Performance Evaluation of Link State Routing Protocol in an Enterprise Network

M. Nawaz Lakhmir, Ayaz Ahmed Qureshi, M. Ibrahim Channa, Fareed Ahmed Jokhio, and Shahzaman Nizamani.

Abstract **- A link-state routing protocol is having a capability to create topological view of the massive networks. It collects information from all inter-linked routers which produce identical view of the network topology. A created topology-map of the network selects the best path for smooth traffic communication across the hops. The main task of this research is to measure the performance of the two link state routing protocols i-e Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS). We develop an enterprise network to compare the performance of OSPF and IS-IS under different parameters. The detailed analysis of the said routing protocol will help in designing enterprise network models and selecting an appropriate routing protocol under different traffic conditions.**

Index Terms-- IS-IS, LINK-STATE, OSPF, OPNET.

I. INTRODUCTION

Set of rules and procedures are called routing protocols, so moving information from source to destination across an internetwork in which routing is at the core of every data network. The protocols have the capability to exchange data effectively and efficiently among the routers across the network[1]. Routing protocols are divided into two main categories: Distance vector routing protocol and Link state routing protocol, which are described below:

A. Distance Vector Routing Protocol.

Routes are advertised as vectors of distance and direction is known as distance vector, which is defined in the view of metric like hop count and next hop or exit interface is considered as direction. For best path discovery, the distance vector uses the Bellman-Ford algorithm [14] which has capability to maintain a database of reachable networks. In this way the algorithm does not have efficiency to know the actual topology of an internetwork [2]. These are the distance vector routing protocols includes Routing Information Protocol (RIP), Interior Gateway Routing Protocol (IGRP), and Enhanced Interior Gateway Routing Protocol (EIGRP). In the following circumstances, the distance vector routing protocol is suitable:

- Simple network.
- No special hierarchical design.
- Less administrative involvement.
- Convergence time is not an issue.

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B. Link State Routing Protocol.

Each router construct a connectivity map to the network in the shape of a graph showing each router is connected with each other and each router find out personal directory of connected networks, link state routing protocol maintain own Link State Packet (LSP) which has routers information such as bandwidth, link type and neighbor identification. Link state routing protocol maintains a topological database as a group of information in Link State Advertisement (LSAs) and sends data to neighbor routers[4]. Link state routing protocols announce their closest neighbors of each router in the network. Convergence ability is very fast in the huge networks.

"The link state routing protocol uses shortest path first (SPF) algorithm [14] for communication form one place to another place and maintains a database of network topology". In this research we have compared and analyze link State routing protocols i-e Open Shortest path first (OSPF) and Intermediate System to Intermediate System (IS-IS) with the use of parameters which includes IP back ground traffic delay, Point-to-Point delay, Throughput (pack/sec) and Utilization using OPNET modeler. The following two protocols are having the capability of the link state routing protocols.

i) Open Shortest Path First (OSPF)

OSPF is uses Dijkstra's algorithm [14] to find out the shortest path to send data source to destination , it is a link state routing protocol and falls into the group of interior routing protocols.

The main advantage of OSPF is that it finds errors and handle them [3]. It allow for fast convergence of routing tables and has scalability to much larger network implementations.

OSPF can load balance network traffic between several path of the similar metrics value, when any change occur in network then it will send message (hello) in all routers and receive hello message from all neighbors to maintain database of all routers, Every router broadcasts link state update messages when network topology changes.

ii) Intermediate System to Intermediate System (IS-IS).

IS-IS is a routing protocol designed to send data traffic efficiently in a enterprise network , IS-IS use link state routing algorithms for send traffic in high speed , It uses Dijkstra algorithms to search the best and shortest path for communication in a network and it create independent database in each router[5].

 ISSN – 1999-4974

II. LITERATURE REVIEW

The performance analysis of several routing protocols like RIP, OSPF, EIGRP, IGRP has done by the Archana Kudtarkar et al in which EIGRP routing protocol is based on real time application and the author concluded that EIGRP will be the finest selection for FTP, email and Database access[1]. Whereas, the authors [3] to [5] has done simulation based comparison analysis of RIP, OSPF, EIGRP, the author determined that to design an ideal routing topology by using OPNET modeler would be the best choice for network designers to implement routing protocol and it is concluded that EIGRP performed better than RIP, OSPF. And in this way the authors [9] to [13] have done the comparison analysis of RIP, IGRP, EIGRP, OSPF and integrated IS-IS with these parameters: Traffic sent, cpu utilization, end to end delay, end to end variation, point-to-point throughput. It has concluded that the link state protocol has improved the distance vector shortcomings and the EIGRP is better than the others. While it has been observed through literature review that there is space in which one may focus on both link state protocols for instance OSPF and IS-IS by using various parameters to compare the routing behavior in the enterprise network.

III. METHODOLOGY

Fig-1 below shows the state of the art to adopt the step by step process for successful completion of the performance evaluation of link state routing protocol of an enterprise network.

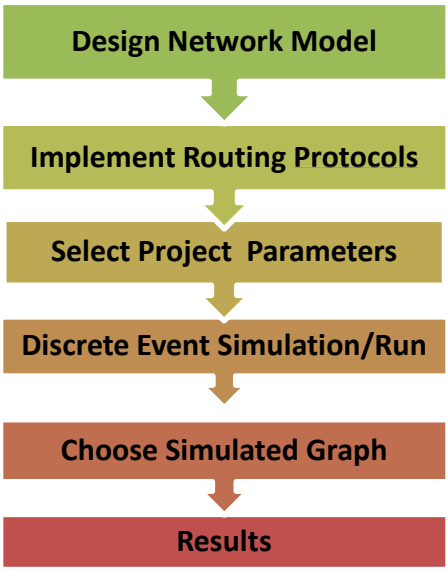

Fig-1. Methodology

The simulated network model shown in fig-2 in which OSPF and IS-IS routing protocols are being enabled for routers to exchange routing information between the router to each other.

The model is showing routers with respect to their countries, which contains different subnets connected to each other with point to point protocol (PPP) by using Digital signal 3 (DS3 44.736 Mbps) with packet formats ip3_dgram.

a) The Parameters detail

To obtain the simulated graphs, we need to choose parameters, according to the project designed to the OPNET simulator.

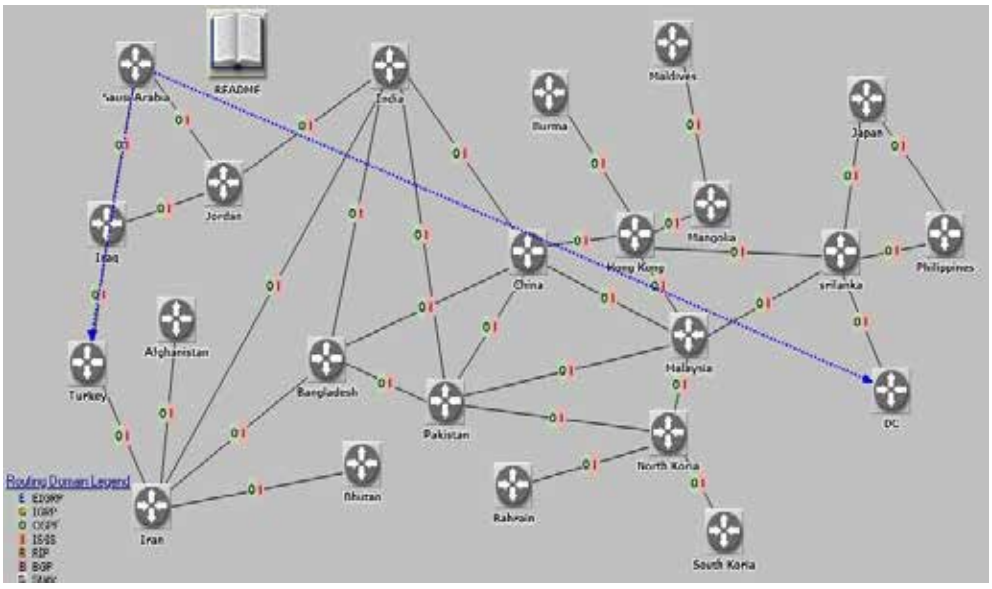

Fig-2 Enterprise Network Model

ISSN – 1999-4974

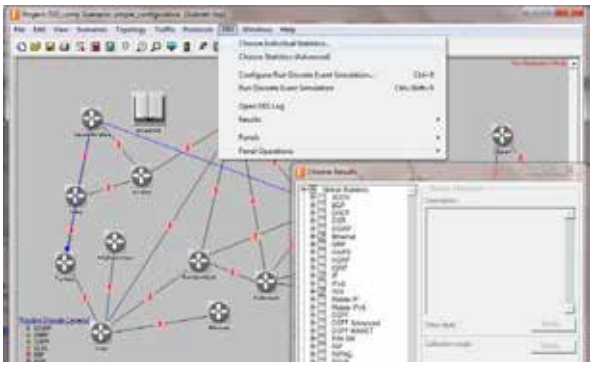

Fig-3 Parameter selection

The parameters are IP traffic delay, Network convergence, Point-to-Point delay, throughput, utilization, traffic sent/received, process delay selected in both routing protocols of OSPF and IS-IS enterprise network models for performance evaluation.

IV. SIMULATED RESULTS

The following figures showing the simulated results obtained from enterprise network model, which we have designed and configured as shown in the fig-2.

Fig-4. IP traffic delay

Fig-4 shows the comparison of OSPF and IS-IS routing protocol in which IP Traffic delay of OSPF is more than the IS-IS protocol.

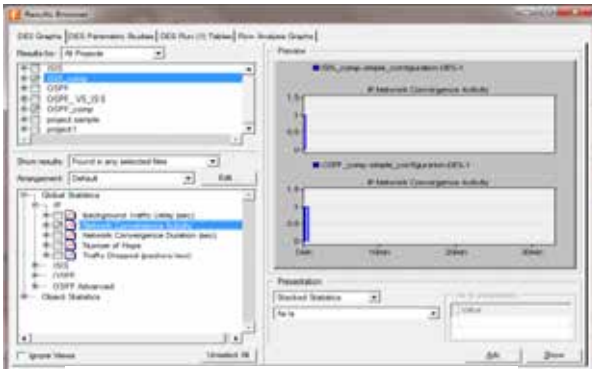

Fig-5. Network Convergence

The overall status of Network Convergence of enterprise network model of OSPF is higher than the ISIS routing protocol. The Network Convergence of IS-IS is better than OSPF as shown in the fig-5.

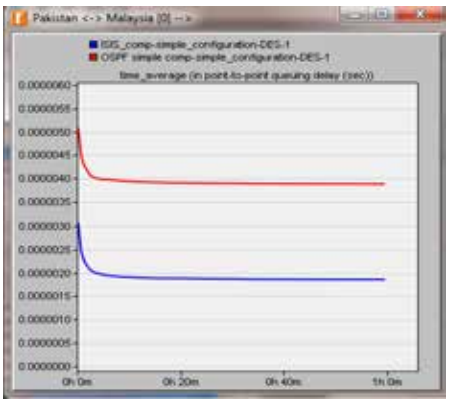

Fig-6. Point-to-Point delay

The fig-6, point-to-point delay is clearly showing the simulated result in favour of ISIS routing protocol.

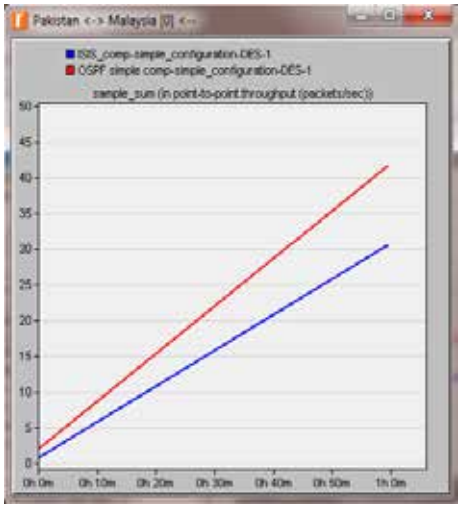

Fig-7. Throughput

In the Throughput parameter as per simulated result shown in fig-7 the OSPF is higher than the ISIS, the throughput is considered as main parameter.

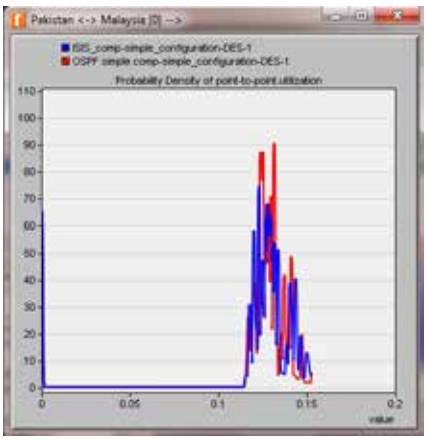

Fig-8. Utilization

ISSN – 1999-4974

The point to point utilization of data between Pakistani router to Malaysian router displayed that the utilization of OSPF has increase than the ISIS Fig-8.

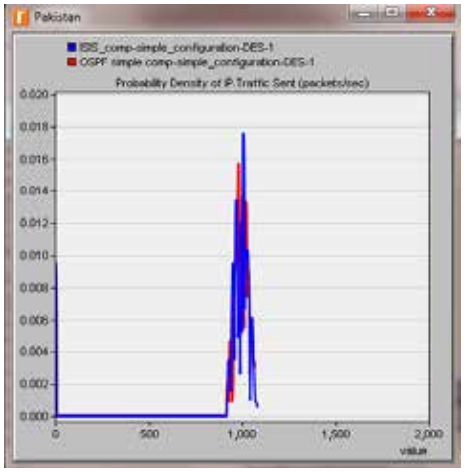

Fig- 9. Traffic Sent

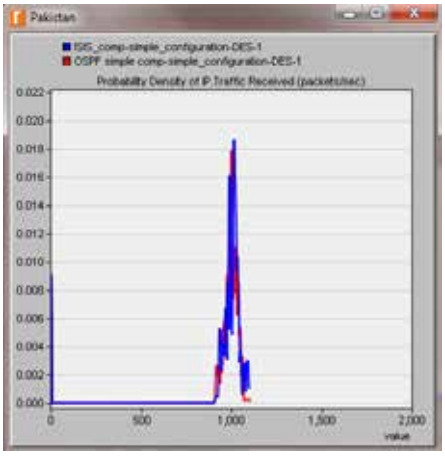

Fig- 10. Traffic Received

The fig-9 and 10 showing the status of the Traffic sent/received is more better in ISIS as compare to OSPF routing protocol.

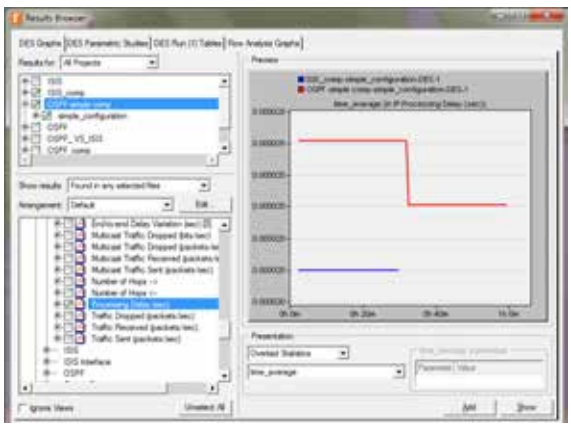

Fig- 11. Process Delay

The OSPF process delay is higher as compare to ISIS protocol as shown in fig-11

V. CONCLUSION

The two same enterprise network models were designed by using OPNET modeler in which OSPF and IS-IS routing protocol were separately applied as to assess the proficiency of both routing protocols. The simulated results are summarized as per selected parameters:

S#	*Name of Parameter*	*OSPF*	*IS-IS*
1	*IP traffic delay*	*High*	*Low*
2	*Network Convergence*	*Normal*	*FASTER*
3	*Point-to-Point delay*	*High*	*Low*
4	*Throughput*	*HIGH*	*Normal*
5	*Utilization*	*HIGH*	*Normal*
6	*Traffic sent/received*	*Normal*	*Faster*
7	*Process delay*	*High*	*LOW*

Table-1 Parameter wise status of OSPF & IS-IS

The Best performance of IS-IS routing protocol in different parameters such as IP traffic delay, Point-to-Point delay, Network convergence, Traffic sent and received and Process delay. While the faster performance of OSPF routing protocol in only two parameters such as Throughput and Utilization.

The analysis from the simulated results clearly support to the IS-IS routing protocol, which is most suitable for any enterprise network.

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 ISSN – 1999-4974