Performance Evaluation of RIP, OSPF, IGRP and EIGRP Routing Protocols in Wired Network Using OPNET

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Abstract—*In a network topology different types of protocols are used for forwarding the packets. Routing protocols determine the best routes to transfer data from one node to another and specify how routers communicate between each other. Most of the popular routing algorithms used are RIP, OSPF, IGRP and EIGRP. RIP is a distance-vector protocol; OSPF is a link-state routing protocol; IGRP is a distance vector protocol developed by Cisco and EIGRP is an enhanced distance vector protocol developed by Cisco. Many comparison and evaluation between different routing protocols has been done using OPNET 9.1. Therefore we can do evaluation on different routing protocol using OPNET 14.5 simulator.*
Keywords: - RIP, OSPF, IGRP, OPNET 14.5

I. Introduction

A routing protocol specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network. Routing algorithms determine the specific choice of route. Each router has a priori knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbors, and then throughout the network. This way, routers gain knowledge of the topology of the network. Static routing is not really a routing protocol. Static routing is simply the process of manually entering routes into a device's routing table via a configuration file that is loaded when the routing device starts up. These routes can be entered by a network administrator who configures the routes manually. Static routing is the simplest form of routing, but it is a manual process. Dynamic routing protocols are supported by software applications running on the routing device which dynamically learn network destinations and how to get to them and also advertise those destinations to other routers.

A. Interior Gateway Protocol (IGP):

Interior Gateway Protocol (IGP) are routing protocols used on the Internet for exchanging routing information within Autonomous Systems. Examples of IGP Protocols: RIP, OSPF, IGRP, EIGRP.

B. Exterior Gateway Protocol (EGP):

Exterior gateway protocol (EGP) are routing protocols used on the Internet for exchanging routing information between Autonomous Systems. Examples of EGP Protocols are BGP, Path Vector Protocol and EGP.

RIP (Routing Information System) is a standardized vector distance routing protocol and uses a form of distance as hop count metric. RIP is a distance vector. Through limiting the number of hop counts allowed in paths between sources and destinations, RIP prevents routing loops. Typically, the maximum number of hops allowed for RIP is 15. However, by achieving this routing loop prevention, the size of supporting networks is sacrificed. Since the maximum number of hop counts allowed for RIP is 15, as long as the number goes beyond 15, the route will be considered as unreachable. OSPF is defined in RFC 2328 which is an interior Gateway Protocol used to distribute routing information within an AS (Autonomous System). Compare to RIP, OSPF has no limitation due to hops (RIP has a limit of 15 hops so any network with more than 15 hops cannot be achieved by RIP. Interior Gateway Routing Protocol is a distance vector routing protocol developed by Cisco systems for routing multiple protocols across small and medium sized Cisco networks. It is proprietary which requires that you use Cisco routers. Enhanced Interior Gateway Routing Protocol is a hybrid routing protocol developed by Cisco systems for routing many protocols across an enterprise Cisco network. It has characteristics of both distance vector routing protocols and link state routing protocols.

II. Related Work

E. S. Lemma at al. in [9], they use OPNET to carry out the network simulations, using a combination of EIGRP&IS-IS, OSPF&IS-IS. The main aim of that paper was to configure multiple routing protocols on a selected network topology and analyze the performance improvement of the network. Sumit Kumar Yadav, evaluation of RIP, OSPF routing protocols in [7]. They evaluate both protocols on the basis of bandwidth and delay using opnet. Another work of the same authors where there is a comparative analysis of the routing protocols EIGRP and OSPF is shown in [6]. In order to evaluate OSPF and EIGRP's performance, their authors designed three network models configured with OSPF, EIGRP and a combination of EIGRP and OSPF and the three topologies where simulated using the Optimized Network Engineering Tool (OPNET). The evaluation results show that, in general, the combined implementation of EIGRP and OSPF routing protocols in the network performs better than each one of them alone.

III. Classification Of Interior Gateway Protocol

Interior Gateway Protocol (IGP) are routing protocols used on the Internet for exchanging routing information within Autonomous Systems. Examples of IGP Protocols: RIP, OSPF, IGRP, EIGRP.

A. Routing Information System (RIP)

The Routing Information Protocol (RIP) is a distance-vector based algorithm, is one of the first routing protocols implemented on TCP/IP. In a network, each router that uses this protocol has limited knowledge of the network around it. This simple protocol uses a hop count mechanism to find an optimal path for packet routing. A maximum number of 16 hops are employed to avoid routing loops. However, this parameter limits the size of the networks that this protocol can support. The popularity of this protocol is largely due to its simplicity and its easy configurability. However, its

disadvantages include slow convergence times, and its scalability limitations. Therefore, this protocol works best for small scaled networks.

B. Open Shortest Path First (OSPF)

Open Shortest Path First (OSPF) is a very widely used link-state interior gateway protocols (IGP). This protocol routes Internet Protocol (IP) packets by gathering link-state information from its neighboring routers and constructing a map of the network. OSPF routers send many message types including hello messages, link state requests and updates and database descriptions. Djisktra's algorithm is then used to find the shortest path to the destination. Shortest Path First (SPF) calculations are computed either periodically or upon a received Link State Advertisement (LSA), depending on the protocol implementation. Topology changes are detected very quickly using this protocol. Another advantage of OSPF is that its many configurable parameters make it a very flexible and robust protocol. Contrary to RIP, however, OSPF has the disadvantage of being too complicated.

1) Characteristics :-

- Link State
- Routes IP
- Routing Advertisements: Partial When Route Changes Occur
- Metric: Composite Cost of each router to Destination (100,000,000/interface speed)
- Hop Count: None (Limited by Network)
- Variable Length Subnet Masks
- Summarization on Network Class Address or Subnet Boundary
- Load Balancing Across 4 Equal Cost Paths
- Router Types: Internal, Backbone, ABR, ASBR

C. Interior Gateway Routing Protocol (IGRP)

Interior Gateway Routing Protocol is a distance vector routing protocol developed by Cisco systems for routing multiple protocols across small and medium sized Cisco networks. It is proprietary which requires that you use Cisco routers. This contrasts with IP RIP and IPX RIP, which are designed for multi-vendor networks. IGRP will route IP, IPX, Decnet and AppleTalk which makes it very versatile for clients running many different protocols. It is somewhat more scalable than RIP since it supports a hop count of 100, only advertises every 90 seconds and uses a composite of five different metrics to select a best path destination.

1) Characteristics :-

- Distance Vector
- Routes IP, IPX, Decnet, Appletalk
- Routing Table Advertisements Every 90 Seconds
- Metric: Bandwidth, Delay, Reliability, Load, MTU Size
- Hop Count: 100
- Fixed Length Subnet Masks
- Summarization on Network Class Address
- Load Balancing Across 6 Equal or Unequal Cost Paths (IOS 11.0)

D. Enhanced Interior Gateway Routing Protocol (EIGRP)

Enhanced Interior Gateway Routing Protocol is a hybrid routing protocol developed by Cisco systems for routing many protocols across an enterprise Cisco network. It has characteristics of both distance vector routing protocols and link state routing protocols. It is proprietary which requires that you use Cisco routers. EIGRP will route the same protocols that IGRP routes (IP, IPX, Decnet and Appletalk) and use the same composite metrics as IGRP to select a best path destination. As well there is the option to load balance traffic across equal or unequal metric cost paths.

1) Characteristics:-

- Advanced Distance Vector
- Routes IP, IPX, Decnet, Appletalk
- Routing Advertisements: Partial When Route Changes Occur
- Metrics: Bandwidth, Delay, Reliability, Load, MTU Size
- Hop Count: 255
- Variable Length Subnet Masks
- Summarization on Network Class Address or Subnet Boundary
- Load Balancing Across 6 Equal or Unequal Cost Paths (IOS 11.0)

IV. Result And Analysis

Figure 1 shows the router traffic sent/received in bits/sec of the four protocols in wired network. From the graph of routing traffic sent/ received we observe that EIGRP has the highest bandwidth efficiency while RIP has the lowest. It should be noted that OSPF has better bandwidth efficiency than EIGRP when there are no new routers added. OSPF has the highest initial peak because the routers must first map out the network before choosing a path. This requires routers to distribute a significant amount of information initially.

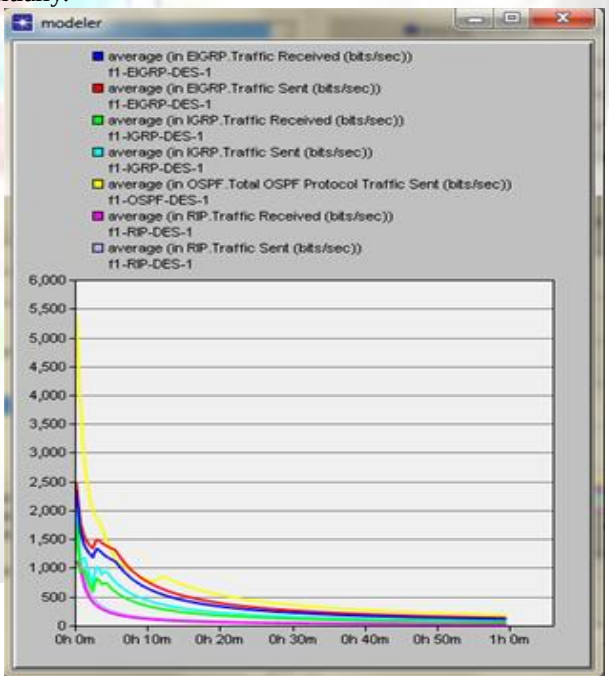

Fig.1: Routing Traffic Sent in bits/sec

The Figure 2 shows the convergence activity of each protocol. The first, second, and third peaks represents the initial setup, the link failure at 200 seconds, link recovery at 400 seconds, the link failure at 500 seconds, link recovery at 600 seconds, the link failure at 650 seconds, link

recovery at 700 seconds, the link failure at 710 seconds, link recovery at 720 seconds and the link failure at 730 seconds, link recovery at 740 seconds. The width of each peak represents the convergence duration. The longer a protocol takes to converge, the wider the peak will be. From these results we observe that EIGRP has the fastest convergence in all the stages while OSPF has a faster convergence time than RIP during a link-failure.

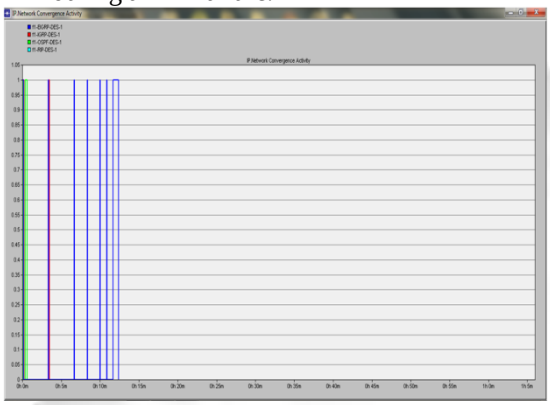

Fig. 2: Convergence Activity

From the Figure 3 it can be seen that the convergence time of EIGRP has a better performance than OSPF networks. The figure shows that the convergence time of EIGRP has less time than OSPF when a link fails at 200 seconds and recovers at 400 seconds following the change in link utilization. Graph indicates that network convergence duration of EIGRP is lower than OSPF network. This is because when a change occurs through the network, it detects the topology change and sends query to the immediate neighbors to have a successor and propagated this update to all routers. In the case of OSPF network, all routers within an area update the topology database by flooding LSA to the neighbors and routing table is recalculated. As a consequence, OSPF takes much time to be converged.

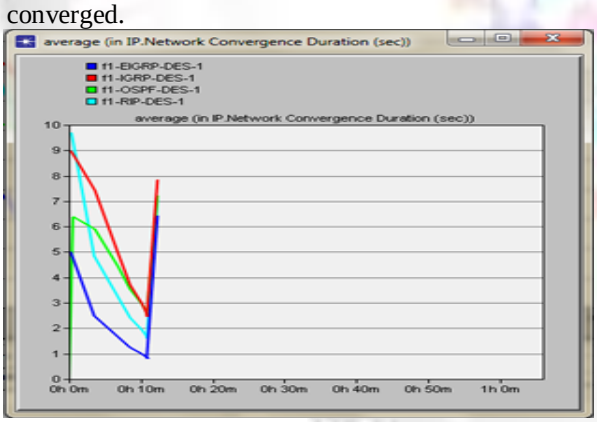

Fig. 3: Convergence Duration

V. Conclusion

Our simulations confirmed that EIGRP is the best choice for the network implemented as it has a fast convergence, while also efficiently utilizing bandwidth. OSPF is the second choice for networks, RIP performs poorly in large networks and is therefore limited to small, simple networks. For the future work, we can do the comparison between different network topology using routing protocols RIP, OSPF, EIGRP by using OPNET v14.5 simulator.

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