Comparative performance evaluation of RIP with OSPF routing protocol

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***Abstract*— Routing protocols are a set of rules used by routers to exchange data between source and destination devices. There are quite a number of routing protocols, out of which, Routing Information Protocol and Open Shortest Path First routing protocols play a dominant role in the internet for optimal data transfer and communication paths in the network. This research paper will basically discuss the performance evaluation of wired routing protocols Open Shortest Path First (OSPF) & Routing Information Protocol (RIP). Also, this paper will use network performance metrics traceroute for the performance evaluation of these routing protocols and discuss the most appropriate routing protocols for small and large-sized network design.**

Keywords— *OSPF, RP, RIP, CBR, voice application, transmitter power (mW), antenna gain.*

I. Introduction

A computer network is the interconnection of computers either using weird or wireless media alongside its peripherals to facilitate the sharing of information among them. [18], Computer network is the act of connecting two or more computers electronically for the purpose of sharing information and to allow collaboration between users in a wide range to communicate and share available resources [10].Computer networks are divided into many types and are available in various industries. However, this research will introduce three main types of computer network namely; PAN, LAN, WAN, and MAN.

A Personal Area Network (PAN) connects an individual person to his/her personal devices around him/her via wired or wirelessly such as mobile phone, computer, smart watches, ear buds etc. This connection established among the devices; PAN enables communication among these devices [19].

A Local Area Network (LAN) comprises of two or more computers that are connected through network media channels and designed to operate and span within a short distance normally in buildings, school, or home. It's usually privately owned and has topologies such as bus, ring, star, and tree [10].

A Wide Area Network (WAN) interconnects several LAN's using satellite links, leased telephone lines or similar network media channels from various locations such as buildings, school, and home to form a wider network that spans to wider areas such as countries, states, and the world in general[10].

A Metropolitan Area Network spans throughout a city by connecting a number of LAN's to a large network so that resources can be shared LAN to LAN and as well device to device. It can be a single network such as cable TV network [10].

However, the network this research will basically focus on is the LAN network. The following routing protocols would be used in attaining the objective of this research which is to measure the performance of both RIP and OSPF.

Open Shortest Path First (OSPF), is a dynamic and hierarchical routing protocol that utilizes the Dijkstra Shortest Path First algorithm (SPF) to calculate the shortest routing path and designed to support routing in Transport Control Protocol (TCP) / Internet Protocol (IP) networks within an area. It's designed to scale efficiently to support large enterprise networks [17].

OSPF is a link-state technology and a classless protocol, its multicast either to address 224.0.0.5 of all OSPF routers or 224.0.0.6 all designated routers. It interrelates the Hello, Election, Flooding and Shortest Path-First (SPF) algorithms to form neighbor relationships with adjacent routers in the same area. Since it uses Link-State, it breaks the traditional method of advertisement which is advertising the distance. It instead advertises the status of directly connected links using Link-State Advertisements (LSAs) when it notices a change to one of its links to update it. The LSAs is refreshed every 30 minutes [3].

The process of OSPF builds and maintains a neighbor table (contains list of all neighboring routers), a topology table (contains list of all possible routes to all known networks within an area) and a routing table (contains the best route for each known network) [3].

Routing Information Protocol (RIP), is a distance-vector protocol designed for use on smaller networks, it uses a form of distance (hop count) as its metric to rate the value of different routes, and sends out periodic routing updates every 30 seconds and sends out the full routing table every periodic update. Through limiting the number of hop counts allowed in paths between sources and destinations, RIP prevents routing loops whereas the maximum number of hop counts allowed for RIP is 15, and if goes beyond the route is considered as unreachable [4].

RIP has two versions (RIPv1 and RIPv2) and utilizes the Bellman-Ford distance-vector algorithm to determine the best path to a particular destination based on distance. RIPv1 is classful and uses broadcast UDP packets that doesn't include a subnet mask with its routing table updates, and is a contiguous network that does not allow varying subnet masks to exist. While RIPv2 is classless which uses multicast packets to exchange the routing information that includes the subnet mask with its routing table updates and allows discontiguous networks and varying subnet masks to exist [11].

A network simulator enables users to virtually create a network comprising of devices, links, applications etc, and study the behavior and performance of the Network. The scope of this research is to measure the performance evaluation of routing protocols of both RIP and OSPF of a LAN network.

II. ROUTING PROTOCOLS

A. Routing Information Protocol

This section will present an evaluation of wired RIP and OSPF routing protocols. The goal of routing protocols is to forward data packets from the source to the destination. The difference between the routing protocols to be discussed in this research are basically based on searching, recovering of the route path, and maintenance [2].Routing protocol is a process by which network information are obtained, and by which sent data packages are controlled by the means of an algorithm which determines a specific route to take. Its purpose is to reduce the time delay, reduce power consumption, reduce packet loss rate, reduce routing overload, improve bandwidth usage, and improve throughput [2][7].According to [2] [22], RIP uses a distance-vector algorithm and is a dynamic protocol that is mostly deployed in LAN and WAN networks. It's been updated from RIPv1 to RIPv2 and now to RIP next generation (RIPng). According to [20], RIP has four main components for its routing metric which are routing stability, routing timers and routing update process.

Research papers [2][7][22][4] highlighted some of its merit like supports load balancing, prevents routing loop due to limiting hop count to 15, capable of been implemented on all routers, and works well in small networks. According to [22] [4], the transport protocol used by RIP is User Datagram Protocol (UDP) and has a reserved port number of 520.

According to [4], RIP determines best path to route data packets using hop count as a routing metric which is the total number of hops it traverses to reach the intended destination. However, it has a maximum of 15 hops that it can traverse. The research papers [2] [7][22][4] also indicated some of its weaknesses such as lack of efficiency, bandwidth consumption, congestion, convergence time and scalability limitation due to the maximum hop count of 15.According to [2][22][4], in RIP network with its distance-vector, the neighboring routers receives an entire broadcast of an RIP table of the sending router after every 30 seconds. Here, the neighboring router that receives the RIP table will then

update its own routing table with the information and then immediately sends the updated table to its neighbors.

According to [7][4][20, performance is regulated in RIP network using four kinds of timer namely; route update timer, route invalid timer, hold-down timer, and route flush timer. The Route update timer sets 30 seconds interval for a router to send its entire routing table to its neighbors. The Route invalid timer sets 180 seconds time to determine the invalidity of a route that hadn't updated. The hold-down timer sets 180 seconds to determine for how long to suppress a routing information when an update packet is received but an indication to the route is unreachable. The flush timer sets 240 seconds by default to remove an entry from the routing table when a route is marked unreachable or invalidated.

B. Open Shortest Path First Protocol

According to [12][20][13][8], OSPF is based on open standards and mostly deployed by corporate network which uses Link State Advertisement (LSA) routing protocol, it calculates route based upon data stored in a Link State Database (LSDB) and uses Djkstra's algorithm to determine and choose the shortest and more intelligent path available to deliver packets to the best and shortest path in the network from source to destination within the LSDB to send information to its neighboring routers using accumulating cost of links in the path. This is because OSPF routers knows its OSPF neighbor and full adjacency and topology table. According to [20], it was created in other to overcome efficiency and to address the issues RIP network encounters as discussed earlier. The journal further states that it has different packets such as hello packets, topology description, link state request, link state update, and link state acknowledgement. Moreover, it provides with only one type of timer which is hello timer which interface at to 10 seconds and dead time at 120seconds.According to [9], OSPF detects changes in the topology such as link failures and convergence loop-free within seconds that was constructed to determine the routing table.

According to [12][20], it states the merits of OSPF is that it overcomes the RIP problems by the support of the Variable Length Subnet Mask, has better convergence, load balancing, no limitation of hop-counts, supports IP-multicast for sending updates and reducing load on the network, provides authentication, and the network can be divided into areas. According to [12][20], some of the demerits of OSPF is that it requires more memory resources to hold neighbor information tables, extra CPU processing to run SPF algorithm, difficulty to configure distance vector protocol.

C. Comparison between RIP and OSPF

TABLE I. COMPARISON BETWEEN RIP AND OSP

	RIP		OSPF
	RIPv1	**RIPv2**	
Speed of Convergence	Slow		Fast
Scalability-Size of Network	Small		Large
Use of VLSM	No	Yes	Yes
Routing	Classful	Classless	Classless
Administrative distance	120		110
Authentication	No	MD5	MD5
Protocol	UDP		IP
Protocol Variety	Distance vector		Link-state
Transmission	Broadcast	Multicast	Multicast
Standard	Open		Open

Metric	Hop count	Bandwidth/ Delay
Resource Usage	Low	High
Implementation	Simple	Complex
Algorithm	Bellman-ford	Dijkstra
Path Selection	Hop based	Shortest path

III. METHODOLOGY

This section had will discuss on the type of methodology and simulator software that this research has adapted to make a review on. This research will implement the quantitative research methodology to research and show the simulations conducted in other researches to show the performance evaluation of the RIP and OSPF routing protocols using wired media connections to the nodes. The simulation results will be studied based on a reference research paper that used a Graphical Network Simulator (GNS3) as a tool to measure the performance of both RIP and OSPF routing protocols to identify which is best for a real-time computer network [16].

To identify the routing protocols performance of both RIP and OSPF, the reference research used “Ping” to identify the packet delivery and used “traceroute” to identify the path that was passed using the GNS3 tool.

A. Simulator

Graphical Network Simulator (GNS3) is the tool that the research paper to be studied by this research used to measure the performance of the RIP and OSPF protocols. The research highlighted that it chose GNS3 software over Packet Tracer and other simulation tools because it focusses on running a test on the host specifications to comprehend the logic of what’s expected by allowing various parameters available to be set up in the real network, in this context, the performance measurement. It further states that the GNS3 tool supplies with a realistic approach when simulating a network [16].

Graphical Network Simulator (GNS3) is a tool that allows multiple emulated systems such as Cisco routers, Windows and Linux virtual machines, Juniper and Vyatta routers, to emulate, prototype complex networks without the need for physical routers using Cisco Internetworking Operating Systems. It was primarily developed by Jeremy Grossmann. [6].

B. Simulation Scenario

The objective of this research is to conduct a performance evaluation on a wired network of both RIP and OSPF routing protocols by reference. However, to achieve this, performance metrics needs to be adopted such as throughput and delay.

The throughput measures the number of packets that had been delivered per unit of time, while delay is the time interval a packet is sent from source to the intended destination [2].

The reference performance evaluation will be referred to a journal [16] where they conducted an experimental simulation on the performance of RIP and OSPF protocols.

The simulation conducted by the reference research paper that is been studied used seven Cisco routers to design a LAN on an IPv4 networks to conduct the performance tests for both RIP and OSPF routing protocols. For the seven routers, each network is identified with a respective Class C IP addresses on its router and configured with a loopback address of Class A addresses respectively. The research paper did not provide with various nodes nor switches to each network segment. The research paper used tables and screenshots to discuss on the results of the performance key metrics.

To identify the routing protocols performance, the reference research used “Ping” to identify the packet delivery and used “traceroute” to identify the path that was passed using the GNS3 tool [16].

C. Routing Protocols Simulation in Wired Network

When simulating a wired network, physical wired links need to be established to interface links that connects to the hosts together with setting up the nodes via configurations of routing protocols so as the traffic would work and flow conveniently. In doing so, the network technician or engineer must set the bandwidth and delay [15].

The key metrics used by the reference research paper [16] that this research is referring to are throughput and delay. Throughput measures the number of packets that had been delivered per unit of time, while delay is the time interval a packet is sent from source to the intended destination [2].

The reference research paper used [16] utilized same network design topology to provide information for both the RIP and OSPF protocols. It used seven Cisco routers to design a LAN for both the RIP and OSPF. On this topology, to avoid lower latency and get higher throughput it has a series and parallel wired connections to routers. Basically, it wired connected R1, R2, R4, R5 one after another, then it connected from R3, R6, R7 one after another. It is then parallelly wired connected R2 to R3 and R5 to R6. However, in the topology a long path connectivity exists of R1 – R2 – R4 – R5 – R6 – R7 directly, whereas the shortest path was the wired connectivity of R1 – R2 – R3 – R6 – R7 [16].

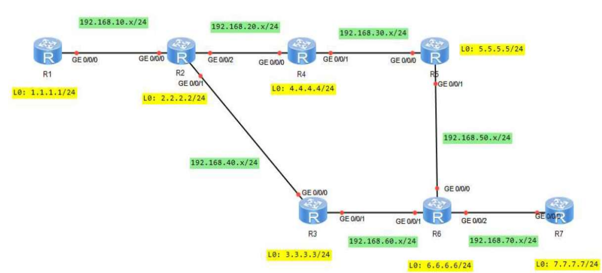

Fig. 1. Wired Network Design Topology [16]

D. Performance Evaluation of Routing Information Protocol (RIP)

The research paper [16], used the above network design to simulate RIP protocol whereas it provides with the hostname, router version, and interface configurations. The information is shown in Table II.

TABLE II. THE RIP INFORMATION CONTENTS

	RIP
Interface	Fast Ethernet
Hostname	R1 To R7
Router version	Ver. 2

After it identified with the information above, the reference research then configured the loopback addresses and IP addresses where the simulation was conducted upon successful IP and loopback configuration. The shortest path was determined upon sending a ping request test. Below is the IP and loopback configurations for the design topology.

No	Router Name	IP Address	Int LoopBack
1	Router 1 (R1)	192.168.10.1	1.1.1.1/24
2	Router 2 (R2)	192.168.10.2 192.168.20.1 192.168.40.1	2.2.2.1/24 8.8.8.1/24
3	Router 3 (R3)	192.168.40.2 192.168.60.1	3.3.3.1/24
4	Router 4 (R4)	192.168.20.2 192.168.40.1	4.4.4.1./24
5	Router 5 (R5)	192.168.30.2 192.168.50.1	5.5.5.1/24
6	Router 6 (R6)	192.168.50.2 192.168.60.2 192.168.70.1	6.6.6.1/24
7	Router 7 (R7)	192.168.70.2	7.7.7.1/24

Fig. 2. Topology Design Configurations c[16]

Two tests were conducted; "Ping" was initiated to determine the amount of time it takes the routers to communicate and "traceroute" was initiated to determine the shortest path from the R1 to R7 and the time taken to communicate.

E. Performance Evaluation of Open Shortest Path First (OSPF)

The research paper [16], used the above network design to simulate OSPF protocol whereas it provides with the area, router version, router-id and interface configurations. The shortest path was determined upon sending a ping request. The information is shown in Table III.

TABLE III. THE OSPF INFORMATION CONTENTS

	OSPF
Interface	Loopback0, Fast Ethernet
Area	Area 0 OSPF
Hostname	R1 To R7
Router version	Protocol OSPF 1
Router-id	**R1** = 1.1.1.1 To **R7** = 7.7.7.7

Two tests were conducted; "Ping" was initiated to determine the amount of time it takes the routers to communicate and "traceroute" was initiated to determine the shortest path from the R1 to R7 and the time taken to communicate.

IV. RESULTS AND DISCUSSION

This section presents the result findings of the reference research simulation studied conducted and its discussion.

The table below will show the ping test initiated in the RIP and OSPF performance evaluation in which it was set to retrieve each of the routers communication for 4 times for an optimal result.

TABLE IV. THE PING TEST RESULTS IN RIP AND OSPF

			RIP	**OSPF**	
No	Router Communication	Number of Test	Average (ms)in GNS 3	Average (ms) in GNS 3	Success
1	R1 – R2	I	94	77	100%
		II	113	97	
		III	214	107	
		IV	177	83	
2	R2 – R3	I	129	102	100%
		II	112	114	
		III	164	100	
		IV	175	88	
3	R2 – R4	I	130	164	100%
		II	183	142	
		III	156	107	
		IV	174	108	
4	R4 – R5	I	126	120	100%
		II	132	110	
		III	112	92	
		IV	196	88	
5	R5 – R6	I	156	97	100%
		II	112	116	
		III	147	104	
		IV	131	121	
6	R6 – R7	I	148	110	100%
		II	203	94	
		III	133	84	
		IV	136	127	
7	R3 – R6	I	101	71	100%
		II	121	90	
		III	160	79	
		IV	176	84	
8	R1 – R7	I	482	399	100%
		II	366	327	
		III	475	307	
		IV	393	329	

Based from the table above, the average time attained of 177ms in RIP whereas 83 in OSPF I the 4th test from R1 to R2 shows that RIP is slower than OSPF likewise from the nearest router to the farthest. It proves that OSPF data transfer time is better than RIP, it has broader reach of networks and more convergence speed.

The other metric which is the "traceroute" was used to send data packet which in return shows the shortest path whereas it took R3 then goes to R6. The table below shows the traceroute results. However, the figure 5.1 and 5.2 are results from command prompts, these results were studied to produce the information in the Table V.

TABLE V. THE TRACEROUTE TEST RESULTS IN RIP AND OSPF

			RIP	**OSPF**
No	Router Trace	Number of Test	Time I	Time II
1	Method of OSPF R1 – R7 Farthest router distance	I	268	388
		II	540	524
		III	388	280
		IV	316	580
		V	400	348
		VI	384	392
2	Method of RIP R1 – R7 Farthest router distance	I	380	848
		II	572	432
		III	256	540
		IV	388	464
		V	468	932
		VI	500	772

Figures 3 and 4 shown a subset of visualizing the Table V. RIP and OSPF results.

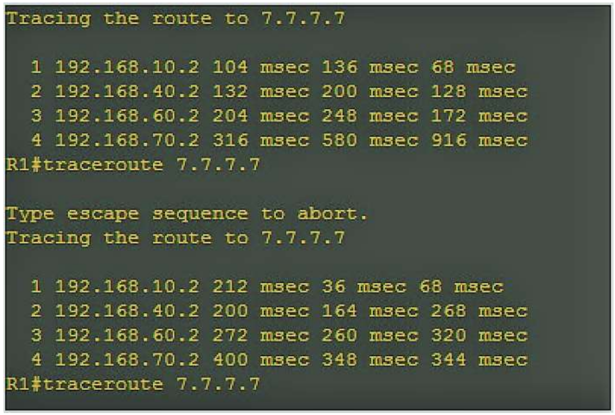

Fig. 3. Traceroute of RIP Protocol [16]

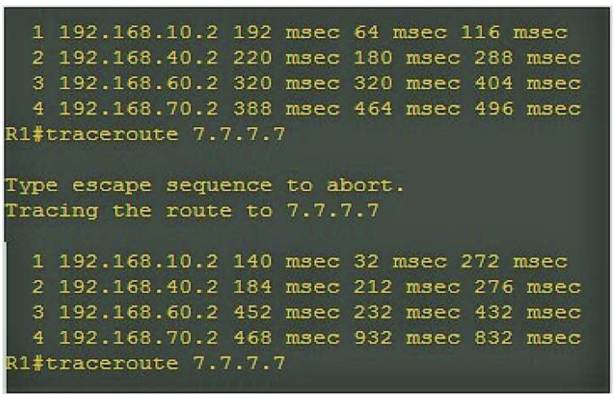

Fig. 4. Traceroute of OSPF Protocol [16]

V. CONCLUSION

The results of this research were obtained from a reference research paper whereas the aim of this research is to evaluate on performance of RIP and OSPF routing protocols using wired connection. RIP which is a "distance vector" routing protocol determines the best paths while OSPF which is "link state" determines the first shortest path. The evaluation performance metrics considered were throughput and delay. The simulation indicates that OSPF outperforms RIP in a wired LAN connection through efficient throughput and packet delay in the networks because of the link and coverage adjustments. [20]. However, if RIP is deployed within a limited number of nodes, its performance is better than OSPF. The ping and traceroute command were used to obtain the average time, based from their results obtained, OSPF is faster than RIP.

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