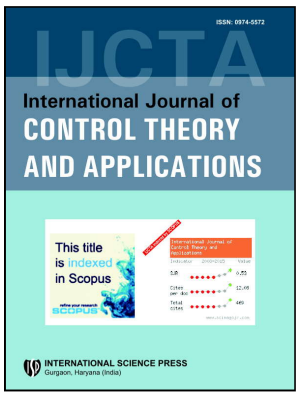

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Performance Analysis of RIP, EIGRP, OSPF and ISIS Routing Protocols

Shailja Pant[1], and Ankur Dumka[2]

[1]M.Tech Student, Department of Computer Science and Engineering Uattrakhand Technical University, Dehradun, Uttarakhand, India, Email: shailjapant30@gmail.com
[2]Assistant Professor, Department of Computer Science and Engineering University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India, Email: ankurdumka2@gmail.com

Abstract: In computer network, routers are used for the purpose of moving the data or packets in a network. The working of router is controlled by using routing protocols which are mainly divided into two types: interior gateway routing protocols and exterior gateway routing protocols.

This paper focuses on analyzing the performance of four interior routing protocols i.e. RIP, EIGRP, OSPF and ISIS when implemented on same network topology using Graphical Network Simulator (GNS3), and develop a simulator application which would return routing table of nodes in the topology. Along with this, routing protocols are compared on different parameters like hop count, administrative distance, route propagation, updates, path metric, time required for reaching destination, round trip time etc.

Keywords: RIP, EIGRP, OSPF, ISIS, GNS3, RTT, TTL.

1. INTRODUCTION

Routing is the process of moving data packets from one node to another node in a network by using routers. To route packets from source to destination, a router should contain the destination address, should knowneighbor routers along with all possible routes. For obtaining all these information routing protocols are used. A routing protocol determines the best path for a router to send packets in a network. A routing table is created by each router that contains all the required information of routes.

The routing protocols are broadly classified as Interior and Exterior gateway protocols. Which are further divided as distance vector, link state and path vector routing protocols as shown in figure1. In this paper four interior routing protocols RIP, EIGRP, OSPF and ISIS are analyzed.

1.1. Routing Information Protocol (RIP):

Routing Information Protocol (RIP) is one of the most widely used intra-domain routing protocol based on the distance vector routing algorithm. RIP was started as a part of Xerox Network System (XNS), but it was the

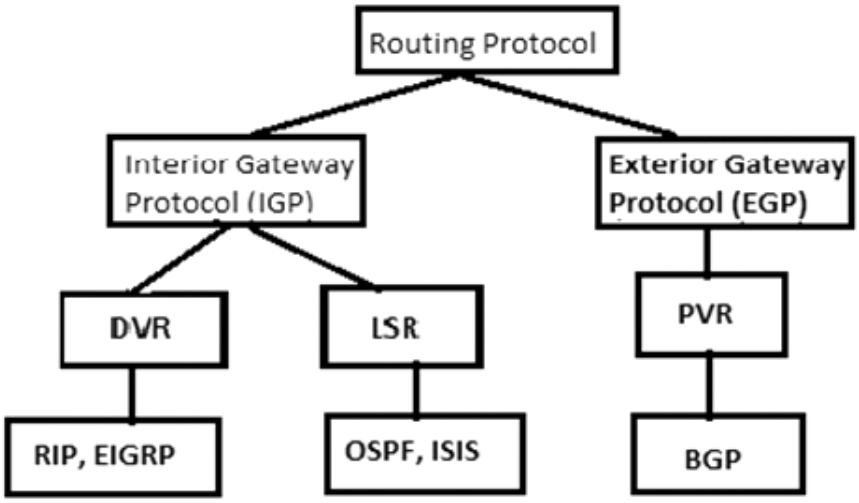

Figure 1: Classification of routing protocol

Berkeley software Distribution (BSD) version of UNIX that helped make the use of RIP widespread [1].RIP employs the hop count as a routing metric and implement limitation on the maximum hops allowed in a network, thus prevent the routing loop problem. But as the hop count is limited to 15, it also limits the size of the network. RIP selects the path which has least number of hops as the shortest path.

Characteristics:

- Type: It is a Distance Vector routing protocol
- Metric: number of jumps i.e. Hop Count
- Maximum jumps: The maximum number of jumps is 15
- Update timer: 30 sec
- Invalid Timer: 180 sec
- Flush Timer: 240 sec
- Holddown Timer: 180 sec

1.2. Enhanced Interior Gateway Routing Protocol (EIGRP)

Enhanced Interior Gateway Routing Protocol (EIGRP) is an advanced distance vector routing protocol along with the features of link state routing algorithm designed by Cisco system. Unlike other distance vector routing protocols, EIGRP uses multicasting for sending the routing updates that helps in saving bandwidth as well as system time too. It only sends incremental updates, reducing the workload on the router, i.e. it sends partial trigger updates only when a change occurs. EIGRP uses diffusing update algorithm (DUAL) to improve the efficiency and to prevent calculation errors and help in attaining fast convergence.

EIGRP uses composite metric for selecting the best path in a network which includesbandwidth, delay, load and reliability. EIGRP metric can be calculated by using following formula:

Metric = [K1*bandwidth+(K2*bandwidth) /(256 - load)+K3*delay] * [K5/(reliability+K4)]

Where: K1,K3=1 and K2,K4,K5=0.

Characteristics:

- Type: It is an Advanced Distance Vector routing protocol.
- Routes IP, IPX, DECnet, AppleTalk
- Routing Advertisements: Partial advertisements are done i.e. onlywhen any route Changes Occurs.
- Metrics:a composite metric of Bandwidth, Delay, Reliability and Load is used.
- Hop Count: 255 is the maximum hop count.
- Hello Timer: 1 second on Ethernet, 60 seconds on Non-Broadcast
- Holddown Timer: 3 seconds on Ethernet, 180 seconds on Non-Broadcast.

1.3. Open Shortest Path First (OSPF)

Open Shortest Path First (OSPF) is also an intra-domain based on link state routing protocol. It is a routing protocol developed for Internet Protocol (IP) network by IGP working group of the internet [1]. OSPF uses Dijkstra algorithm for selecting the best route to send packets in a network. OSPF divides Autonomous system into areas for handling routing in an efficient and timely manner. In OSPF, router uses routing packets known as Link State Packets (LSA) to obtain and maintain the state of link. Areas in OSPF are Primary area (Backbone Area) and Secondary area (Stub-area, Not-so-stubby area (NSSA), Totally stubby area, NSSA totally stubby area). Routers inside an area flood the area with routing information. At the border of an area, special routers called Area Border Routers (ABR)summarize the information about the area and send it to other areas. The routers inside the backbone are called the Backbone Routers (BR). [2]

Characteristics:

- Type: It is a Link State routing protocol.
- Routing Advertisements: Partial advertisements are done i.e. only when any route Change Occurs.
- Metric:Bandwidth and delay are used as metrics.
- Hop Count: None i.e. hop count are limited by the network.
- Load: Load Balancing is across 4 equal cost paths
- LSA Types: Intra-Area (1,2) Inter-Area (3,4), External (5,7)
- Fast Hello Timer: 250 msec. for Ethernet, 30 seconds for Non-Broadcast
- Dead Timer: 1 second for Ethernet, 120 seconds for Non-Broadcast.

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

Intermediate System-to-Intermediate System (IS-IS) is a link state routing protocol developed by Digital Equipment Corporation (DECnet Phase V) and standardized by ISO in 1992. The purpose of IS-IS was to make possible the routing of datagram using the ISO-developed OSIprotocol stack called CLNS. [3]

A router is termed as intermediate system in IS-IS. There is support for variable length subnet masks, which is standard with all link state protocols. IS-IS assigns the routing process to an interface instead of a network.IS-IS uses Dijkstra algorithm for shortest path selection. It provides two-level network hierarchy using areas that are similar to OSPF. The routers in the backbone area are called L2 routers; the internal routers in low-level areas are called L1 routers. IS-IS uses Link State Packets (LSP) packets to obtain and maintain the topological map of the network.

Characteristics:

- Type: It is Link State routing protocol.
- Routing Advertisements:Partial advertisements are done i.e. only when any route Change Occurs.
- Metric: Variable Cost (default cost 10 assigned to each interface)
- Hop Count:None i.e. hop count are limited by the network.
- Load: Load Balancing is done Across 6 Equal Cost Paths.
- Hello Timer Interval: 10 seconds
- Dead Timer Interval: 30 seconds
- Router Types: Level 1 and Level 2
- LSP Types: Internal L1 and L2, External L2.

2. RELATED WORK

Syed YasirJalali, SufyanWani and Majid Derwesh [4]compared the results of simulation for convergence, throughput, link utilization and queuing delay concluding that the performance of EIGRP is the best among all.Prachi Thakur and Yogesh Bansal [5] discussed different dynamic routing protocols, design issues and had given pros and cons of RIP, EIGRP as well as OSPF. Vishal Nigam, Md. SamilFarouqui and Gunjan Gandhi [6] focused on comparing dynamic routing protocols RIPv1, RIPv2, OSPF and EIGRP on the basis of various parameters and shown difference between the distance vector and link state routing. Jeevan Prasad Adhikari[7] has analyzed the performance of Protocols RIP & EIGRP and concluded that EIGRP protocol is better than RIP protocol.Jagdeep Singh and Dr. Rajiv Mahajan [8] also analyzed routing protocolRIP, EIGRP and OSPF and come to the conclusion that EIGRP perform better than other two as well as the combination of these three routing protocols.Pankaj Rakheja, Prabhjotkaur, Anjali gupta and Aditi Sharma [9] have analyzed the performance ofRIP, OSPF, IGRP and EIGRP on the basis of throughput, queuing delay and link utilization and concluded that OSPF performs better than other protocols.An analysis of OSPF and ISIS is done by Oran Sharon [10] found that the scheme suggested in IS-IS more efficient than OSPF in terms of arrival times of update packets. In terms of bandwidth each scheme consumes, while in terms of the number of memory accesses, IS-IS outperforms OSPF.

3. SIMULATION SETUP

A simulation network is developed by using Graphical Network Simulator (GNS3) for the purpose of analysis of routing protocols.GNS3 is an open source software emulator developed primarily by Jeremy Grossmann in 2007 (additional developers are David Ruiz, Romain Lamaison, Aurelien Levesque, and Xavier Alt [11]) that allows simulation of complex networks without having dedicated hardware such as routers and switches.

To provide complete and accurate simulations, GNS3 uses following emulators:

- Dynamips - a Cisco IOS emulator.
- Qemu - a generic and open source machine emulator and virtualizer.
- Virtual Box - free and powerful virtualization software.

For the purpose of designing a network topology Cisco router c7200, IOS image c7200-jk9s-mz.124-13b is used as shown in figure 2.

The routing protocols are configured on each router one at a time. There are two modes for configuration:privileged mode and global mode. For entering the privileged mode enable command is used.For

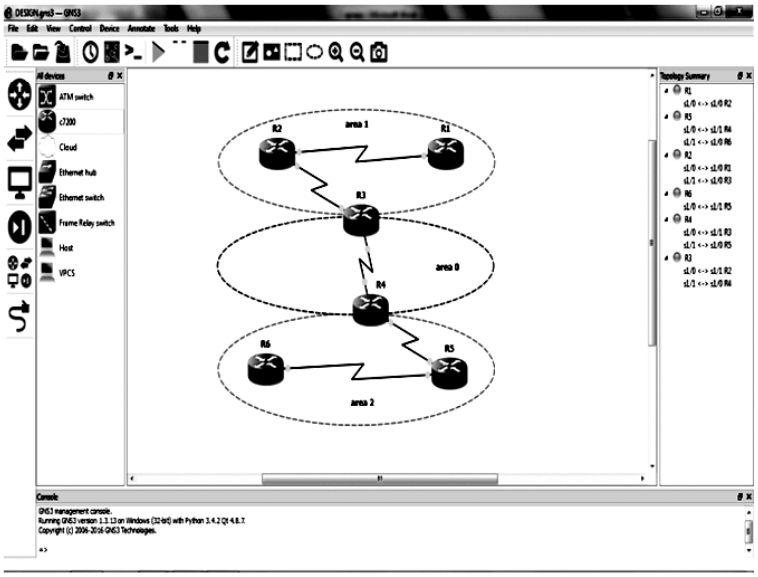

Figure 2: Network Topology design Using GNS3

making any global change to the router configure terminalcommand is used, that is in global configuration mode. Aglobal command is set only once and affects the entirerouter [12].

4. RESULTS AND ANALYSIS

Routing Tables of RIP, EIGRP, OSPF and ISIS are obtained after implementing them on each routerindependently in same network scenario. Each routing table indicates the name of routing protocol along with network ip and subnet mask, its AD value, metric,exit interface ip, length of time for which part particular route has been present in routing table and finally the exit interface.

Table 1
Theoretical comparison of RIP, EIGRP, OSPF and ISIS routing protocols.

Parameters	RIP	EIGRP	OSPF	ISIS
Type of protocol	DVR	Hybrid	LSR	LSR
Algorithm	Bellman-Ford	DUAL	Dijkstra	Dijkstra
Metric	Hop Count	Bandwidth, Delay, Load, Reliability	Bandwidth Delay	Cost
Hop count limit	15	255	none	none
Updates	Route table	Only changes	Event triggered	Event triggered
Timers	30 sec	60 sec	30 sec	10 sec
Convergence	slow	Very fast	fast	fast
Classless support	no	yes	yes	yes
VLSM support	no	yes	yes	yes

In table1 a comparison of RIP, EIGRP, OSPF and ISIS is done on the basis of different theoretical parameters that includes type of protocol, metric used by each protocol, limit of the hop count, type of update, timers, convergence and support of VLSM as well as classless support is shown.

Table 2
Practical comparison of RIP, EIGRP, OSPF and ISIS routing protocols

Parameters	RIP		EIGRP		OSPF		ISIS	
Administrative distance	120		90/170		110		115	
RTT (msec)	R1-R6	R6-R1	R1-R6	R6-R1	R1-R6	R6-R1	R1-R6	R6-R1
Min	137	140	135	154	149	152	144	183
Avg	192	191	188	196	172	133	171	213
Max	248	252	244	258	204	216	203	249
TTL (msec)	R1-R6	R6-R1	R1-R6	R6-R1	R1-R6	R6-R1	R1-R6	R6-R1
	129.76	109.40	121.38	116.22	105.12	112.26	103.00	104.54

In table2 a comparison is shown between the different routing protocols that are implemented on a simulated network and the round trip time as well as time-to-live are analyzed when a packet is sent from fist router (R1) to last router (R6).

- **Administrative Distance:** AD measures the reliability of a given routing protocol. The lesser the administrative distance, the more reliable the network.
- **Round-trip time (RTT):** It is the length of time taken to send a packet plus the length of time taken for acknowledgement of that received packet as shown in figure 3.

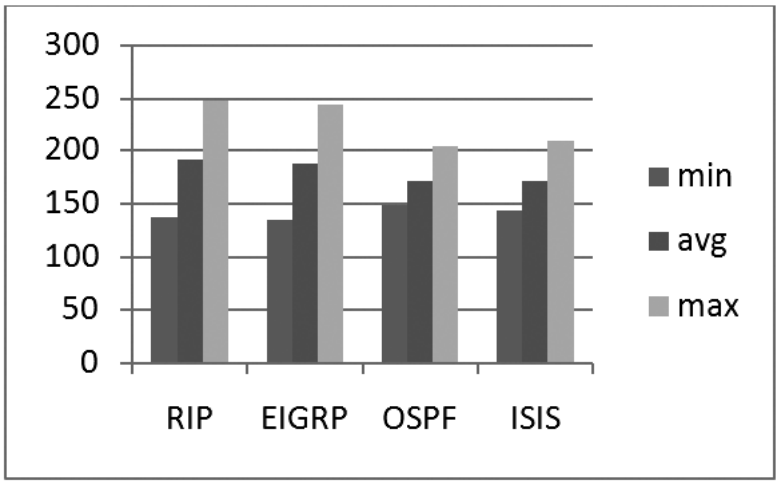

Figure 3: Round Trip Time taken by a packet from R1 to R6 in each protocol.

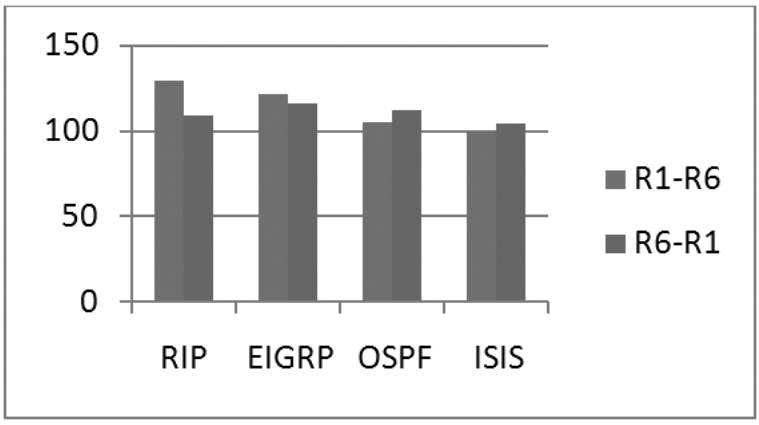

Figure 4: Time taken by a packet to reach the destination

- **Time-to-live (TTL):**The time-to-live value, also known as hop limit, is used in determining the intermediate routers being traversed towards the destination and gives the time for which the packet remains alive in the network as shown in figure 4.

The smallest minimum round trip time taken by a packet i.e. time to reach from source to destination and give back the acknowledgement to source is by using EIGRP protocol while the smallest maximum round trip is offered by OSPF and the smallest RTT average value is shown by ISIS. On analyzing all these values it is seen that an overall round trip time taken by a packet in OSPF is better. Similarly, on analyzing time-to-live values, the average time taken by a packet to travel from source to destination is least time in ISIS while RIP provides the highest value.

5. CONCLUSION AND FUTURE WORK

In this paper comparison between RIP, EIGRP, OSPF and ISIS routing protocol is done on the basis of some theoretical as well as practical parameters. After analyzing the output obtained on implementing these protocols it can be concluded that in most of the cases OSPF & ISIS have more or less same performance, EIGRP have a moderate performance while RIP has very poor performance as compared to all the three routing protocols.

In this thesis a comparison analysis on routing protocols is done on the basis of some parameters. In case of future work, a research work can be done on comparing the end-to-end delay, queuing delay, jitter, etc. of each protocol as well as the behavior of these protocols can be analyzed on a much bigger scenario or complicated network. The security analysis for all these protocols can also be considered in future work.

REFERENCES

[1] Bhaskar verma, Ankur Dumka et. al. ,"Implementation and comparison of performance of various EGPs and IGPs with traffic management", Indiacom2015, second international IEEE conference (BVICAM), 11-13 march 2015.

[2] Ankur Dumka and Hardwari Lal Mandoria, "Layer 3 service implementation in different routers", Indiacom2014, second international IEEE conference,2014, pp-716-718.

[3] Syed YasirJalali, SufyanWani and Majid Derwesh, 'Qualitative Analysis and Performance Evaluation of RIP, IGRP, OSPF and EGRP Using OPNET™', Advance in Electronic and Electric Engineering, 2014.

[4] Prachi Thakur and Yogesh Bansal "Survey of IP routing protocols", International Journal of Advanced Research in Computer Science and Software Engineering, July 2014.

[5] Vishal Nigam, Md. SamilFarouqui and Gunjan Gandhi 'Enhanced Comparative Study of Networking Routing Protocols', IJARCSSE, Feb 2014.

[6] Jeevan Prasad Adhikari, 'Performance Analysis of Protocols RIP & EIGRP using GNS3 Software', International Journal of Innovative Technology and Exploring Engineering, Apr 2013.

[7] Jagdeep Singh and Dr. Rajiv Mahajan, 'Simulation Based Comparative Study of RIP, OSPF and EIGRP', International Journal of Advanced Research in Computer Science and Software Engineering, Aug 2013.

[8] Pankaj Rakheja, Prabhjotkaur, Anjali gupta and Aditi Sharma 'Performance analysis of RIP, OSPF, IGRP and EIGRP Routing Protocols in a Network', International Journal of Computer Applications, June 2012.

[9] Oran Sharon "Dissemination of routing information in broadcast networks: OSPF versus IS-IS", IEEE network, Jan/Feb 2001.

[10] GNS3Graphical Network Simulatorby Mike Fuszner.

[11] Rajender Kumar, Jitender Vats, Arvind Kumar "A comparative study of routing protocols", (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 2 (5) , 2011.