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A Comprehensive Study and Analysis of Different Routing Protocols for Enterprise LAN

A F M Zainul Abadin, Sohag Sarker, Md. Sarwar Hosain, Md. Manik Ahmed & Ahmed Imtiaz

Abstract:

Due to growth of economy, government policies, available inexpensive smart devices and low cost broadband services in both developed and developing countries the numbers of Internet users are increasing drastically over the last decades. Recently, the Internet of Things (IoT) and Industry 4.0 have become global trends. Through Internet of Things (IoT) everyone will be connected his/her devices at home, at work stations, on road, at field or anywhere else. In a network topology, various protocols are used for forwarding the packets. Routes of information (packets) are established by appropriate routing protocols. A routing table is managed by the router for successful delivery of packets from the exact predefined nodes i.e. source node to destination node. The amount of information stored by the router about the network depends on the algorithm it follows. Most of the used popular routing algorithms are RIP, OSPF, IGRP and EIGRP. In this report, we have tried to evaluate the performance of RIP, OSPF, IGRP and EIGRP for the parameters: convergence, throughput, queuing delay and end to end delay utilization through simulation which has been performed using OPNET. We have tried to find out the best protocol suits for the designed Enterprise Local Area Network (ELAN) as well as pros and cons of each protocol.

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About Author (s)

A F M Zainul Abadin, Department of Information and Communication Engineering, Pabna University of Science and Technology, Pabna, Bangaldesh.

Sohag Sarker (Corresponding author)**,** Department of Information and Communication Engineering, Pabna University of Science and Technology, Pabna, Bangladesh. Email: sohagsarker5614@gmail.com

Md. Sarwar Hosain, Department of Information and Communication Engineering, Pabna University of Science and Technology, Pabna, Bangladesh.

Md. Manik Ahmed, Assistant Programmer, Office of the examination controller, Rabindra University Bangladesh, Shahjadpur, Sirajgang, Bangladesh.

Ahmed Imtiaz, Department of Computer Science and Engineering, Rangamati Science and Technology University, Rangamati, Bangladesh.

1. Introduction

The principal purpose of routers is to forward Internet Protocol (IP) packets. To quickly accommodate shifts in the network, the routing protocol uses a variety of algorithms, processes, and messages (Mitra et al., 2016 and Bahl, 2012). According to the characteristics of the routing protocol, the protocols are classified into different groups. At the network layer, there are two levels of protocols: round and routing protocols. A round protocol is responsible for transporting packets across the network(s) and routing protocols are responsible for properly transporting packets from source to destination. At the network layer IP is considered as routed protocol and the various routing protocols are: Routing Information Protocol (RIP), Internet Gateway Routing Protocol (IGRP), Open Shortest Path First (OSPF) and Enhanced Internet Gateway Routing Protocol (EIGRP).

For any network topology, the function of router is to receive pieces of data (packets), look at their final destination and forward them to the next network via exit interface. Selection of next network the packet has to pass through is made based on routing table. Routing table contains information about different destinations that router has learned and in case there is no any entry in the routing table that matches with the destination of received packet, packet will be dropped. The routing table is made by routing protocols which work differently according to their algorithms. They are of two main categories: Static or Dynamic. Static routing protocol is unique while dynamic routing protocols are of different types (Forouzan, 2010).

As per the diagram below, dynamic routing protocols are of two main categories, which are interior or exterior. Interior protocols are those that operate within one same autonomous system (AS) and route packets between different AS there should be an exterior protocol configured. Interior routing protocols are further in two classes name distance vector and link state.

Distance vector protocols are: Routing Information Protocol (RIP version 1 and version 2), Interior Gateway routing protocol (IGRP), and Enhanced Interior Gateway routing protocol (EIGRP). Link State routing protocols include: Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS) (Fortzet al., 2002).

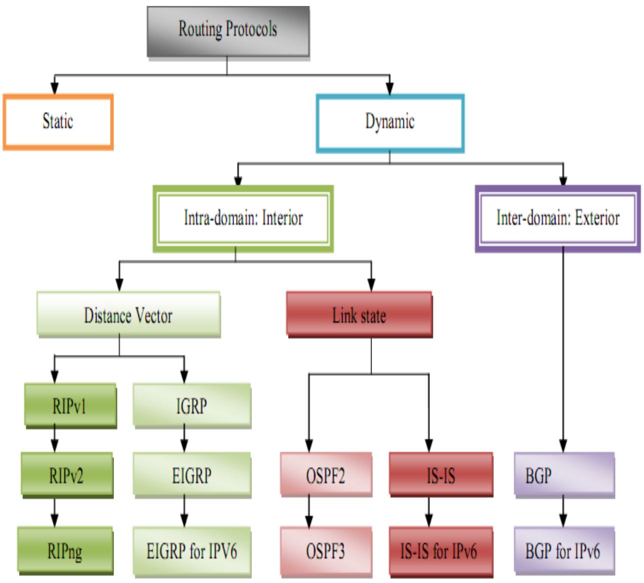

Figure 1: Categorization of routing protocols (KURADUSENGE and HANYUWIMFURA, 2016).

Border Gateway Protocol (BGP) is an example of exterior routing protocol unlike static routing protocol; dynamic routing protocols have versions for IPv4 and IPv6. Initially Cisco Systems has developed a distance vector routing protocol named "Interior Gateway Routing Protocol (IGRP)" and in 1992 has released its advanced version named "Enhanced Interior Gateway Routing Protocol (EIGRP)"(Cisco, 2003). Because of different weaknesses and being a classful protocol, IGRP has been replaced by EIGRP since IOS 12.3 release. EIGRP is a distance vector routing protocol but has some in link state features and therefore is called hybrid routing protocol.

Packets are used to forward the destination from the routing table source. RIP performs the use of a primary protocol identified as distance-vector, which takes hop count as a cost. In case of many paths, RIP uses path that has the lowest cost (fewer hops). The only metric used in RIP is the hop count as such the path doesn't need to determine by this protocol be the fastest. IGRP was developed by cisco system for small and medium-sized protocols. It is based on distance-vector algorithm. The most accelerated path to IGRP is selected based on delay, bandwidth, reliability, and loading parameters (although it utilizes bandwidth and delay by default).

OSPF was developed by the Internet Engineering Task Force (IETF) in 1988 and deployed for large and small networks (Cisco, 2003). In an autonomous system, OSPF spreads the information among the routers. OSPF was developed to overwhelm the scalability issues faced in RIP. OSPF was based on a link-state algorithm (Shehzad). EIGRP is a routing protocol formed by cisco systems. It is the enhanced version of IGRP, which uses the characteristics of both link-state and distance-vector algorithm. EIGRP provides high-performance efficiency and provides faster convergence. Comparison among the RIP, IGRP, OSPF, and EIGRP are shown in Table 1.

Table 1: Comparison among RIP, IGRP, OSPF and EIGRP.

Sl	Features	RIP	IGRP	OSPF	EIGRP
1	Algorithm	Distance vector	Distance vector	Link state	Both distance vector & link state
2	Metric	Hop count	Depends on delay, bandwidth, channel occupancy and reliability of the path	Depends on bandwidth delay, throughput and RTT	Bandwidth, load, delay, hop count and reliability
3	Maximum no of hops	15-16 hops is considered to be Infinity	Maximum 255 (default 100)	Depends on the size of routing tables	Maximum 255
4	Subsystem Segmentation	Autonomous system is treated as single subsystem	No segmentation of AS	Breaks the autonomous system in areas	System is not divided in areas
5	Integrity	No authentication in RIP-1. Authentication is added to RIP-2	No authentication	Supports authentication	Supports authentication
6	Complexity	Simple	More complex than RIP	Relatively complex	Highly complex
7	Protocol or port	UDP 520	IP 9	IP 89	IP 88

2. Research Methodology

The various key points involved in the research work are discussed in this section. Various methods are compared with each other and the justification of chosen method is given in this section. Three methods are available for performance evaluation of protocols in a network which include mathematical or analytical analysis, direct measurement and computer simulation. After taking all the constraints and parameters under consideration mathematical and computer simulation are suitable for our research. There are various advantages of mathematical analysis like cost, time and the ability of providing best predictive results. The direct measurement as a choice of method could be expensive but an alternative to simulation. In direct measurement the analysis is to be done on an operational network which can lead to disruptive situation and an operation network could be very expensive in terms of configuration complexity. The choice of direct measurement is reasonably reliable results. There are various simulators like NS-2, NS-3, Qualnet, Telnet, Omnet++, OPNET, etc(Karim and Khan, 2011). To do simulation work, the simulator was to be chosen suitably. The proper choice after having various considerations was the OPNET simulator offered by OPNET Technologies inc. OPNET modeler is an object-oriented and discrete event system (DES) based network simulator. The DES is a widely used efficient simulation tool and well known for its effective execution, performance, and reliability (Opnet, 2021).

3. Network Model and Implementation Tool

This segment addresses multiple components used in developing the networks and their purposes. The following are the elements recommended in network models operating on OPNET.

Application Config: this is a node that is used to establish the application within the network and also used for specifications like Ace Tier Information, application specifications eg. web browsing (heavy HTTP), voice encoder scheme.

Profile Config: this is a node that is used to illustrate applications and maintain them. These user profiles formed on this node are used on various nodes in the network to produce application-layer traffic.

Profile Config is additionally used to mark the traffic patterns followed by the applications.

CS_7000_6s_a_e6_fe2_fr4_slr4_tr4: This model represents a specific configuration of an IP based router gateway model. Its specifications are

Ethernet_wkstn: this is a node model that expresses a workstation with client-server applications working over TCP/IP and UDP/IP. The workstation raises one underlying Ethernet connection of 10mbps, 100mbps, and 1000mbps.

PPP_DS3: These are full-duplex links that correlate the two IP nodes 100BaseT: 100BaseT full-duplex links are applied to interpret the Ethernet connections. These links can combine any sequence of the nodes such as Station, Hub, Bridge, Switch, and LAN nodes.

Failure Recovery: this controller node is employed to model the failure-recover scenarios. For implementing the time and status of the objects in the model it presents the attributes.

OPNET Modeler 14.5 has been used for the simulation analysis (Sood, 2007). This section describes the architecture of the network and how the four protocols are implemented on this network model. The situation of the four networks is created below, which will be described in detail in the upcoming sections. Scenario 1 has been modeled as the baseline scenario for the OSPF protocol. Scenario 2 has been modeled as a baseline scenario for the RIP protocol. Similarly, 3 and 4 scene models have been modeled for the IGRP and EIGRP protocols, respectively.

In the network model, we will use five Cisco 7200 routers and two PCs (workstations), application configuration, profile configuration and link failure component. To study the outcomes from other scenarios (1,2,3 and 4), a baseline network model comprising of five Cisco 7200 routers connected via ppp_ds3 links and two Ethernet work stations. The two PCS in our network is the video conferencing workstations.

The four different network configurations for analyzing protocols namely RIP, IGRP, OSPF, and EIGRP are shown in figures 2-5.

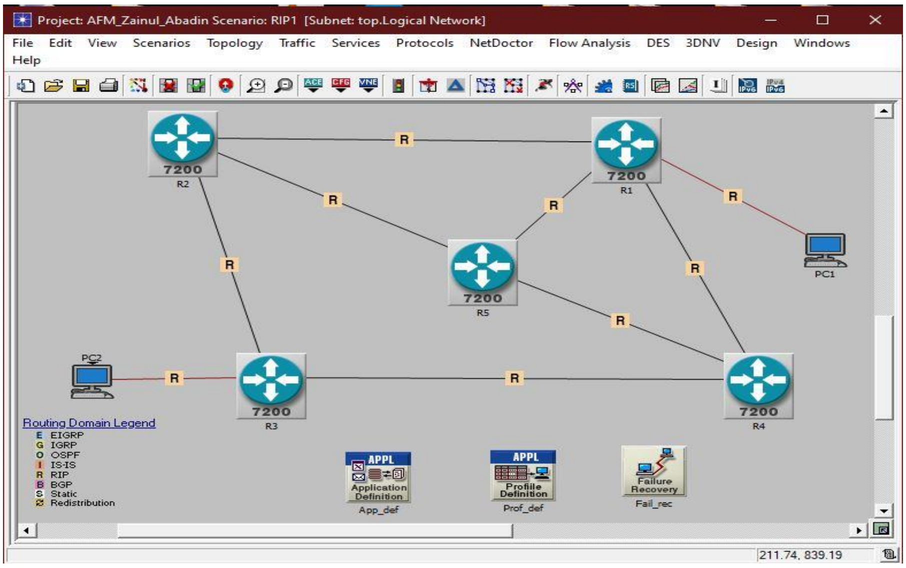

Figure 2: Network Configuration for RIP.

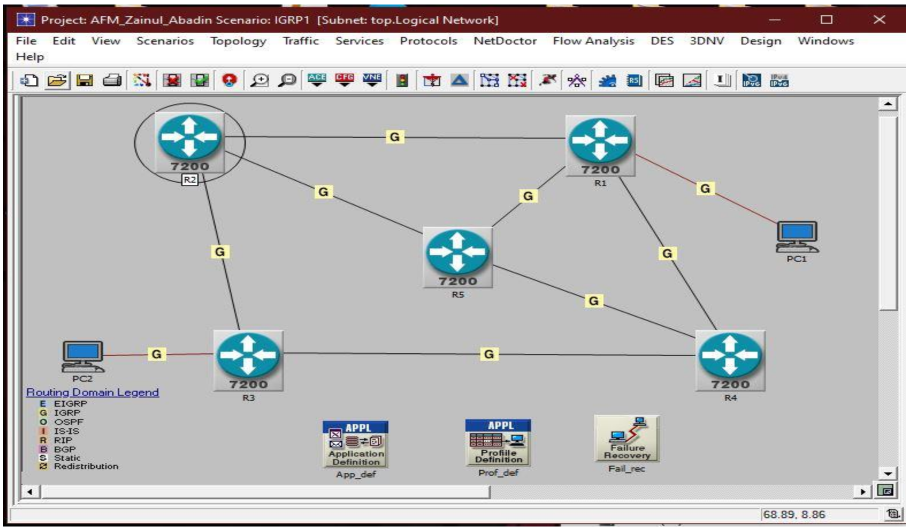

Figure 3: Network Configuration for IGRP.

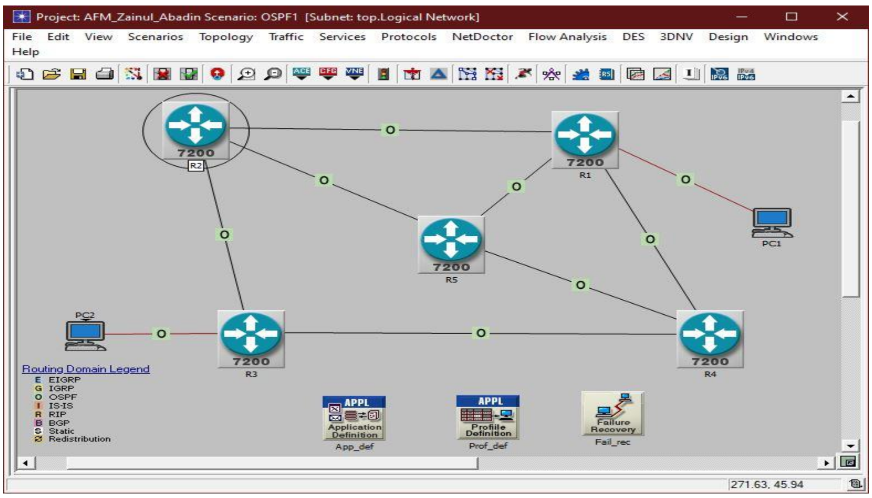

Figure 4: Network Configuration for OSPF.

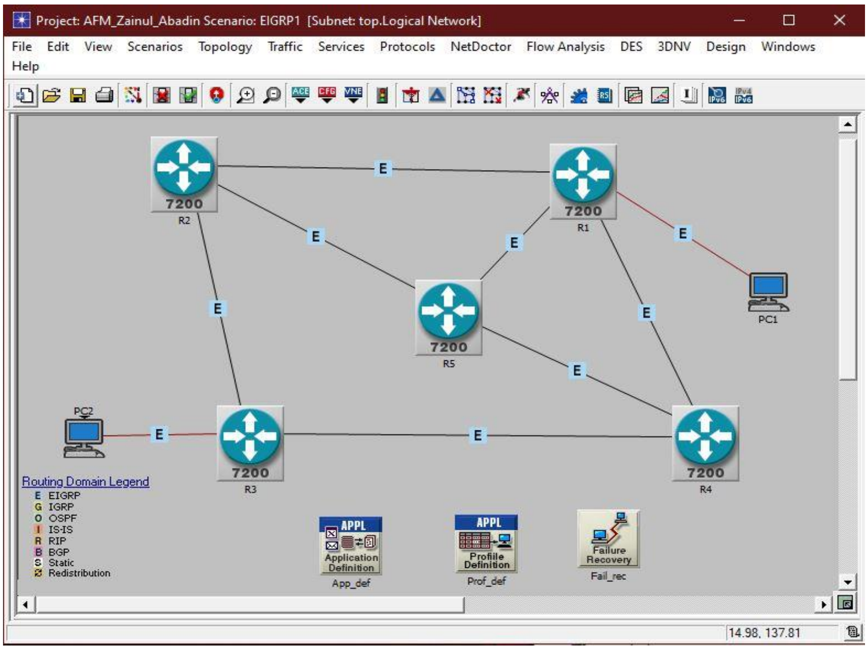

Figure 5: Network Configuration for EIGRP.

4. SIMULATIONS AND PERFORMANCE ANALYSIS

We have investigated the performance of protocols particularly RIP, IGRP, OSPF, and EIGRP respectively over a network with various situations and on simulating the network for 15 minutes in case of situation 1 and for 6 minutes in case of situation 2, we have investigated the performance in duration of convergence of RIP, IGRP, EIGRP, and OSPF respectively. When the network was examined following these two situations, the result for convergence in the case of RIP, OSPF, IGRP, and EIGRP severally is shown in Figure 6-7.

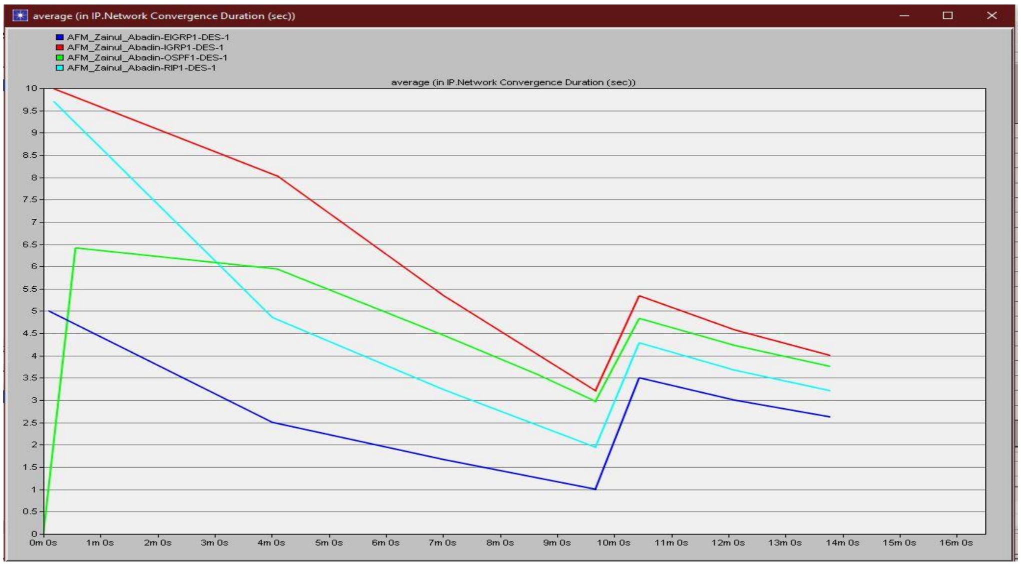

Figure 6: Convergence in case of situation 1.

Distance vector protocols such as RIP and IGRP are notoriously slow to convert, or adapt to changes in network topology. After a change in the network and before all routers are converted, there is a possibility of routing errors and lost data. Link-state routing protocols, such as OSPF and EIGRP conversion are faster. Since IGRP advertises less frequently, it uses less bandwidth than RIP but slows down a lot.

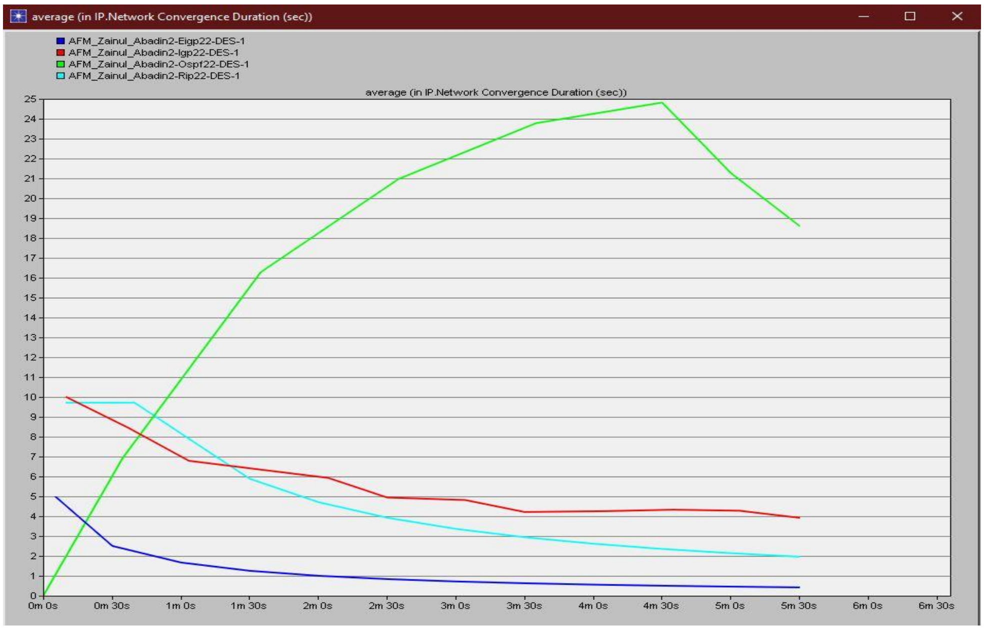

Figure 7: Convergence in case of situation 2.

Conversion with EIGRP is faster because it uses a dual update algorithm or an algorithm called DUAL, which detects a router when a specific route is unavailable run since each OSPF router has a copy of the topology database and a specific region routing table. Changes aredetected faster than distance vector protocols and alternative routes are determined.And analyzing the performance parameters such as throughput, utilization and delay, as per results plotted EIGRP has the highest throughput followed by OSPF, IGRP and RIP shown in figure 8.

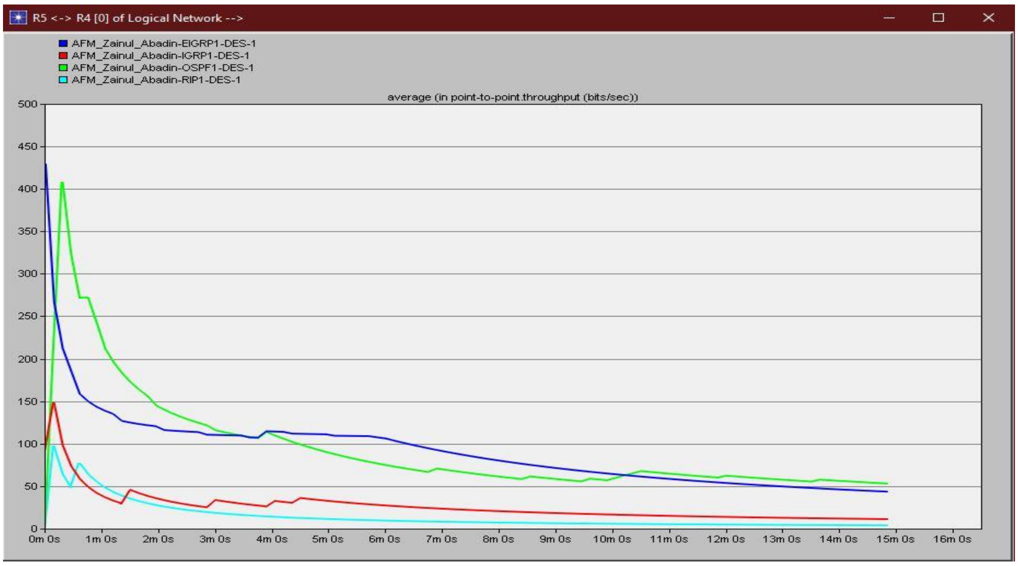

Fig. 8: Point to point throughput (bits/sec).

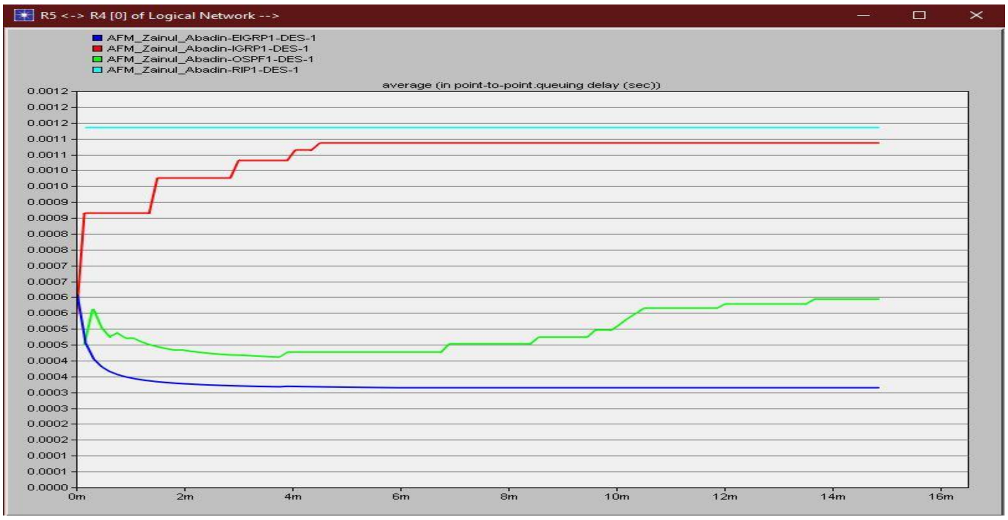

Fig. 9: Point to point queuing delay (sec).

For the case of queuing delay EIGRP has the least delay followed by OSPF, IGRP and RIP shown in figure 9 and for the case of link utilization EIGRP has the maximum link utilization followed by OSPF, IGRP and RIP as shown in figures 10-11.

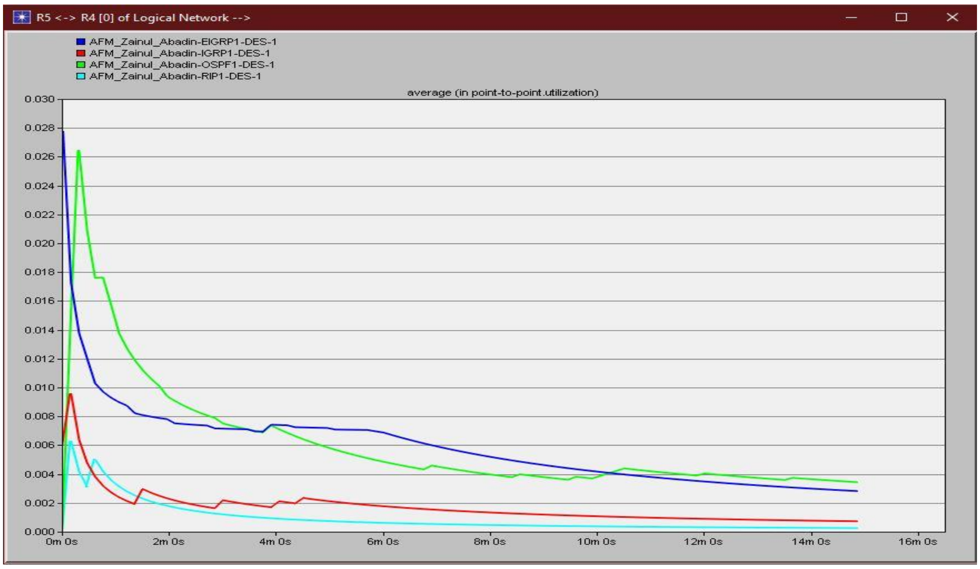

Figure10: Point to point Utilization.

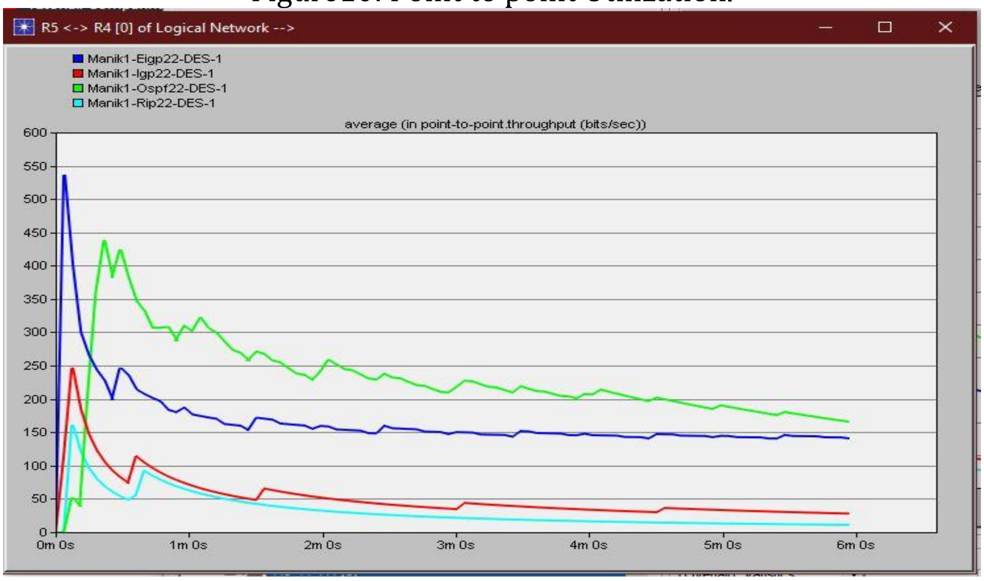

Figure 11: Point to point throughput for 6 min (bits/sec).

5. Conclusion

A comprehensive study and analysis in this paper helps us to summarize some concluding statements for implementing routing protocols in an enterprise LAN. In a network topology, various routing protocols are used for forwarding the packets. A routing table is managed by the router for successful delivery of packets from the exact predefined nodes i.e. source node to destination node. From our close observations on the simulation results of different routing protocols particularly OSPF, RIP, IGRP and EIGRP for convergence, throughput, link utilization, and queuing delay, we may think about the performance of EIGRP to be the best among all. The second to EIGRP comes OSPF, which has the second highest link utilization and throughput after EIGRP. The choice between these two protocols i.e. OSPF and EIGRP can be difficult. Thus we may conclude that when we consider the above scenarios, EIGRP performs better but when the other criterion like least cost of transmission and lower router overhead are taken into consideration OSPF can be an alternate choice.

References

Bahl, V. (2012). Performance Issues and Evaluation considerations of web traffic for RIP & OSPF Dynamic Routing Protocols for Hybrid Networks Using OPNET, *International Journal of Advanced Research in Computer Science and Software Engineering*, 2(9).

Cisco Systems, I., Cisco Networking Academy Program. (2003*). CCNA 1 and 2 Companion Guide,*Third Edition.

Forouzan, B. A. (2010). *TCP IP Protocol Suite (4 ed.).*NEW DELHI, INDIA: McGraw Hill Education.

Fortz, B., Rexford, J., and Thorup, M.(2002). Traffic Engineering With Traditional IP Routing Protocols,*IEEE Communications Magazine*, 118-124.

Karim.A., Khan, M., A. (2011).Behaviour of Routing Protocols for Medium to Large Scale Networks, *Australian Journal of Basic and Applied Sciences*, 5(6), 1605-1613.

KURADUSENGE, M., andHANYUWIMFURA, D.(2016). Operation and Comparative Performance Analysis of Enhanced Interior Routing Protocol (EIGRP) over IPv4 and IPv6 Networks, *International Journal of Advanced Research in Computer Science and Software Engineering*, 6(7).

Mitra, D., Sarkar, S., and Hati, D. (2016). A Comparative Study of Routing Protocols, *International Research Journal of Advanced Engineering and Science*, 2(1), 46-50.

Opnet Modeler Manual, Available: hhttps://opnetprojects.com/opnet-manual/ (April 20, 2021).

Shehzad, M.N., and Najam-Ul-Sahar, Simulation of OSPF Routing Protocol Using OPNET Module(A Routing Protocol Based on the Link-State Algorithm), Iqra University Islamabad.

Sood, A. (2007). Network Design by using OPNET™ IT GURU Academic Edition Software. *Rivier Academic Journal*, 3(1).

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