Performance Evaluation of Wireless Routing Protocols: RIP and OSPF in WLAN

Abdulla Muaz
School of Technology
Asia Pacific University of Technology and Innovation (APU)
Kuala Lumpur, Malaysia
tp060110@mail.apu.edu.my

Dr Kuruvikulam Chandrasekaran Arun
School of Technology
Asia Pacific University of Technology and Innovation (APU)
Kuala Lumpur, Malaysia
kchandran.arun@staffemail.apu.edu.my

Abstract— ***The network layer's function is to route packets from the source device to the destination device with the help of routers. The routers route the packets using various routing protocols. In this paper, we analyze and compare the routing protocols RIP and OSPF used by routers to see which routing protocol performs better in wireless network in terms of performance. Also, the paper presents the simulation results of these protocol comparisons in terms of throughput and delay.***

Keywords— OSPF, RIP, WLAN, CBR, Voice Application, Transmitter Power (mW), Antenna Gain.

I. Introduction

In the world of digital connectivity, network performance is the most important attribute of all. Today, almost every one of us is connected through a wireless device and very much importance is given on the performance of the network we are on. Whether it is a home, a school, a university or a huge company, the fact remains the same. According to [1], there over 18.2 million wireless local area (WLAN) connected devices across the world. The report which he published on statista.com also forecasts that this number will reach up to 22.2 million by the year 2021. This shows how fast the use of WLAN connected devices increases in the organizations. Wireless peripherals such as laptops, smartphones, cameras and printers offer organizations and users many benefits such as portability and flexibility, increased productivity, and lower installation costs [2]. But can they perform well without a proper WLAN network?

In order to achieve the best out of all these digital services, we need to have a quality network in terms of the performance. In a network, data from one device to another is sent as Internet Protocol (IP) packets. Sending of these IP packets is the primary purpose of routers in a network [3]. When a packet travels from one node to another, it passes through several routers and normally there exist multiple paths between source and destination. The routing protocols of the network layer decides which path a packet to follow from a source to a destination [4]. There may be several limitations in providing the right route for the user to in order to send and receive the data. These limitations may be the number of routers in the network, the distance between the routers or the nodes, network traffic or the size of the network. Hence choosing the most appropriate routing protocol for a network is one of the most critical task of a network manager.

This paper will discuss about the two of the most common routing protocols which are, Routing Information Protocol (RIP) and Open Shortest Path first (OSPF). The paper will provide a detailed literature review on these two routing protocols, also highlight about the kind of environment these routing protocols suits the best. Besides that, Empirical evaluation of RIP and OSPF will be performed using NetSim simulator to make sure if the results match with the studies done by the researchers. The performance of both RIP and OSPF routing protocols will be analyzed based on the average throughput and average delay of each protocol.

II. Routing Protocols

In networking, routing can be done either by manually (i.e. Static routing) or with routing protocols (i.e. dynamic routing). According to [5], static routing configures routers manually so it does not check the connection once it has been established, however dynamic routing protocol periodically checks the connection for update as it is maintained dynamically with the help of routing protocols. When compare with dynamic routing protocols, static routing protocol requires very less memory. As a result, it is very efficient in bandwidth allocation. On the other hand, dynamic routing protocol is simpler to configure and if any router goes down it would choose a different or better path between sources to destination [5]. In case of static routing it would be a difficult task for the administrator if he has to do any update in the routing configuration.
For many reasons, dynamic routing protocols are most widely used routing protocol in the latest world of networking. RIP and OSPF both falls under dynamic routing protocols which will be discussed in the following sections.

A. Distance Vector and Link State Routing protocols

Dynamic routing protocols can again be classified into two classes of protocols. The distance vector and state routing protocols. Distance vector protocol determines the best route based on the algorithm formulated by Bellman–Ford and Ford–Fulkerson. Distance vector routing protocol chooses the best path by distance calculation and a vector direction of next router as reported by neighboring routers [6]. Distance vector protocols require the routers to share the changes that happens to the network periodically. Link state routing protocols collects the information about the connected routers and send it to the entire network so that each can choose the best path of all the interconnected networks.

When compare with the distance vector, it consumes more power processing power and memory as it has a complete picture of the network [6].

B. Routing Information Protocol (RIP)

Routing Information Protocol (RIP) is a distance vector routing protocol which determines the best path for sending and receiving data packets based on the hop counts. In other terms the RIP counts the number of routers that has to be passed in order to send a data packet to the destination. When transmission data in a network with RIP protocol, the maximum number of Hop is 15 and if the hop count goes beyond this limit, the rout will be considered as unreachable. According to [7] the main advantage of Routing information protocol is that it uses the User Datagram Protocol (UDP) and reserved port is 520. Their report also highlights that Routing Information Protocol (RIP) is poor and only suitable for using in smaller networks.

As RIP chooses the best path based on hop counts, it may literary avoid the fastest route in most of the situation. In a network environment closest may not be the shortest. Figure 1. shows an example of how RIP works.

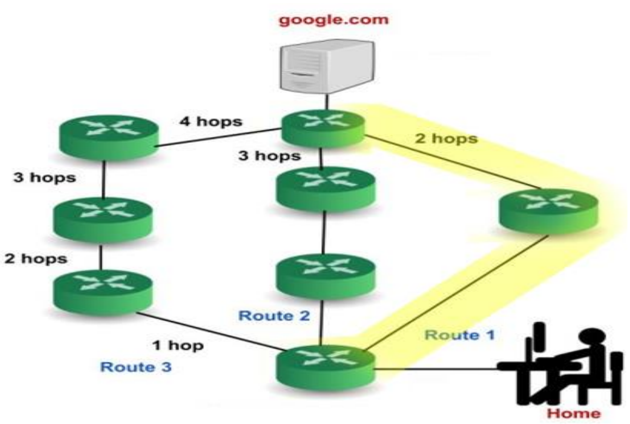

Fig. 1. Example RIP Network, Source Afteracademy

In Figure 1, there are 3 possible routes. Rout 1, Rout 2 and Route 3. Route 2 may be the best to choose in terms of network quality and distance from user to destination, but the RIP will choose route 1 because it requires just 2 routers or hops to pass-through to reach google server. Just like any other distance vector protocol, RIP also has set of timers which updates its routing tables at regular intervals (mostly set for 30 seconds) because it is an important part for its convergence activities, but this increases the network traffic. According to [8] the RIP has timers called update timer, invalid timer, flush timer and hold-down timer. Due to these timers, this protocol is considered as a routing protocol that has slow convergence activity. However, He also highlights that the energy or CPU usage of RIP is less compared with OSPF. Some of the advantages of RIP are that it is easy to setup and supports almost all the types of routers. It also doesn't not require to update when every time there is a change in the network topology.

C. Open Shortest Path First (OSPF)

OSPF (Open shortest path first) is a link state routing protocol introduced in mid 1980s by Internet Engineering task force. OSPF is one of the most commonly used routing protocols in many of the large enterprises because of efficient convergence in the network [8].

The routers in the OSPF network dynamically builds their own routing tables based on the link state routing information they receive from all the connected OSPF configured routers in the network. After updating the routing tables, the routers then find the shortest route for each of the router in the network. This is done by using the Dijkstra algorithm. When exchanging the network information among the routers, OSPF exchanges only link state advertisements instead of the complete network information. Therefore, OSPF networks coverage far more quick than the RIP.

Figure 2. shows how OSPF chooses the best route to transfer packets from user to the destination. Unlike routing information protocol (RIP), OSPF chooses the shortest path based on the cost. Cost is calculated by dividing the reference bandwidth by interface bandwidth.

For example, the OSPF matric cost value for a 10Mbps Ethernet will be 10. (ie: 100/10 = 10). The default OSPF Cost for a Fast Ethernet and a Gigabit Ethernet interface are same, which is 1.

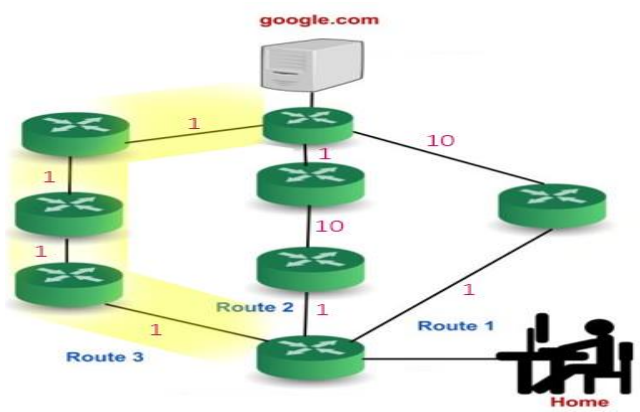

Fig. 2. OSFP Example. Source: Afteracademy

Total Cost:
Route 1: 1+10 = 11
Route 2: 1+10+1 = 12
Route 3: 1+1+1+1 = 4 ✓
Therefore, OSFP chooses Route 3.

D. Pros and Cons (RIP and OSPF)

According to most of the studies and real world experiences it is understood that RIP is a great fit for small networks. RIP supports almost all the types of routers and it is easy to setup and configure. On the other hand, If RIP is implemented in a large network, it will affect the network traffic as RIP multicasts the routing table in every 30 seconds [9]. According to a research paper published by [10], RIP is more suitable for smaller networks because the latency results and convergence time in RIP is better than OSPF.

In terms of bandwidth management, OSPF is more efficient than RIP, hence chances of packet loss during transmission is less in OSPF configured networks. The report also states that throughput rate of OSPF is better than RIP. [10] Also did a simulation to compare the performance of both RIP and OSPF. Their findings confirmed them that OSPF has a faster time-efficiency than RIP. Their report concluded that "OSPF serves highest throughput, most moderate queuing delay and suitable for more extensive networks."

The main disadvantages of OSPF is that it requires more CPU process to run the shortest path tree algorithms and more RAM to store multiple copies of routing information.

III. Methodology

This empirical evaluation only focuses on the comparison of Routing Information Protocol (RIP) and Open Shortest Path first (OSPF) protocol. The Simulation will be conducted using NetSim which is one of the best simulators used in the networking industry today. NetSim covers simulations for various types of networks including wired, wireless, mobile and sensor networks. For this study, we will be simulating a wireless network.

The results will be collected and compared based on quantitative data collected through the simulation processes. Throughput and Delay are main key metrics which will be used to determine the performance of both the routing protocols.

A. Network setup:

To do the performance evaluation on both RIP and OSPF network, first a WLAN network is designed based on the following requirements. Figure 3. shows the overview of the network design.

1- Network consists of 5 routers

2- 2 switches

3- 12 Wireless Laptops (3 for each department)

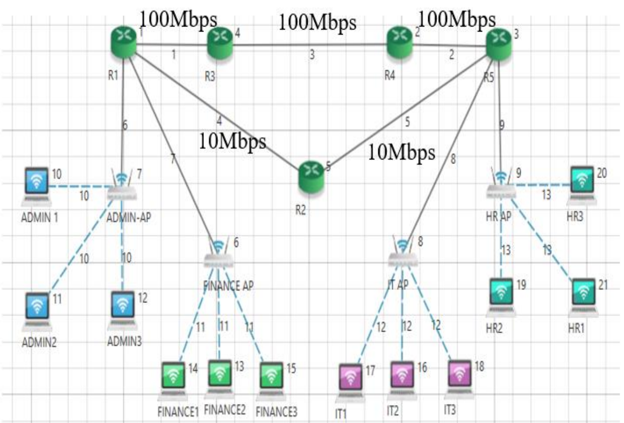

Fig. 3. Network overview

B. Procedure (How simulation is done)

Simulations is done based on 3 scenarios. In all the scenarios same nodes are used as the source and destination (ADMIN1 selected as Source node and HR3 as the destination node).

In the first simulation attempt, video is selected as the application type. Secondly, Voice is used and final simulation is done using database.

Simulation time is set to 100 in all the attempts. Rest of the settings are kept as default. For example, update time for RIP is set to 30 and Increment age for OSPF is set as 1.

IV. Simulation Results

A. Application Type Video (RIP)

As shows in Figure 4., packets generated are 999 and received 998. Throughput shows as 0.051965 Mbps and Delay time is 2504.626215 microseconds.

Application_metrics Detailed View

Application Id	Throughput Plot	Application Name	Packet generated	Packet received	Throughput (Mbps)	Delay(microsec)
1	Application throughput plot	App1_VIDEO	999	998	0.051965	2504.626215

Fig. 4. Result (Application Type Video (RIP))

B. Application Type Video (OSPF)

Figure 5. shows the result of OSPF when application is selected as video. Same number of packets generated but packets received are less when compare with RIP. Throughput is 0.044894 mbps and delay time is 3383.217335 micro seconds.

Application_metrics Detailed View

Application Id	Throughput Plot	Application Name	Packet generated	Packet received	Throughput (Mbps)	Delay(microsec)
1	Application throughput plot	App1_VIDEO	999	848	0.044894	3383.217335

Fig. 5. Result (Application Type Video (OSPF))

C. Application Type Voice (RIP)

Figure 6. shows the result of RIP when application type is selected as Voice. Total packets sent and received are same which means no packet is lost during the transmission. Throughput is 0.063987 mbps and delay time shows as 1265.736327.

Application_metrics Detailed View

Application Id	Throughput Plot	Application Name	Packet generated	Packet received	Throughput (Mbps)	Delay(microsec)
1	Application throughput plot	App1_VOICE	4999	4999	0.063987	1265.736327

Fig. 6. Result (Application Type Voice RIP)

D. Application Type Voice (OSPF)

Figure 7 shows the OSPF result when the packets are transferred as for voice. According to the results, 4999 is sent as total packets and received is 4243. Throughput is 0.054310 Mbps and total delay is 1299.297033 micro seconds.

Application_metrics Detailed View

Application Id	Throughput Plot	Application Name	Packet generated	Packet received	Throughput (Mbps)	Delay(microsec)
1	Application throughput plot	App1_VOICE	4999	4243	0.054310	1299.297033

Fig. 7. Result (Application Type Voice (OSPF))

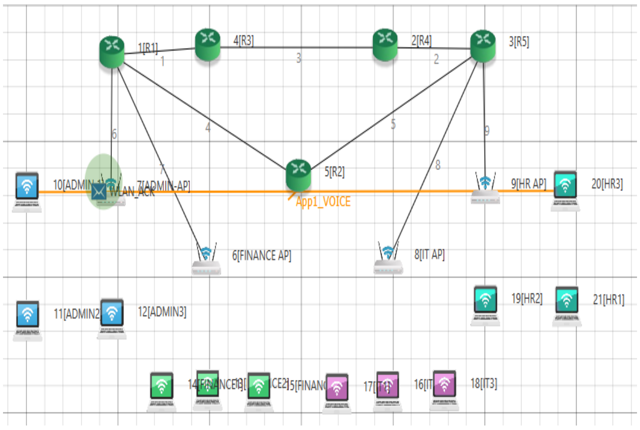

Fig. 8. Packet ket Transmission OSPF

E. *Application Type Database (RIP)*

Figure 9 shows the result for RIP when application type is selected as Database. Packets sent are 3500 and received are 3472. Throughput is 0.079378 Mbps and delay is 25965.027376 microseconds.

Application_metrics ☐ Detailed View

Application Id	Application Name	Packet generated	Packet received	Throughput (Mbps)	Delay(microsec)
1	App1_DATABASE	3500	3472	0.079378	25965.027376

Fig. 9. Result (Application Type DATABASE (RIP))

F. *Application Type Database (OSPF)*

Figure 10 shows the results of OSPF when application type is selected as Database. According to the result total packets sent are 3500 and received are 3481. Throughput is 0.079577 Mbps and Delay is 340812.949392.

Application_metrics ☐ Detailed View

Application Id	Application Name	Packet generated	Packet received	Throughput (Mbps)	Delay(microsec)
1	App1_DATABASE	3500	3481	0.079577	340812.949392

Fig. 10. Result (Application type Database (OSPF)

V. Combined Results of the Simulations

According to the results, it shows that in terms of Delay RIP performed better in all 3 scenarios.

It's also noticed that Delay time for OSPF is very high when application type is selected as Database. In terms of throughput OSPF performed better when Application is selected as Database. Rest of the simulation scenarios (Video and Voice) performance of RIP is better than OSPF.

In addition to throughput and Delay matrices, it's also noticed that throughput moving average is also better in RIP when compare with the OSPF. Below two graph shows throughput moving average of RIP and OSPF when Video is selected as the application type.

TABLE I. Combined Results of the Simulations

Metrics	*THROUGHPUT (Mbps)*		*DELAY (Micro Secs)*	
Application Type	RIP	OSPF	RIP	OSPF
Video	0.051965	0.044894	2504.626215	3383.217335
Voice	0.063987	0.054310	1265.736327	25965.027376
Database	0.079378	0.079577	25769.799320	340812.949392

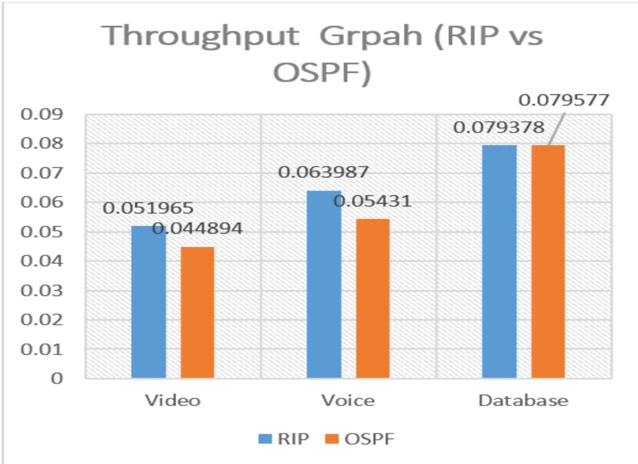

Fig. 11. Throughput Graph for RIP and OSPF

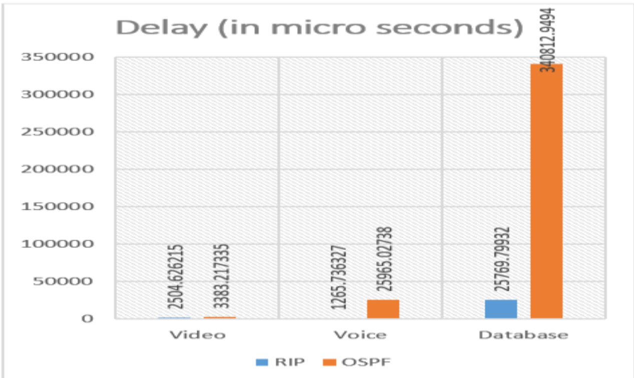

Fig. 12. Delay time Graph RIP vs OSPF

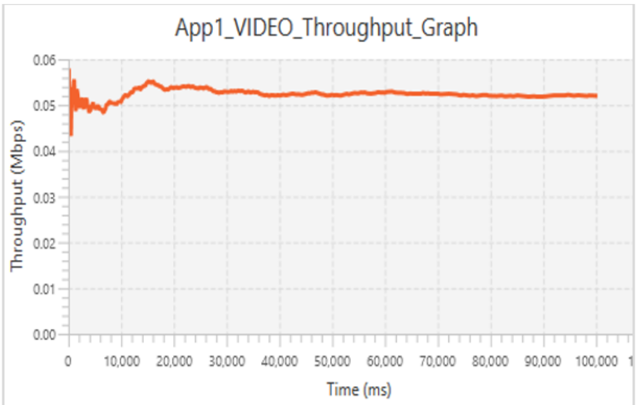

Fig. 13. Throughput moving average (RIP)

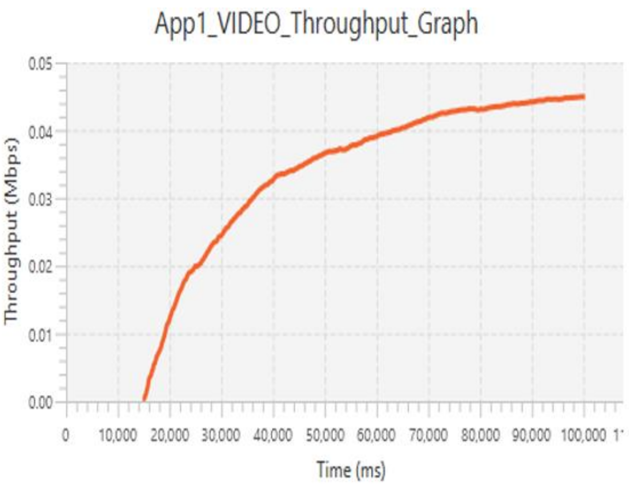

Fig. 14. Throughput moving average for OSPF

VI. Conclusion

Routing protocols play a very important role in exchanging data efficiently in a network environment. Hence, choosing a suitable routing protocol is a vital decision that network administrators has to make. According to the studies it is known that there are many factors that may affect the network traffic and its efficiency. Therefore, when selecting a routing protocol for a network, one should think of possible issues that may arise due to a bad decision. The size and complexity of the network, the processing capacity and the how much memory each router can hold are some of the aspects that should be taken into the consideration. Most of the studies say that RIP is suitable for small networks and OSPF is the best for larger networks. It is also proved by most of the researchers that RIP has drawbacks such as limitations in number of routers it can accommodate in a network and the method of choosing the best route. On the other hand, OSPF is identified as a better routing protocol than RIP in many ways. Mostly it is proved as the best routing protocol for large and complex network environments. Most of the research also OSPF consumes more processing power and RAM when compare with RIP.

The empirical evaluation done using Netsim shows RIP works better than OSPF in the designed network. The two network metrics throughput and Delay time proves that RIP performs better in most of the scenarios. Besides that, it is also noticed that packet loss is more in OSPF than RIP. The main reason why OSPF didn't perform well in the designed network is believed due to the high consumption of CUP processes and the Memory at the initial stage of the execution. This shows very clearly from the throughput moving graph (figure14). Another reason is that the latency results and convergence time in RIP is better than OSPF. Therefore, as most of the studies shows, RIP is a great fit for small and simple networks such as Wireless Local Network Area (WLAN).

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