Volume 4, Issue 2, February 2014 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Enhanced Comparative Study of Networking Routing Protocols

Vishal Nigam
B.Tech Student, ECE Department
Lovely Professional University
Phagwara,Punjab(India) -144411

Md. Samil Farouqui
B.Tech(ECE) LPU (Punjab,India)
Lovely Professional University
Phagwara,Punjab(India) -144411

Gunjan Gandhi
Asst. Professor (ECE)
Lovely Professional University
Phagwara,Punjab(India)-144411

Abstract— This paper focuses on the different dynamic routing protocols used in computer network. Dynamic routing is when protocols are used to find networks and update the routing tables on router. Routing Protocols are key elements to modern communication networks. With the expansion of the existing networks and the emergence of new applications that require a real time communication, routing protocols become one of the most important decisions in the design of these networks. A routing protocol is used by routers to dynamically find all the networks in the internetwork and to ensure that all routers have the same routing table. Basically, a routing protocol determines the path of a packet through an internetwork

Keywords— RIPv1, RIPv2, OSPF, EIGRP,OPNET

I. INTRODUCTION

Routing is the prime factor in this modern era of internet communication. Several routing protocols are in existence in these days. The most commonly used routing protocols are RIP (Routing Information Protocol), OSPF (Open Shortest Path First), IGRP (Interior Gateway Routing Protocol) and EIGRP (Enhanced Interior Gateway Routing Protocol). Two types of routing protocols are used in internetworks: interior gateway protocol (IGPs) and exterior gateway protocol (EGPs). IGPs are used to exchange information in the same autonomous system (AS). EGPs are used to communicate between different ASes. Border Gateway Protocol is an example of EGP. Routing protocols are based on routing algorithms, which rely on various metrics to find the best path to transmit data across networks. The software used for the simulation purpose for the routing protocols is GNS3. Routing is used in networks to control and forward data. For a router to be efficient and effective, the critical factor is the choice of the routing protocol. Routing protocols find a path between network nodes; if multiple paths exist for a given node then the
shortest path is selected by protocol. Metrics include cost, bandwidth, maximum transmission unit (MTU), packet delay, and hop count. Routing protocols utilize a routing table to store the results of these metrics. All routing protocols are defined based on an algorithm. This algorithm must describe some procedures in order to make the routing protocols operate correctly. These procedures are:

- A procedure to receive and send information about the network.
- A procedure to find the best path to a destination and install the route in the routing table.
- And finally, a procedure to detect, react and inform to other devices about changes in the network
- topology.

The two main existing algorithms are Bellman-Ford algorithm and Dijsktra algorithm. Depending on which algorithm is used, the routing protocols are classified in Distance Vector or Link State, respectively. In the subsequence paragraph we will discuss about these algorithms in brief.

II. THEORETICAL ANALYSIS OF PROTOCOLS

Routing protocols are classified in Distance Vector or Link State protocols according to the method they use to exchange information about the network and to use this information to calculate the best path to a destination. As already mentioned there are three important protocols which are considered for real life network application (RIP,OSPF, EIGRP).As already said there are two main classes of adaptive routing protocols in the internet: distance vector and link state. This paper presents the comparison between distance vector and link state.

Metrics and Routing :-

Metrics :- The measurements of path cost usually depend on the metric parameters. Metrics are used in a routing protocol to decide which path to use to transmit a packet through an internetwork.

Metric Parameters:- A metric is measured to select the routes as a mean of ranking them from most preferred to least preferred. Different metrics are used by different routing protocols. In IP routing protocols, the following metrics are used mostly :-

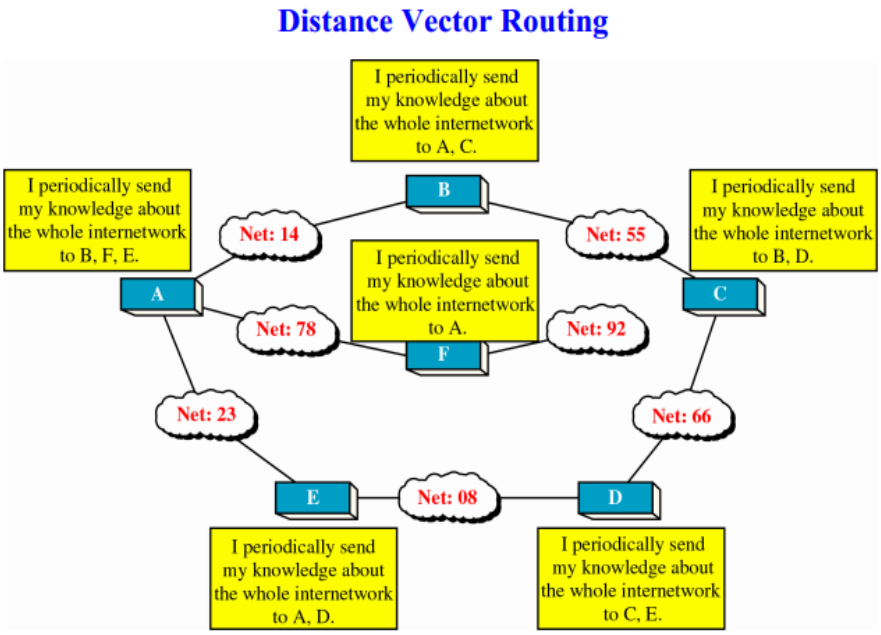
- Hop count: It counts the number of routers for which a packet traverses in order to reach the destination.
- Bandwidth: A bandwidth metric chooses its path based on bandwidth speed thus preferring high bandwidth link over low bandwidth.

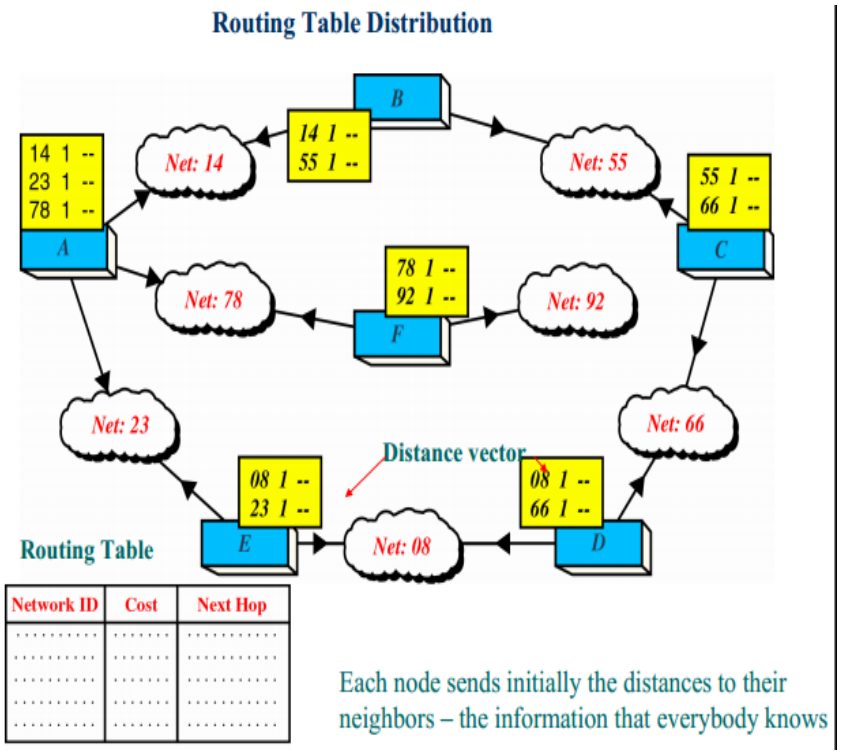
- Delay: Delay is a measure of the time for a packet to pass through a path. Delay depends on some factors, such as link bandwidth, utilization, physical distance travelled and port queues.
- Cost: The network administrator or Internet Operating System (IOS) estimates the cost to specify an ideal route. The cost can be represented either as a metric or a combination of metrics.
- Reliability: It calculates the link failure probability and it can be calculated from earlier failures or interface error count.

III. ROUTING INFORMATION PROTOCOL

RIP is a standardized Distance Vector protocol, designed for use on smaller networks. RIP was one of the first true Distance Vector routing protocols, and is supported on a wide variety of systems. RIP is implemented on top of the User Datagram Protocol(UDP) as its transport protocol. It is assigned the reserved port number 520. RIP prevents routing loops by implementing a limit on the number of hops allowed in a path from the source to a destination. The maximum number of permitted hops is 15. Hence a hop count of 16 is considered an infinite distance. This hop number limits the size of networks that RIP may support. RIP selects paths that have the smallest hop counts. However, the path may be the slowest in the network. RIP is simple and efficient in small networks. However, it may be inefficient in larger networks.

Below is the graphical explanation of Distance Vector Routing :-





RIP adheres to the following Distance Vector characteristics:

- RIP sends out periodic routing updates (every 30 seconds).
- RIP sends out the full routing table every periodic update.
- RIP uses a form of distance as its metric (in this case, hop count).
- RIP uses the Bellman-Ford Distance Vector algorithm to determine the best "path" to a particular destination.

Any network that is 16 hops away or more is considered unreachable to RIP, thus the maximum diameter of the network is 15 hops. A metric of 16 hops in RIP is considered a poison route or infinity metric. If multiple paths exist to a particular destination, RIP will load balance between those paths (by default, up to 4) only if the metric (hopcount) is equal. RIP uses a round-robin system of load-balancing between equal metric routes, which can lead to pinhole congestion. It generates great amount of traffic in networks with periodic updates and it always do not select the fastest route for the packages. This is the reason why RIP is used in small and fixed size networks. RIP may be implemented in all types of routing devices. Consequently, it is a better choice in a multi brand, mixed network.

RIP UPDATES :-

RIP sends routing-update messages at regular intervals and when the network topology changes. When a router receives a routing update that includes changes to an entry, it updates its routing table to reflect the new route. The metric value for the path is increased by one, and the sender is indicated as the next hop. RIP routers maintain only the best route (the route with the lowest metric value) to a destination. After updating its routing table, the router immediately begins transmitting routing updates to inform other network routers of the change. These updates are sent independently of the regularly scheduled updates that RIP routers send. Each RIP router on a given network keeps a database that stores the following information for every computer in that network:

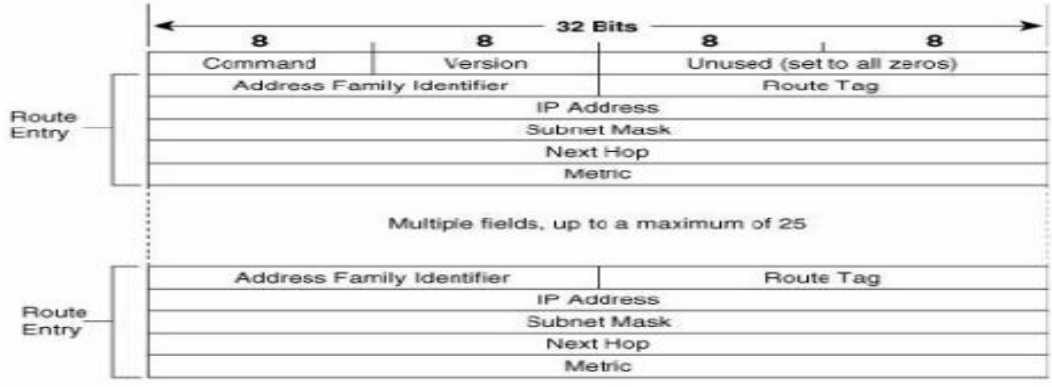
- IP Address. The Internet Protocol address of the computer.
- Gateway. The best gateway to send a message addressed to that IP address.
- Distance: The number of routers between this router and the router that can send the message directly to that IP address.

RIP Versions :

- RIP has two versions, Version 1(RIPv1) and Version 2(RIPv2).
- RIPv1(RFC 1058) is class full, and thus does not include the subnet mask with its routing table updates. Because of this, RIPv1 does not support Variable Length Subnet Masks (VLSMs). When using RIPv1, networks must be contiguous, and subnets of a major network must be configured with identical subnet masks. Otherwise, route table inconsistencies (or worse) will occur.
- RIPv2 (RFC 2543) is classless, and thus does include the subnet mask with its routing table updates. RIPv2 fully supports VLSMs, allowing discontiguous networks and varying subnet masks to exist.

The following table shows the advantages and disadvantages of RIP

Advantages	Disadvantages
Simple	In heterogeneous networks RIP is not scalable and is inefficient to use in networks with more than one LAN protocol because RIP is based on number of hops to reach destination
Easy to configure	The periodic updating of routing table consumes bandwidth because RIP propagates entire routing table to neighbour routers
	RIP is not suitable for large networks because the number is limited to 15 hop count.



RIPv2 Message Format

Configuring RIP :

To configure RIP routing, just turn on the protocol with the router rip command and tell the RIP routing protocol which network to advertise.

```
Router1> enable
Router1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router1(config)# router rip version 2
Router1(config-router)# network 192.10.0.0
```

IV. EIGRP(ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL)

Enhanced Interior Gateway Routing Protocol is a hybrid routing protocol. Its covers all the advantages of distance vector and link state routing protocols. EIGRP is an enhanced version of IGRP. This routing Protocol is developed by Cisco. It utilizes the the Diffusing Update Algorithm(DUAL). EIGRP is a hybrid protocol having features of both Link State Routing and Distance Vector Routing. EIGRP is the advanced version of the IGRP Protocol. It is a IGP i.e. interior gateway protocol but it is also used as EGP i.e. exterior gateway protocols sometimes. Key capabilities of EIGRP are :

- Fast Convergence
- Support for IPv4 and IPv6
- Support for summaries and discontagious work
- Uses DUAL algorithm
- Support for VLSM (variable Length Subnet Masking)
- Partial update support
- Multiple network layer protocol

We call EIGRP as a hybrid protocol because EIGRP doesn't send link state packet as OSPF but it sends the basic distance vector updates which contains the information about the network and also the cost of reaching them from the perspective advertising router. EIGRP link state characteristic shows that it sync the routers at starting and then after each update or change it send the specific updates or changes. EIGRP supports a maximum hop count of 100 and has a default hop count of 100. A router running EIGRP stores all its neighbour's routing tables so that it can quickly adapt to alternate routes. If no appropriate route exists, EIGRP queries its neighbours to discover an alternate route. These queries propagate until an alternate route is found.

As EIGRP supports for variable length subnet masks it permits the routes to be automatically summarized on the network boundary. Like all other routing protocols OSPF metrics is cost which is given by the administrator. The cost metric of OSPF can either be delay or bandwidth. Bandwidth is inversely proportional to cost i.e. the higher the bandwidth is the lower the cost would be. EIGRP supports multiple Network layer protocols : IP,IPX, Apple Talk and IPv6 which is an interesting feature of IGRP. Only IS-IS protocol comes a bit close to EIGRP in term so multiple network layer protocol support feature otherwise no other protocol has this feature making EIGRP on the top of the list. EIGRP uses the concept of Protocol Dependent Module to support different network layer protocol.

	DISTANCE VECTOR	***LINK STATE***
Algorithm	Bellman-Ford	Dijsktra
Network view	Topology knowledge from the neighbour point of view	Common and complete knowledge of the network topology
Best Path Calculation	Based on the fewest number of hops	Based on the cost (hops, BW, delay...)
Updates	Full routing table	Link State Updates
Updates Frequency	Frequently periodic updates	Triggered updates
Routing Loops	Needs additional procedures to avoid them	By construction, routing loops cannot happen
CPU and Memory	Low utilization	Intensive
Simplicity	High simplicity	Requires a trained network administrator

Configuring EIGRP :

To start an EIGRP session on a router, use the router eigrp command followed by the autonomous system number of the network. Remember as withIGRP, we use the classful network address, which is all subnet and host bits turned off.

```
R1#conf t
Enter configuration commands, one per line. End with
CNTL/Z.
R1(config)#router eigrp ?
<1-65535> Autonomous system number
R1(config)#router eigrp 10
R1(config-router)#network 20.0.0.0
R1(config-router)#
R1(config-router)#end
R1#
```

The AS number, as you see can be any number from 1 to 65535. A router can be a member of as many ASes as you want it to be.

EIGRP works on the neighbour discovery mechanism. There are three conditions that must be met before there will any neighbour ship established.

- Hello Received
- AS number matching
- Same metric

Hello message is used to establish the initial phase of neighbourship establishment. EIGRP that belongs to different AS number do not share the routing automatically.

Reliable Transport Protocol (RTP)

EIGRP uses a proprietary protocol called Reliable Transport Protocol (RTP) to manage the communication of messages between EIGRP speaking routers. And as the name suggests, reliability is a key concern of this protocol . Cisco has designed a mechanism that leverages mu l t i cast s an d u n i cast s t o deliver updates quickly and to track the receipt of the data.

VLSM Support in EIGRP

EIGRP supports the use of VLSM(Variable Length Subnet Masking). It allows the conservation of address space through the use of subnet masks that more closely fit the host requirement.

EIGRP Metrics

EIGRP uses a single factor to compare its routes and select the best possible path EIGRP can use a combination of four, called a composite metrics :

- Bandwidth
- Delay
- Reliability
- Load

EIGRP also supports the concept of load balancing.

V. OSPF(OPEN SHORTEST PATH FIRST)

OSPF is a open standard routing protocol which has been adopted by a wide variety of network vendors, including Cisco. If we have to use multiple routers and all of them are not of CISCO then we don't have any choice apart from using the other protocols (RIPv1,RIPv2 or OSPF), but as we know RIP cannot be used for larger networks therefore we are not left with any choice then but using the OSPF.

OSPF works on the DIjkstra Algorithm i.e. first a shortest path tree is constructed and then the routing table is populated with the resulting best path . OPSF was developed by Interior Gateway Protocol (IGP) working group of the Internet Engineering Task Force for the Internet Protocol (IP) Networks. OSPF is a link state protocols which is used to distribute information within a single Autonomous System. OSPF also has three versions

- OSPFv1 was published in RFC 1131
- OSPFv2 was published in RFC 2328
- OPSFv3 was published for IPv6 was released in RFC 2740

OSPF is also quick in convergence but not as quick as EIGRP but it supports multiple, equal-cost routes to the same destination but OSPF doesn't support IPv6 and IPv4 both at the same time. OSPF had following features which makes it one of the best routing protocol in the field :-

- OSPF is a link state routing protocol
- OSPF consist of areas and autonomous system
- OSPF minimizes routing update traffic
- It also supports the VLSM/CIDR
- Support unlimited hop count

OSPF AND RIP COMAPRISON :

Characteristic	OSPF	RIPv2	RIPv1
Type of protocol	Link state	Distance vector	Distance vector
Classless support	Yes	Yes	No
VLSM support	Yes	Yes	No
Auto-summarization	No	Yes	Yes
Manual summarization	Yes	No	No
Discontiguous support	Yes	Yes	No
Route propagation	Multicast on change	Periodic multicast	Periodic broadcast
Path metric	Bandwidth	Hops	Hops
Hop count limit	None	15	15
Convergence	Fast	Slow	Slow
Peer authentication	Yes	Yes	No
Hierarchical network requirement	Yes (using areas)	No (flat only)	No (flat only)
Updates	Event triggered	Route table updates	Route table updates
Route computation	Dijkstra	Bellman-Ford	Bellman-Ford

OSPF MESSAGE ENCAPSULATION

Data Link Frame Header	IP Packet Header	OSPF Packet Header	OSPF Packet Type
1.MAC Source Address 2.MAC Destination Address	1.IP Source Address 2.IP Destination Add.	Type Code 1.Router ID 2.Area ID	1.Hello 2.DBD 3.LSR 4.LSU 5.LSAck

OSPF is designed in hierarchal fashion so that larger networks can be divided into smaller internetworks called the "AREAS". This the best feature and design of the OSPF. There are reasons why OSPF creates the hierarchical design :

- To decrease routing overhead
- To speed up the convergence process

OSPF Area:

OSPF area design created hierarchal structure so that the flow of data packets is maintained in the network. Any OSPf design will have at least one area i.e. area 0. If there are more than one area the one of the area needs to be the back bone

area which is connected to all other area. Areas can be implemented in two formats IP address format and the decimal address format. Areas can be configured in several types that depends on the type of the network.

OSPF TERMINOLOGY :

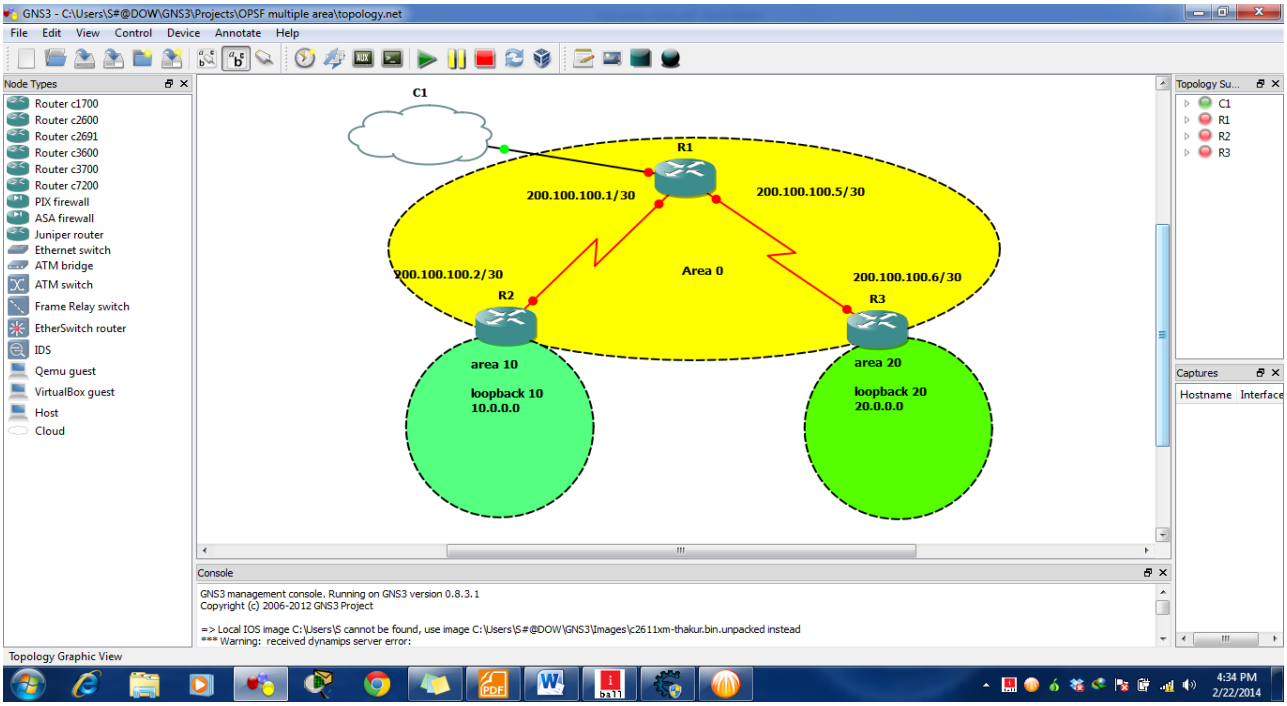
The following are important OSPF terms which are used frequently :

- Link : It's a router assigned to any network
- Router ID : It's an IP address to identify the router
- Adjacency : It's a relationship between two OSPF rotuers.
- Hello Protocol
- OSPF Areas

CONFIGURING OSPF :

Router(config)# router ospf 1
Router(config-router)# network 200.100.100.0 0.0.0.7 area 0

The configuration command for OSPF consist of network id, Wild Card Mask ,and the area number.
OSPF mutliple areas design on GNS3.



VI. CONCLUSION :

In this paper we have discussed various routing protocols and presented a comprative analysis of selected routing protocls such as RIP,EIGRP,OSPF. The comparative analysis is done on the varioius parameters the routing protocls are based upon. RIPv2 offers many useful features which can be used to increase the efficiecny of RIPv1. RIP is new complete protocol for IPv6. Moving to EIGRP,it supports the feature of VLSM and DUAL algortihm in order to improve the routing mechanism. OSPF is the link state protocol which uses the concept of the Link State Adevertisement(LSA). OSPF also provides the concept of Load Balancing and it also supports the unlimited hop count support.Also the newer routing protocols supports the classless routing (CIDR), which also extends the use that older routing protocols which extensively uses the IPv4 foramt will no longer will be existence as IPv6 is going to take the lead. In the near future, IPv6 sites should expect to run OSPF for IPv6 as an internal routing protocol and a version of IDRP for external routing. In the not-so-near future the picture is far less clear -- what is seen as the "right" technology right now may not be suitable for the Internet of tomorrow.

ACKNOWLEDGEMENT

I would like to express my special appreciation and thanks to my advisor Mr. BalVinder Thakur, you have been a tremendous mentor for me. I would like to thank you for encouraging my interest in networking and for allowing me to grow as a network analysis. Your advice on both research as well as on my career have been priceless. I would also like to thank my professor Manie Kansal for guiding me even at hardship. also want to thank you for letting my defense be an enjoyable moment, and for your brilliant comments and suggestions, thanks to you. I Would Also Like To Thank Mr. Gunjan Gandhi For His Support Guidance.

REFRENCES

[1] CCNA by Todd Lammle, 5th edition.
[2] Bates, T., R. Chandra, Y. Rekhter, and D. Katz. "Multi-Protocol Extensions for BGP4." RFC 2858, 2000.
[3] Computer Networks byAndrew s Tenenbaum, 4th edition
[4] TCP/IP and Internetworking by Douglas E Comer, 2009.
[5] A Visual Teaching and Learning Environmentfor the Open Shortest Path First Routing Protocol Eric Gamess
[6] Convergence Behavior of RIP and OSPF Network Protocols By Hubert Pun B.A.Sc., University of British Columbia, 1998
[7] Simulation Based P erformance Analyses on RIPv2,EIGRP , and OSPF U sing OPNET Bing W u
[8] Performance Comparison of Two Dynamic Routing Protocols: RIP and OSPF by Fatima A. Hamza,
[9] Performance Analysis of RIP, OSPF, IGRP and EIGRP Routing Protocols in a Network by Pankaj Rakheja Assistant Professor ITM University, School of Engineering & Tech,
[10] Bernard Fortz,Jennifer Rexford and Mikkel Thorup., Traffic Engineering With Traditional IP Routing Protocols." IEEE Communications Magazine. October 2002,
[11] Radia Perlman, "A Comparison between Two Routing Protocols: OSPF and IS-IS,"IEEE Network Magazine, September, 1991.
[12] Xianhui Che, Lee J. Cobley, "VoIP Performance over Different Interior Gateway Protocols", International Journal of Communication Networks and Information Security (IJCNIS), Vol. 1, No. 1, April 2009.

