elements make up an IS-IS network, such as areas, domains, intermediate systems (routers), end systems (user devices), and areas. Routers are arranged into groups under IS-IS called areas, and several areas are combined to form a domain. Layer 1 routers are those located within the region, and Layer 2 routers are those that link segments together. When it comes to network addresses.

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4. Types of Switching Techniques

Routers in modern computer networks primarily use packet switching, and within packet switching, the two main approaches are datagram switching (connectionless) and virtual circuit switching (connection-oriented) The optimal technique will depend on the particular requirements and characteristics of the network.

4.1 Datagram Switching (Connectionless)

In datagram switching, every packet is handled separately, and it could travel via various routes to get to its destination. There is no need for a pre-established connection or dedicated path. The Internet, based on the Internet Protocol (IP), is a classic example of a datagram-switched network. IP is con-nectionless and uses routers to make independent forwarding decisions for each packet. Datagram switching is commonly used in routers, especially in the context of the Internet (IP-based networks). Routers make independent for-warding decisions for each packet based on destination addresses, and the flex-ibility of datagram switching aligns well with the dynamic nature of internet traffic. İt is Simple and flexible, Each packet is treated independently, making it well-suited for handling variable data rates and bursty traffic and also Can adapt to changes in the network topology or node failures without affecting the entire communication.

4.2 Virtual Circuit Switching (Connection-Oriented)

Data transmission in virtual circuit switching starts with the establishment of a logical path or circuit between the source and destination. The path is maintained for the duration of the communication session. The path is determined during a setup phase and remains fixed until the session concludes. Multiprotocol Label Switching (MPLS) is an example of a technology that supports virtual circuit switching in modern networks. MPLS can create label-switched paths (LSPs) to forward packets along a predefined route. It has a predefined path is established before data transmission, ensuring that packets follow the same route, which can simplify congestion control and quality of service (QoS) management. it Potentially lower overhead ,Once the virtual circuit is estab-lished, subsequent packets only need to carry the circuit identifier, reducing per-packet overhead. Virtual circuit switching, while less common in internet routing, may be employed in specific scenarios where predictable routing paths and lower overhead are essential. Technologies like MPLS (Multiprotocol La-bel Switching) provide a way to implement virtual circuits in IP networks for certain applications. The Internet, based on the Internet Protocol (IP), is a classic example of a datagram-switched network. IP is con-nectionless and uses routers to make independent forwarding decisions for each packet.

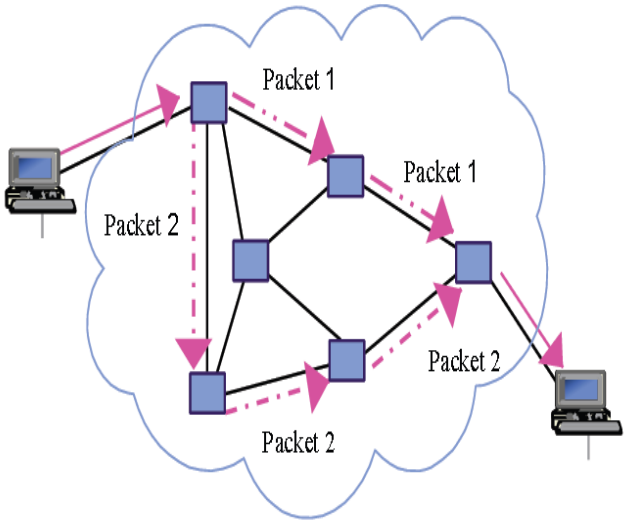

Figure 3 Datagram Switching

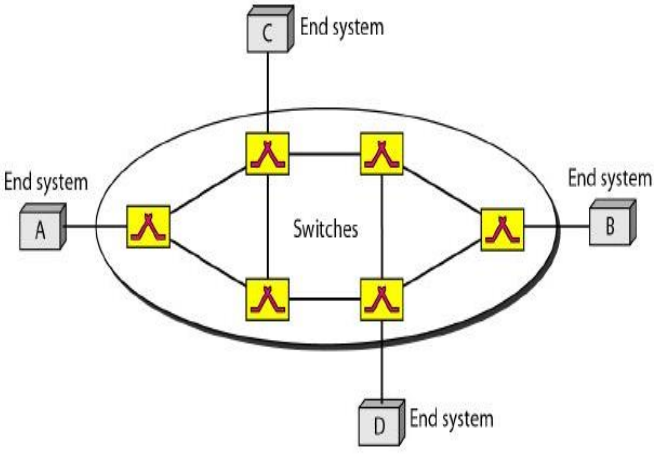

Figure 4 Virtual Circuits Switching.

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4.3 Circuit Switching

Circuit switching is a communication method used in telecommunications networks where two devices construct a dedicated communication line or cir-cuit just for the purpose of having a conversation. This path remains continu-ously open and reserved exclusively for those two devices, allowing them to exchange data Here are the key characteristics and steps involved in circuit switching:

a) **Connection Establishment:** Before data transmission can begin, a dedicated circuit must be established between the calling and receiving devices. This in-volves a series of signalling processes to set up the path through the network.
b) **Path Reservation:** Once the connection is established, the communication path is reserved for the exclusive use of the two devices involved in the con-versation. This ensures that no other devices can use the same circuit during that time.
c) **Constant Bandwidth:** Throughout the communication, a consistent band-width is guaranteed by the dedicated circuit. This indicates that the data rate continues to be steady and predictable.
d) **Fixed Route:** The route taken by the communication path is fixed during the entire duration of the connection. This can be both an advantage and a limita-tion, depending on the network design.
e) Differences b/w Circuit switching, Datagram approach and Virtual Circuit approach. Circuit switching Datagram packet switching Virtual circuit switching

Intense traffic might slow down call setup and lengthen packet latency. switching nodes that are computerized or electromechanical small nodes for switching small nodes for switching for message loss protection, the user is accountable. Packets may be handled individually by the network. Packet sequences may be within the control of the network. Typically, neither speed nor code translation Rapidity and conversion of codes Rapidity and conversion of codes set bandwidth flexible bandwidth utilization Flexible in each packet. After the call setup, there are no extra bits. Each message has ex-tra bits Every packet has extra bitsThe entire conversation's path is set. Every packet has its own route created. Entire conversation has its own route created.

5. Simulation Results

After synthesizing the top module of 1*3 router in Xilinx software we get the schematic of the waveform as shown in below fig 7 . Routers RTL design ana-lysed and verified using Xilinx 14.5. Simulation of RTL design carried on model Sim.

Figure 5 RTL Design of 1*3 Router

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Table 3 Comparative Analysis of Routing Protocol

Features	RIPV1	RIPV2	OSPF	EIGRP	IGRP	ISIS	BGP
Algorithm	Distance vector	Distance vector	Link state	Both distance and link stste	Distance vector	Link state	Both path algorithm
Metric	Hop count	Hop count	Cost Bandwidth	Latency in Bandwidth,reliaility	Latency in Bandwidth ,reliaility	flexible	Hop count
complexity	simple	simple	comparatively intricate	extremely intricate	More intricate than Rip	intricate	intricate
convergence	slow	slow	Faster than RIP	fast	slow	fast	average
Max no of hops	15	15	A single sub-system is considered a self-sufficient system.	Max 255	Max 255	none	255
ports	UDP520	UDP520	IP89	IP88	IP9	IP124	TCP 179
Scale	Mini network	Mini network	Enterprise network	Moderate network	Small to large	large	Connect to different AS
Routing	Classful routing loop	classless	classless	Classless 100% loop free	classful	classless	classless

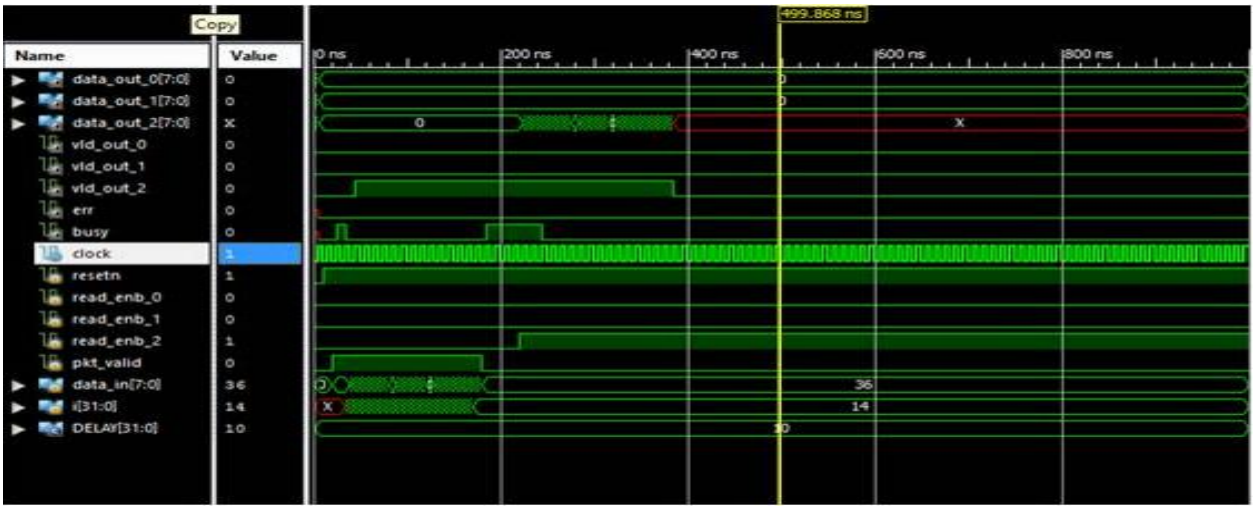

Figure 6 Waveform of 1*3 Router

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Table 2 Difference Between Switching Techniques

Circuit Switching	Datagram Packet Switching	Virtual Circuit Switching
Call setup may be blocked by overload, but established calls are unaffected.	Packet delay is increased by overload.	Intense traffic might slow down call setup and lengthen packet latency.
switching nodes that are computerized or electromechanical	small nodes for switching	small nodes for switching
For message loss protection, the user is accountable.	Packets may be handled individually by the network.	Packet sequences may be within the control of the network.
Typically, neither speed nor code translation	Rapidity and conversion of codes	Rapidity and conversion of codes
set bandwidth	flexible bandwidth utilization	Flexible in each packet
After call setup, there are no extra bits.	Each message has extra bits	Every packet has extra bits
The entire conversation's path is set.	Every packet has its own route created.	Entire conversation has its own route created.

Conclusion

The focus of this study is on the varies routing protocols and switching techniques. In essence, routing helps the routers communicate with one another and share information whereas the Switching technique is used to connect the systems for making one-to-one communication. In a network, routing protocols are used to choose the optimum path for data transport. Here, various routing and switching techniques are discussed, and the characteristics of each routing protocol and switching technique have been compared and implementing it through the design of 1*3 router coded in Verilog. This is to determine the optimal combination of protocols for any intricate network to achieve dependable and quick communication. The choice of switching and routing protocols for a 1x3 router would depend on the specific requirements of your network and the nature of the traffic it will handle. For a 1x3 router, the primary switching consideration is likely the type of switching technology used. Two common types are:

a) Circuit Switching

Advantages: Dedicated bandwidth for the duration of communication, suitable for real-time applications like voice. Considerations: Inefficient for bursty or intermittent traffic.

b) Packet Switching

Advantages: Efficient use of network resources, supports bursty traf-fic, widely used in modern data networks. Considerations: fluctuating latency, which might not be appropriate for voice or other real-time apps. For a 1x3 router, where the network is expected to scale, experience changes in topology, or involve multiple interconnected devices, dynamic routing protocols are generally more suitable than static routing. dynamic routings are OSPF, EIGRP, RIP, etc. The choice of the best routing protocol for 1x3 router design is dependent on the network's complexity and scale, among other things, scalability requirements, convergence speed, and the specific features offered by each protocol. RIP (Routing Information Protocol) has Advantages like it is Simple and easy to configure. Suitable for small to medium-sized networks.it Convergence can be slow and less scalable compared to OSPF or EIGRP. it is best suited small networks with simple topologies. EIGRP (Enhanced Interior Gateway Routing Protocol) it has Fast convergence and Efficient use of band-width. OSPF (Open Shortest Path First) is best Suitable for medium to large networks. Fast convergence, Supports variable-length subnet masking (VLSM) . BGP (Border Gateway Protocol) is Scalable for large networks, particularly at the Internet edge Policy-based routing.it is considered

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for More complex and designed for inter-domain routing. Convergence can be slow for certain scenar-ios. after all analysis he best routing protocol depends on your specific network requirements. For a 1x3 router in a medium-sized network with dynamic topol-ogy changes, OSPF or EIGRP may be suitable choices. If you are in a Cisco-centric environment, EIGRP could be a good fit. If we connecting to the Inter-net or interconnecting autonomous systems, BGP may be required.

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