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Performance Analysis of Interior Gateway Protocols

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Abstract: **Routing Protocols play an important role in present day Data Communication. They determine best routes for transferring data from a source node to destination node. Major classes of routing protocols like EGP (Exterior Gateway Protocol) and IGP (Interior Gateway Protocol) are used for getting best statistics for packet data. The EGP Protocols are further differentiated based on link state or distance vector. In this study protocols RIP, OSPF and EIGRP based on Link State, Distance Vector and a hybrid Protocol which contain functionalities of both link state and distance vector are compared. RIP (Routing Information Protocol) is the oldest protocol which has limited hop count of 16. OSPF (Open Source Shortest path) computes the shortest path based on Dijkastra's Algorithm. It is used for IP networks. Enhanced Interior Gateway Routing Protocol (EIGRP) is a Cisco Proprietary hybrid protocol which consist of functionalities of both Link State and Distance Vector algorithms.**

Performance of different Interior gateway protocols is analyzed and compared based on different parameters. Choice of right protocol depends on number of parameters. Evaluation of these parameters and selecting the best protocol based on them is the main aim of the presented study. Protocols have been implemented with failure scenario. Routing Protocol Convergence has been evaluated which determines how fast the router adapts the changes occurring in the network. The routing protocol that converges fast is considered as best protocol as it adapts quickly to the changes in traffic pattern. Queuing delay, Protocol traffic sent, Throughput are other important parameters on which these protocols have been analyzed. Different services like HTTP, email and Voice are implemented and behavior of protocols with respect to these services has been analyzed and parameters plotted to see the results and draw conclusions.

Riverbed Modeler Academic edition 17.5 has been used for simulation which is the latest updation of OPNET modeler.

1. INTRODUCTION

Routing Protocols play vital role in Data Communication as they determine the route through which the information is propagated in the network.

Routing Information is maintained in form of Routing tables. Inconsistency in routing tables can cause data to be propagated on a wrong path. So maintaining efficiency in routing table is very important. Routing is classified as Static Routing and Dynamic Routing. Static Routing is used when network is not too large. Static Tables are maintained prior to any communication. Any change in the routing table is done manually by system administrator. But if network changes frequently then it becomes difficult to maintain these table as changes are to be made with each changed route. To avoid this problem Dynamic Routing is used. In case of dynamic routing, the table is configured automatically with each route change. The Dynamic routing protocol implemented on router is responsible for the creation, maintenance and updating of a routing table. It is less expensive as compared to Static Routing as route changes are made automatically and is more efficient one.

Dynamic Routing is done both ways. It is used to send the data within an autonomous system or it sends the data outside the network i.e internet. In Same Domain Interior Gateway Protocol (IGP) are used. Examples of Interior Gateway Protocols are Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF) and ISIS (Intermediate System – Intermediate System). And for the routers in different domain network, Exterior Gateway Protocol (EGP) are used such as Border Gateway Protocol (BGP)

IGP is further divided into 02 main categories, Distance Vector and Link State. RIP is example of Distance Vector Algorithm and OSPF is an example of Link State whereas EIGRP is an example of hybrid Protocol which contains functionalities of both Link State as well as Distance Vector.

2. RELATED SEARCH

The performance analysis of different routing protocols namely, RIP, OSPF and EIGRP discussed in [9]. Simulation results have shown that EIGRP is better than RIP and OSPF in terms of network convergence time and it has less bandwidth requirements, better CPU and memory utilization compared to OSPF and RIP. Performance analysis of different interior gateway protocols for real time applications is analyzed in [11]. This paper presents the comparison based on performance of routing protocol using weighted fair Queuing (WFQ) technique and results show that EIGRP provides best performance for non real time applications like FTP, Email and DB access. The authors of [11] suggested that for real time applications IGRP and OSPF is a better choice. [5] has compared different interior gateway protocols for real time

applications. Performance has been measured by dividing the network into different areas. Results shows that EIGRP provides better network convergence than RIP and OSPF and in terms of delay least delay is provided by EIGRP. For network traffic initial traffic was sent by EIGRP but the maximum traffic was sent by OSPF. [7] has analyzed the performance of interior gateway routing protocols on the basis of the cost of delivery, amount of overhead on each router, number of updates needed, failure recovery, delay encountered and resultant throughput. Results have shown that EIGRP has highest link utilization and better performance in terms of throughput, queuing delay and provides better router convergence. [8] Compares different routing protocols on basis of Response time, throughput, Point to Point utilization and queuing delay and concluded that EIGRP performs better than RIP and OSPF. Performance Analysis of Dynamic Routing Protocols Using Packet Tracer have been evaluated by [10] and concluded that EIGRP is better than RIP and OSPF in terms of convergence time, network scalability and handling of routing loops. Our work has tried to look at the performance of different Interior Gateway Protocols. Main aim of this work is to check the efficiency of these protocols based on application requirements. Performance has been analyzed by comparing these protocols based on important parameters like throughput, delay, utilization etc.

3. ROUTING PROTOCOLS

A. Routing Information protocol

RIP stands for Routing Information Protocol. It belongs to the class of Distance Vector algorithms. RIP is one of the first Routing Protocol implemented on TCP/IP and UDP is used to send information through the network which does not provide reliability. When RIP is configured on a router, the broadcast message is sent to all RIP enabled interfaces which then respond by sending a response message which consists of their routing tables. This process continues until the network is converged. Updates are sent every 30 sec which leads to more traffic and in case of RIP hop count of 16 is maintained. After 15 hops the route is considered inaccessible. Due to this reason RIP is used in small networks. It is not considered efficient for large networks.

B. Open shortest path first

OSPF stands for open shortest path first protocol. It was developed by IETF for IP Networks. It belongs to class of interior gateway protocols and uses link state routing. In case of OSPF shortest path is computed and used for routing. Dijkastra's algorithm is used for computing shortest path. Each router in case of OSPF maintains link state information of all routers in the network. Topology of the network is described by link state database. Link state advertisement (LSA) is used for exchanging information between routers. Every router floods LSA to other routers and other routers upon receiving it, processes LSA. So LSA notifies routers whenever topology changes. Different types of link State packets are used in OSPF which consist of Link state Request packet, Link State update, and Link state acknowledgement.

C. Enhanced Interior Gateway Routing Protocol(EIGRP)

EIGRP is a hybrid protocol which consists of functionalities of both Link State and Distance Vector algorithms. It is a Cisco Proprietary Protocol. Dual Updation Algorithm (DUAL) is used for Route Updating. It avoids routing loops and provides fast convergence and route optimization. EIGRP advertises its routing table to its neighbors as distance-vector protocol and forms neighbor relationships similar to link-state protocols. For optimal path metric calculation is made with variables like bandwidth, load, delay and reliability

4. SIMULATION PARAMETERS AND PERFORMANCE METRICS

A. Simulation Model

Riverbed Modeler is used for network simulation. Riverbed Modeler is updated version of opnet modeler. Modeler is developed in C language and provides commercial network simulation environment for network modeling and simulation. Users can design and study various communication networks, protocols, applications and present the graphical structure of actual networks and network components. Different network types and technologies including VoIP, OSPFv3, MPLS, IPv6, TCP etc can be implemented and analyzed to compare the impact of different technology designs on end-to-end behavior. Using the Modeler we can demonstrate technology designs before production; increase network R&D productivity, develop proprietary wireless protocols and technologies and evaluate enhancements to standard based protocols.

B. Performance metrics

Different performance metrics are analyzed and compared to check the performance of three protocols. Some of them are described below:

Convergence: Convergence is very important factor of Interior Gateway Protocol. It is implemented to get the network to normal state. If any change prevails in the network, network is converged to normal state by communicating that change to the whole network through routers and setting the same state in the network. Convergence time is a measure of how fast a set of routers converge the network to a normal state.

Throughput: Throughput in network measures the rate of successful messages that has been delivered in a network.

Throughput is basically measured in bits per second (bps).

Queuing Delay: It is the waiting time of a job in a queue until its execution. As router can process only one packet at a time, but the packets arrival time is faster as compared to processing time. So other packets wait in a queue for their execution.

Email Upload response time: Email application has been included in the scenario. Its upload time is measured and compared to check the performance of three protocols. A protocol which exhibits minimum upload response time is considered best.

Http page response time: Http page response time is the measure of time that a web page takes to load.

C. Results

Protocols are implemented using different scenarios with same network topology**.** Parameters stated above are used to compare the protocols. Failure of node is done at 200 sec and it is recovered at 260 sec. With failure scenario we evaluate the convergence of the network. Different servers for HTTP and Email application are included to check the performance of routing protocol for these applications.

A. Convergence Duration

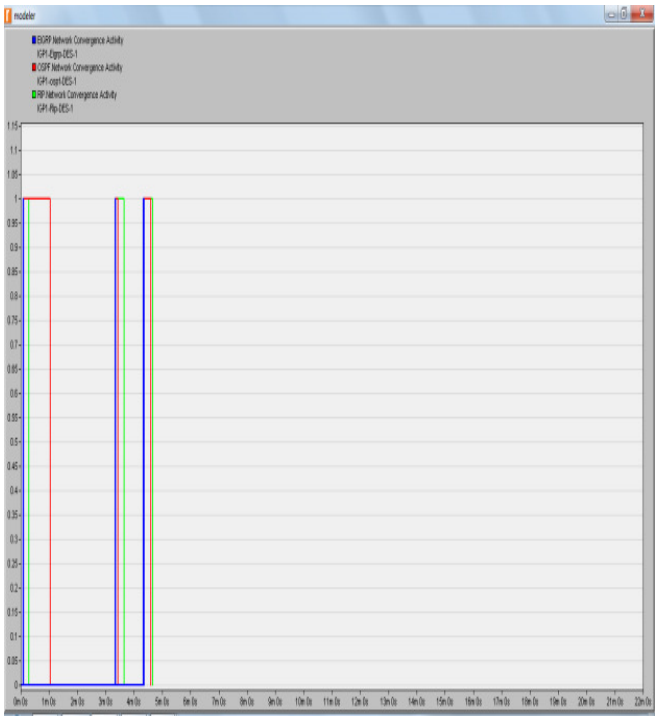

Fig 1: Convergence Activity

To avoid excessive traffic loss, protocols should converge fast and in minimum time. As depicted in Figure 1 EIGRP provides Fast convergence as compared to RIP and OSPF.

B. Convergence Duration

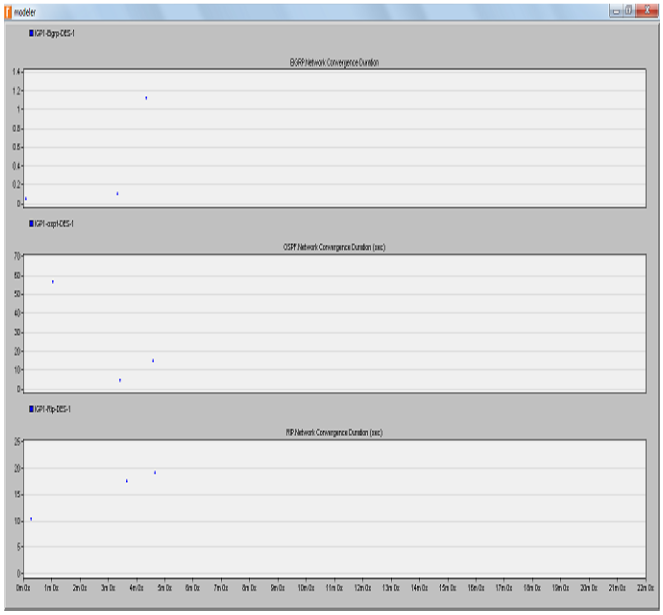

Fig 2: Convergence Duration (sec)

The Convergence time of EIGRP is smaller. First Convergence of EIGRP is around 0.20 sec which is very small compared to RIP and OSPF. This means that interfaces in EIGRP takes smaller time to update Routing table, Topology table and Interface table.

C. Point to Point Utilization

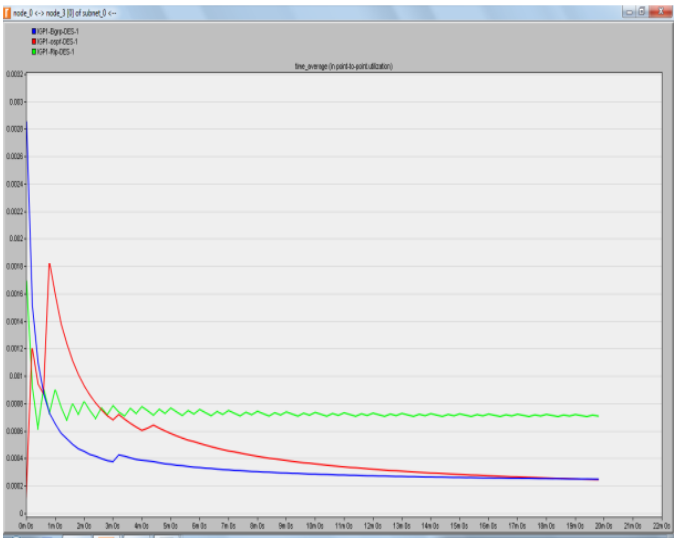

Fig 3: Point to Point utilization

Utilization in case of EIGRP is better as compared to RIP and OSPF.

D. Point to Point Throughput

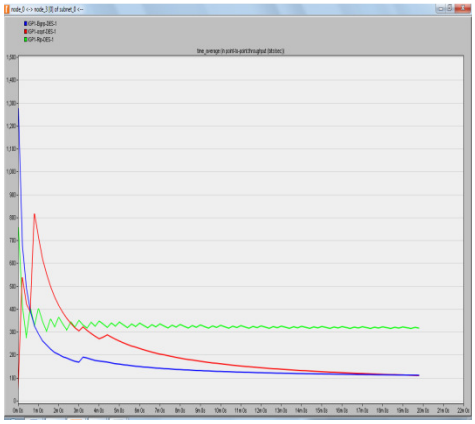

Fig 4: Point to Point throughput

EIGRP provides highest throughput followed by OSPF and RIP.

E. Queuing Delay

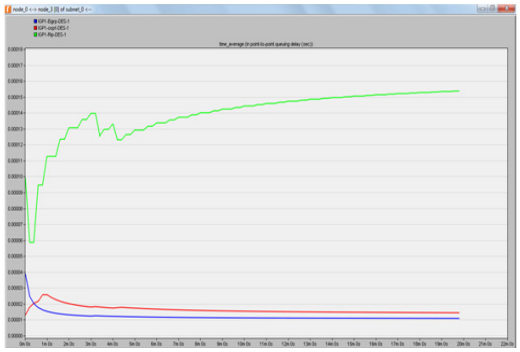

Fig 5:Queuing Delay

RIP exhibits highest Queing delay. OSPF has least delay.

F. Protocol Traffic Sent

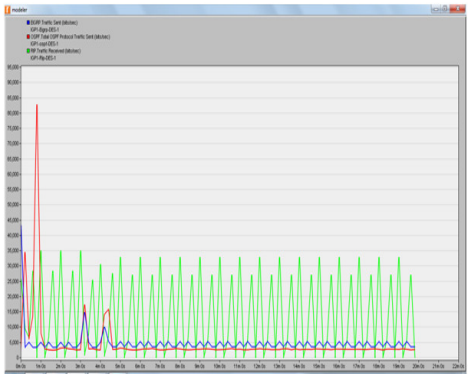

Fig 6: Protocol Traffic Sent

From the graph, we can obsserve three peaks, the first peak represents the initial traffic, the next peak is link failure and the last peak is the link recovery in the network. We can conclude that OSPF generates the highest initial traffic since in OSPF large amount of information is distributed initially. We can see fluctuations in RIP traffic as in this case rout tables are updated every 30 sec.

G. HTTP Page Response

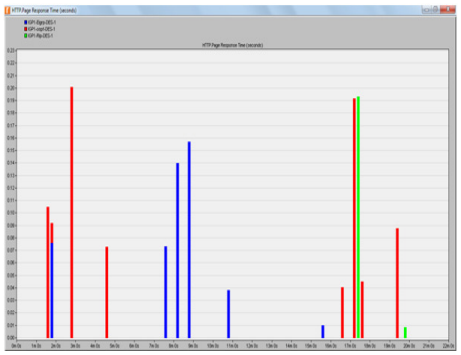

Fig 7:HTTP Page Response

Http page response time of OSPF and RIP is more than EIGRP. The web browsing takes different load conditions into account. Here light web browsing is considered and based on compartive analysis it is considered that EIGRP is best suited protocol for HTTP load Based on parameters.

H. E-mail Upload response Time

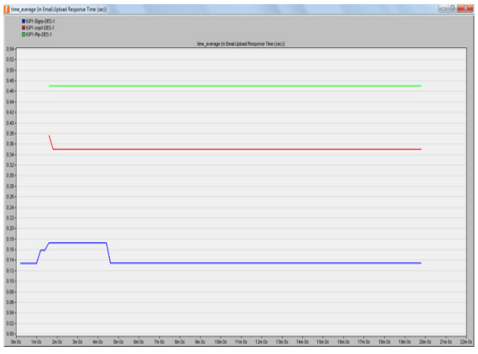

Fig 8:E-mail Upload Response Time

From the graph it is concluded that RIP has highest e-mail uploading time and EIGRP the lowest which means EIGRP is the efficient protocol for email application.

CONCLUSION

Interior gateway protocols like RIP, OSPF, EIGRP are widely used in computer networking. In this paper comparative performance analysis of these protocols is presented.

Performance of routing protocols has been evaluated on basis of some parameters like network convergence; throughput, utilization, queuing delay, HTTP page response and email upload response time.

Results show that to reduce excessive traffic loss and to enhance network scalability convergence time of the network should be minimum. EIGRP exhibit minimum convergence time as compared to OSPF and RIP.

In terms of throughput and utilization, EIGRP is better than RIP and OSPF. If we consider protocol traffic, in case of OSPF initial traffic is at peak and a large fluctuation is observed in case of RIP as updates are sent every 30 sec. For application like HTTP and E-MAIL, EIGRP is considered efficient protocol as it takes less time for page loading in case of HTTP and has the lowest email upload response time as compared to OSPF and EIGRP.

We can conclude that EIGRP is the best choice among Interior Gateway Protocols in terms of throughput, delay and application performance.

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