Performance Evaluation of Routing Protocols for Video Conference over MPLS VPN Network

ABDULLAH AL MAMUN - 201403680

What is MPLS VPN

Multi-protocol **L**abel **S**witching virtual private network is defined by Internet engineering Task Force (IETF)

Goal

1. Design an MPLS layer3 VPN network & configure routers.

2. Evaluation the performance of routing protocols EIGRP & OSPF

Part - 1

17. **Project Title: MPLS Layer 3 VPN**

Objectives:

The objectives of the project are

- Configure MPLS LDP in the Service Provider network.
- Configure VRF in the Provider Edge (PE) routers.
- Configure BGP VPNv4 peering between Routers.
- Configure Peering between PE routers to customer routers.

Outcomes:

At the end of the project, the students will be able to

- Design and implement a MPLS Layer 3 VPN.
- Understand MPLS network requirement from service provider and customer perspective
- How to share routes between different VRFs inside an MPLS network.

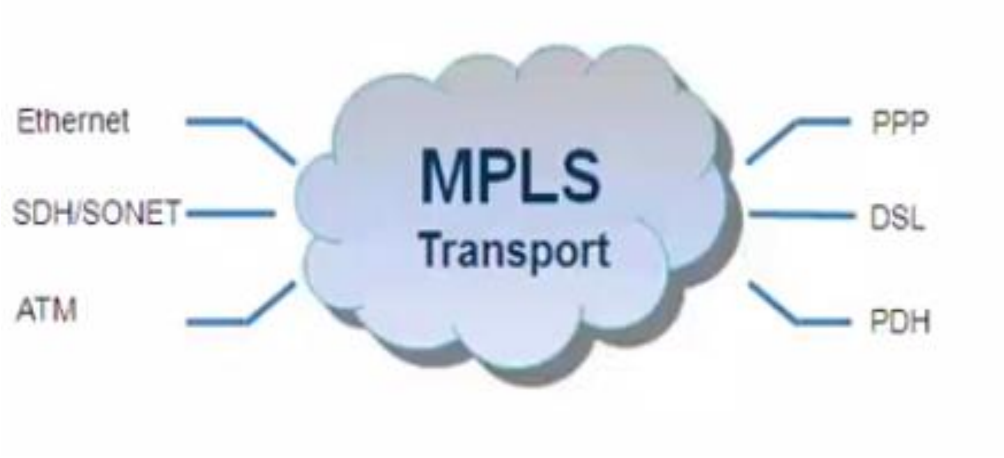
Tools:

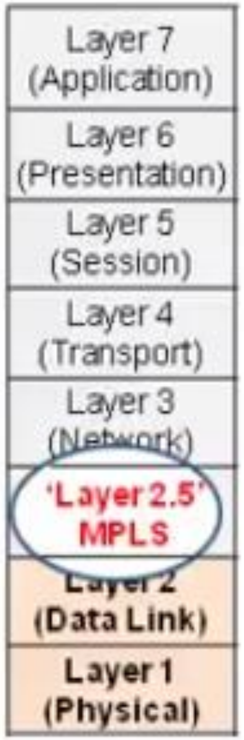
- GNS3.

18. **App development in Android.**

Objectives:

MP = Multi-Protocol. Why layer 3?



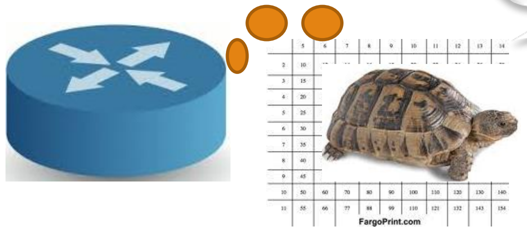


LS = Label Switching

Multiple Network Checking (A match with longest Network mask wins)

IP

Router



Switch

Switch S1

Port	VCI	Port	VCI
1	2	3	1
1	1	2	3
2	1	3	2

In ref

Out ref

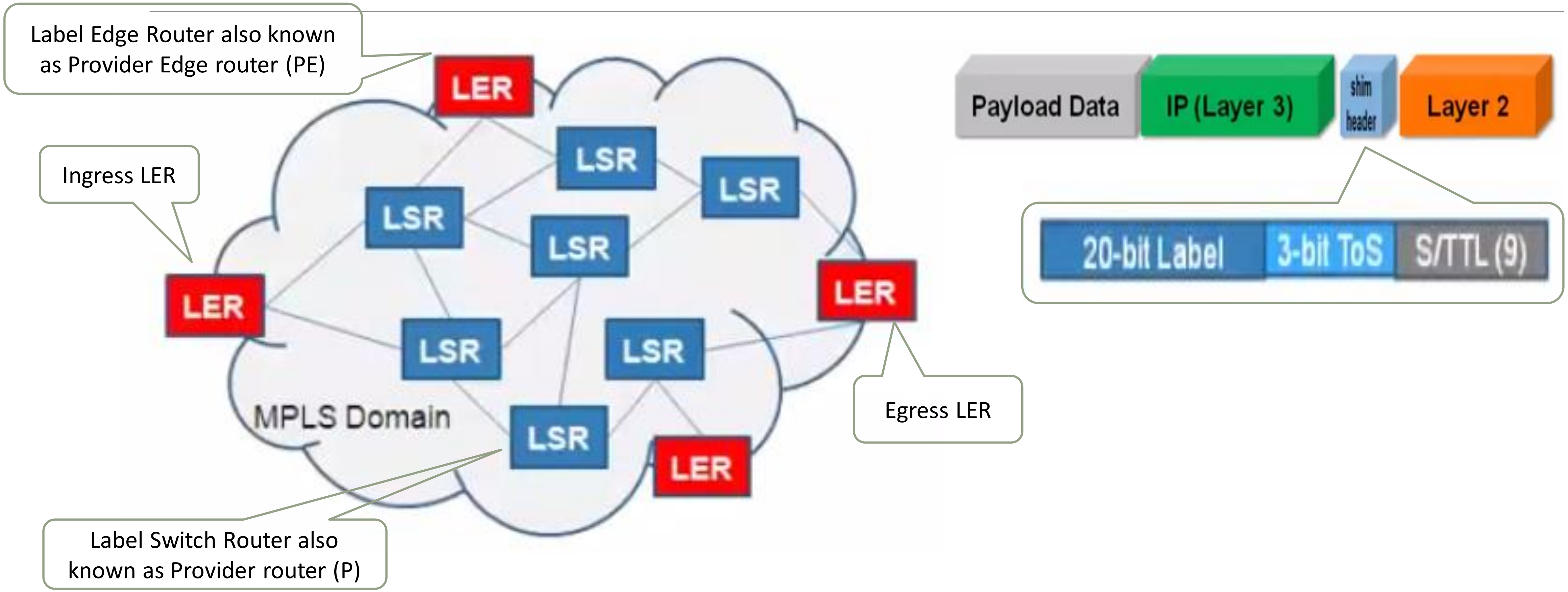
New reference is applied to packet

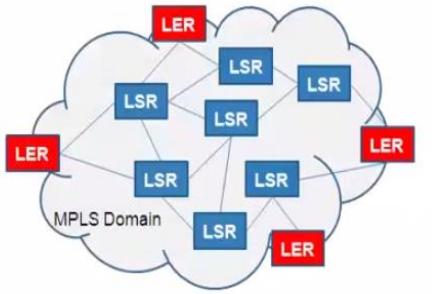
ATM 3 *ATM* 2 *ATM* 1

MPLS uses best of both **switch** if possible, **Router** if necessary

Lebel switch Router (LSR)

MPLS Domain Router & modified header





PUSH

IP Domain

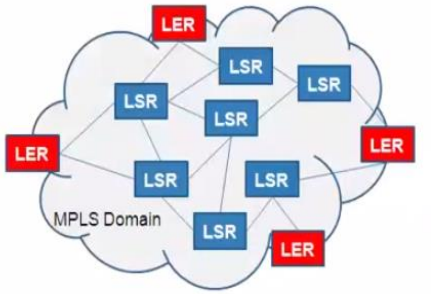
17 Ingress LER

MPLS Domain

Label is Pushed

IP Header Info	Label
xxx.xxx.xxx.xxx	17
yyy.yyy.yyy.yyy	18
zzz.zzz.zzz.zzz	19

IP to MPLS Domain



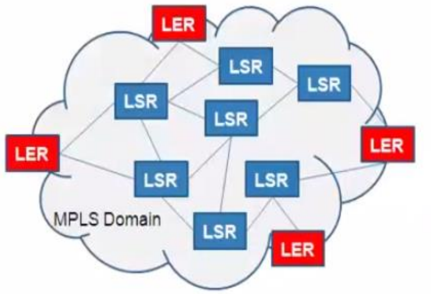
IP Domain

Ingress LER

IP Header Info	Label
xxx.xxx.xxx.xxx	17
yyy.yyy.yyy.yyy	18
zzz.zzz.zzz.zzz	19

MPLS Domain

LER to LSR

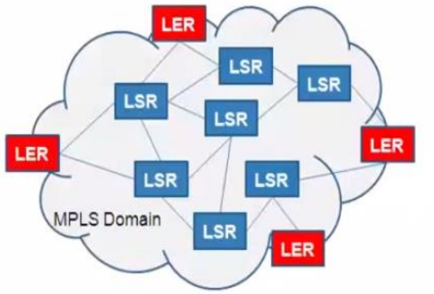


MPLS Domain

LSR

MPLS Domain

Old	New
17	26
18	35
19	47



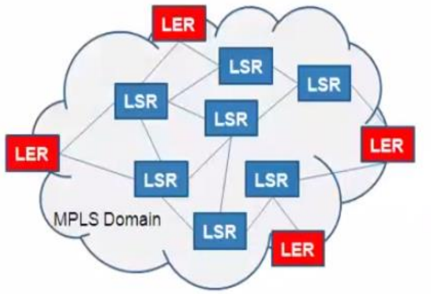
SWAP - 1

MPLS Domain

LSR

Old	New
17	26
18	35
19	47

MPLS Domain



SWAP - 2

MPLS Domain

26

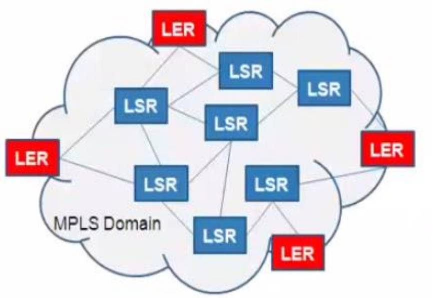
LSR

MPLS Domain

Label is Swapped

Old	New
17	26
18	35
19	47

LSR to LSR

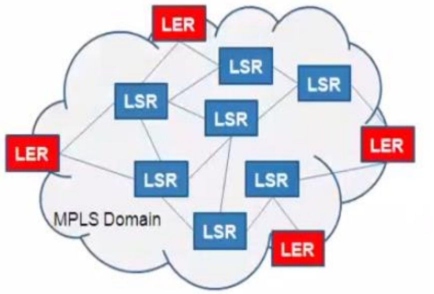


MPLS Domain

LSR

MPLS Domain

Old	New
17	26
18	35
19	47



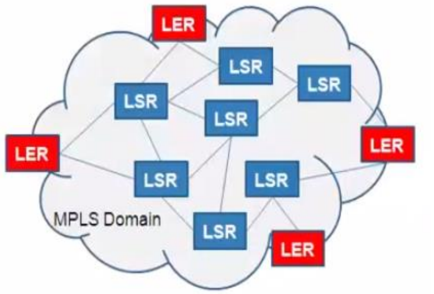
POP - 1

MPLS Domain

LSR

MPLS Domain

Old	New
17	26
18	35
19	47



POP -2

MPLS Domain

Egress LER

IP Domain

Label is Popped

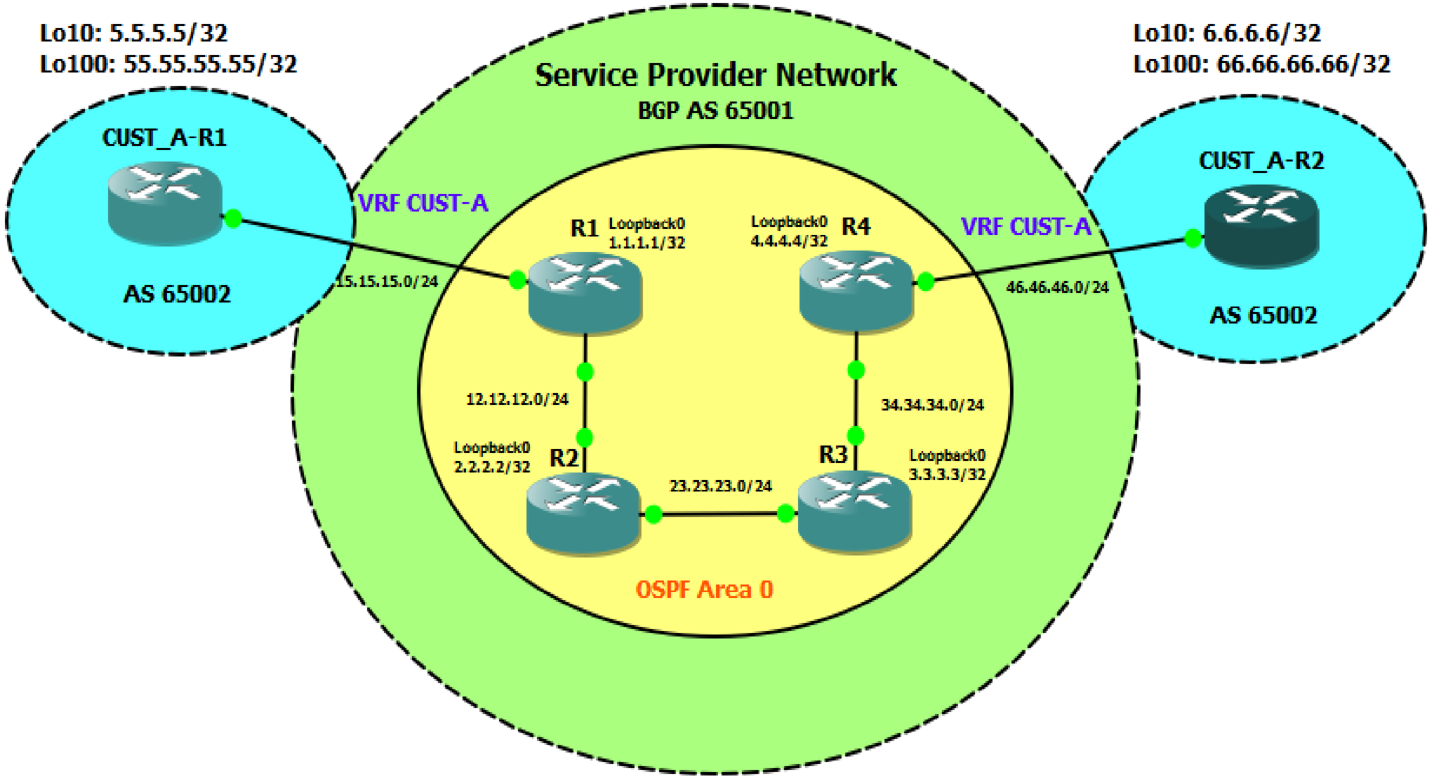
Advantages of MPLS

- Improve Uptime
- Create Scalable IP VPNs
- Improve User Experience
- Improve Bandwidth Utilization
- Hide Network Complexity
- Reduce Network Congestion

Disadvantages

- Your routing protocol choice might be limited.
- Your end-to-end convergence is controlled primarily by the service provider.
- The reliability of your L3 MPLS VPN is influenced by the service provider's competence level.
- Deciding to use MPLS VPN services from a particular service provider also creates a very significant lock-in. It’s hard to change the provider when it’s operating your network core.

Topology (GNS3)



Router configuration

- Configure MPLS LDP in the Service Provider network.
- Configure VRF in the Label Edge (LER) routers.
- Configure BGP VPNv4 peering between Routers.
- Configure Peering between LER to customer routers.

1. Configure MPLS LDP in the Service Provider network.

LDP * = Label Distribution Protocol (16 to 1,048,575)

TABLE I. Label range

Router	Interface	MPLS Label range
Router 1	Fast Ethernet 0/0	1000-1999
Router 2	Fast Ethernet 0/0	
	Fast Ethernet 0/1	2000-2999
Router 3	Fast Ethernet 0/1	
	Fast Ethernet 0/0	3000-3999
Router 4	Fast Ethernet 0/0	4000 - 4999

Command

Router 1 - 4

mpls ip = It's required to form LDP neighbors

mpls label range = assign a range of label on LER or LSR

```
*Mar  1 00:01:10.715: %LDP-5-NBRCHG: LDP Neighbor 3.3.3.3:0 (1) is UP
*Mar  1 00:01:22.723: %BGP-5-ADJCHANGE: neighbor 46.46.46.6 vpn vrf CUST-A Up
*Mar  1 00:01:33.347: %BGP-5-ADJCHANGE: neighbor 1.1.1.1 Up
R4#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#int fa0/0
R4(config-if)#mpls ip
R4(config-if)#mpls label range 4000 4999
R4(config)#exit
R4#
*Mar  1 00:16:12.515: %SYS-5-CONFIG_I: Configured from console by console
R4#
R4#
```

2. Configuration of VRF in the Provider Edge (PE) Routers

VRF = Virtual Routing and Forwarding

It is comparable to a VLAN in a switch. VRF is used to create different routing tables that are separated from each other. Since one VRF can't see what routes are in another VRF, the same IP prefix can exist in different VRFs. However, duplicate IP prefixes will have an issue when it comes to route-leaking between VRFs.

Command

R1(config)#ip vrf CUST-A

R1(config-vrf)#rd 65002:1

R1(config-vrf)#route

R1(config-vrf)#route-target import 65002:1

R1(config-vrf)#route-target export 65002:1

```
R1(config)#ip vrf CUST-A
R1(config-vrf)#rd 65002:1
R1(config-vrf)#route-target import 65002:1
R1(config-vrf)#route-target export 65002:1
R1(config-vrf)#exit
R1(config)#
```

Rd = Route Distinguisher
RD is what Multiprotocol BGP uses to distinguish and makes the route unique

"export" = the route will be marked and announced out with that value;
"import" = put all the routes with that mark, into the VRF's routing table specified above the command.

3. Configuration of BGP VPNv4 peering between R1 and R4

VPNv4 is a collection of all routes from different VRFs that were marked with the extended community route-target.

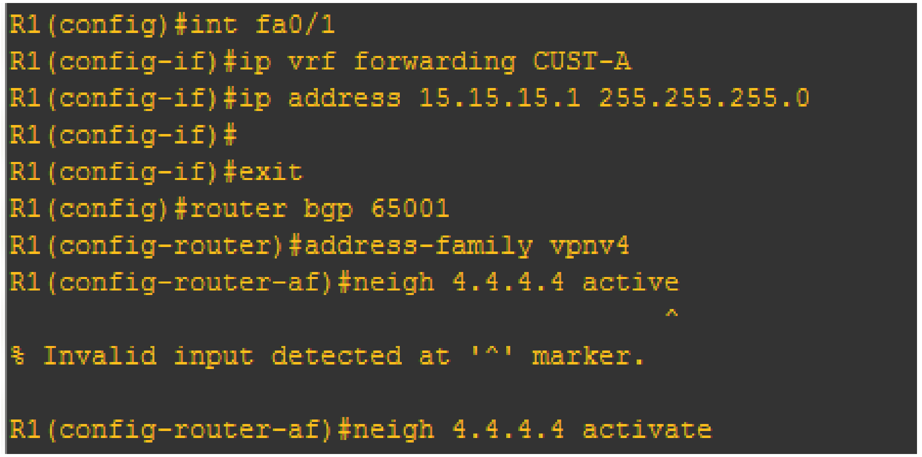
This is the address-family where route-leaking can be performed. Route-leaking is simply sharing a route from one VRF to another. Common application for this is, one company wants to connect to another company's servers and they happen to be connected to the same MPLS provider.

Command

R1(config)#router bgp 65001

R1(config-router)#address-family vpnv4

R1(config-router-af)#neigh 4.4.4.4 activate



```
R1(config)#int fa0/1
R1(config-if)#ip vrf forwarding CUST-A
R1(config-if)#ip address 15.15.15.1 255.255.255.0
R1(config-if)#
R1(config-if)#exit
R1(config)#router bgp 65001
R1(config-router)#address-family vpnv4
R1(config-router-af)#neigh 4.4.4.4 active
                                        ^
% Invalid input detected at '^' marker.

R1(config-router-af)#neigh 4.4.4.4 activate
```

In VPNv4 address-family configuration, I simply issue the neighbor statement and the keyword “activate”. The BGP peering configuration needs to be done outside the address-family. The router understands that VPNv4 peering needs to activate extended communities so it automatically configured.

In regards to the VPNv4 BGP peering, it is not possible to see any prefixes for now since there is no peering yet between the PE s and CEs.

4. Configure Peering between PE routers to customer routers

Configure Peering between PE routers R1 and R4 to customer routers CUST_A-R1 and CUST-A-R2. Announce Loopback 10 and 100 in the CE routers.

Router 1

R1(config)#router bgp 65001

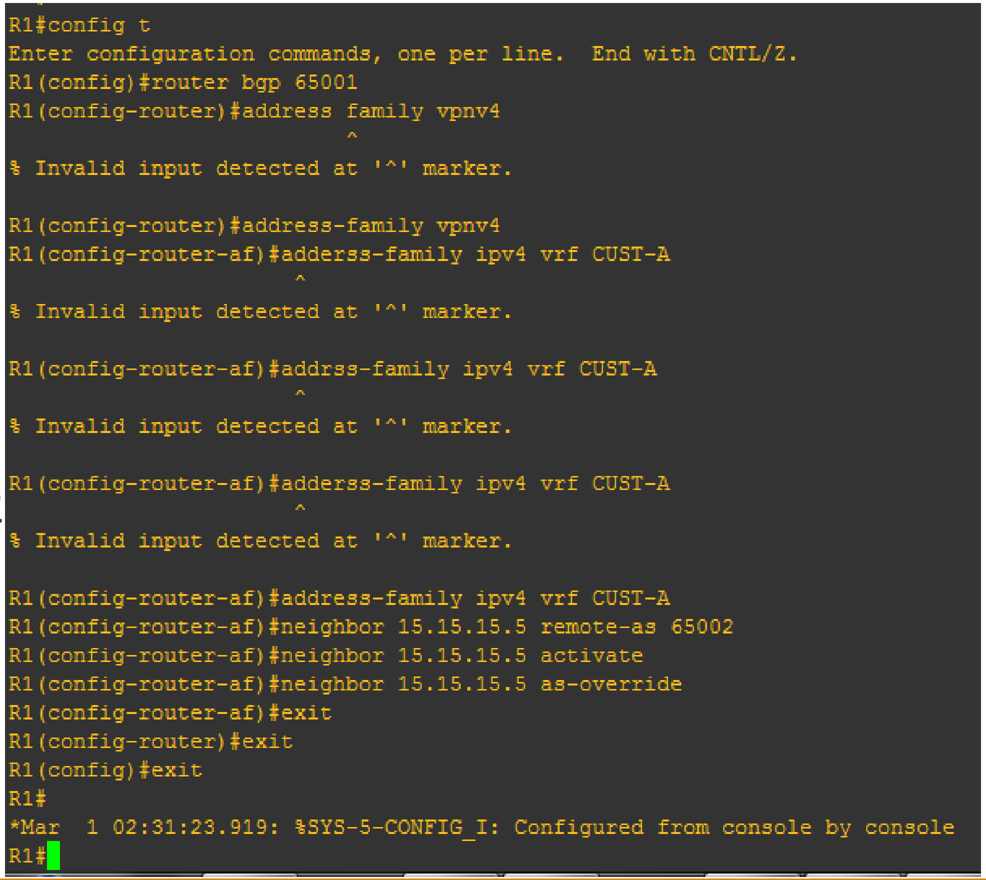
R1(config-router)#address-family vpnv4

R1(config-router-af)#address-family ipv4 vrf CUST-A

R1(config-router-af)#neighbor 15.15.15.5 remote-as 65002

R1(config-router-af)# neighbor 15.15.15.5 activate

R1(config-router-af)# neighbor 15.15.15.5 as-override



```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router bgp 65001
R1(config-router)#address family vpnv4
                           ^
% Invalid input detected at '^' marker.

R1(config-router)#address-family vpnv4
R1(config-router-af)#adderss-family ipv4 vrf CUST-A
                       ^
% Invalid input detected at '^' marker.

R1(config-router-af)#addrss-family ipv4 vrf CUST-A
                       ^
% Invalid input detected at '^' marker.

R1(config-router-af)#adderss-family ipv4 vrf CUST-A
                       ^
% Invalid input detected at '^' marker.

R1(config-router-af)#address-family ipv4 vrf CUST-A
R1(config-router-af)#neighbor 15.15.15.5 remote-as 65002
R1(config-router-af)#neighbor 15.15.15.5 activate
R1(config-router-af)#neighbor 15.15.15.5 as-override
R1(config-router-af)#exit
R1(config-router)#exit
R1(config)#exit
R1#
*Mar  1 02:31:23.919: %SYS-5-CONFIG_I: Configured from console by console
R1#
```

Explanation

The PE is configured with an “address-family ipv4 vrf” when peering with the CE routers. The “as-override” command replaces the AS of the route to circumvent the BGP loop prevention. BGP loop prevention blocks any route that it receives from an eBGP peer with its own AS (65002 in this case) inside it. The AS for the customer is 65002, but notice the output below, the PE’s replaced the AS to 65001 to enable communication between these two routers with the same AS inside an MPLS cloud. CUST_A-R2 is now able to see the CUST_A-R1 routes but with a different AS. Another way to do this is to configure a neighbor statement with “allowas-in” keyword.

However, The BGP-MPLS VPN simulations are directed using two beset interior routing protocol namely EIGRP and OSPF on similar topology as in Fig 1. The rate of a video call call is fixed at 500, 2500 and 4000 calls/hour. Average call duration is set to 10 minutes and the voice flow duration is set to 3 hours. The simulations are beset to measure the voice packet end-to-end delay, voice jitter and mean opinion score as to define the overall video and voice quality in both scenarios during the three following scenarios.

Result and Analysis (part -1)

Connectivity Verification

CUST_A-R2#traceroute 55.55.55.55 source l100

First Test

Tracing the route to 55.55.55.55

TABLE II. END-TO-END DELAY BEFORE MPLS

Route	Delay 1(s)	Delay 2(s)	Delay 3(s)	Avg. Delay(s)
46.46.46.4	224	428	320	324
34.34.34.3	1188	992	1100	1093
23.23.23.2	1108	992	880	993
15.15.15.1	880	968	1172	1007
15.15.15.5	888	888	880	885

Second Test

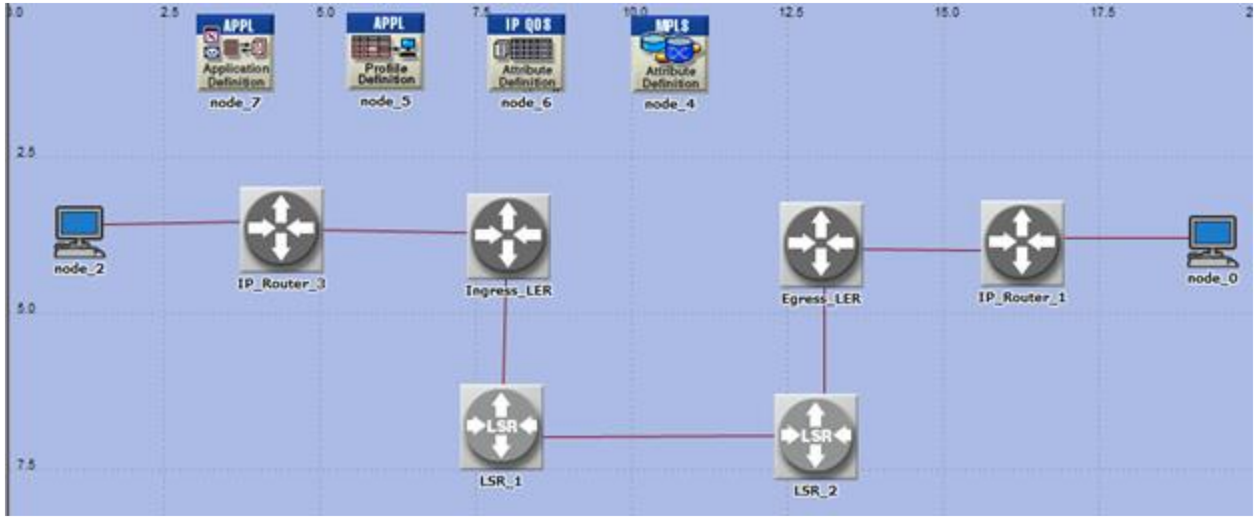
CUST_A-R2#traceroute 55.55.55.55 source l100

TABLE III. END-TO-END DELAY AFTER MPLS

Route	Delay 1(s)	Delay 2(s)	Delay 3(s)	Avg. Delay(s)
46.46.46.4	268	428	356	351
15.15.15.1	1108	1180	928	1072
15.15.15.5	1072	980	920	961

Part-2 : Evaluation of routing protocols for video conferencing application over MPLS

Topology



Topology = EIGRP, OSPF
CODEC = H.393
Video call = 500, 2500, 4000 per hr.
Performance metric = End to end delay, Jitter and MOS

Simulation result

End-to-end packet Delay: The amount of time taken for transmitted a packet across a network from source to destination is shown in below fig. The line graph presents the packet delay for 500 calls per/hours using both EIGRP and OSPF. Initially, the delay is same for both protocols that is almost zero but it is tart to increase suddenly at 890s for eigrp whereas ospf is remain unchanged.

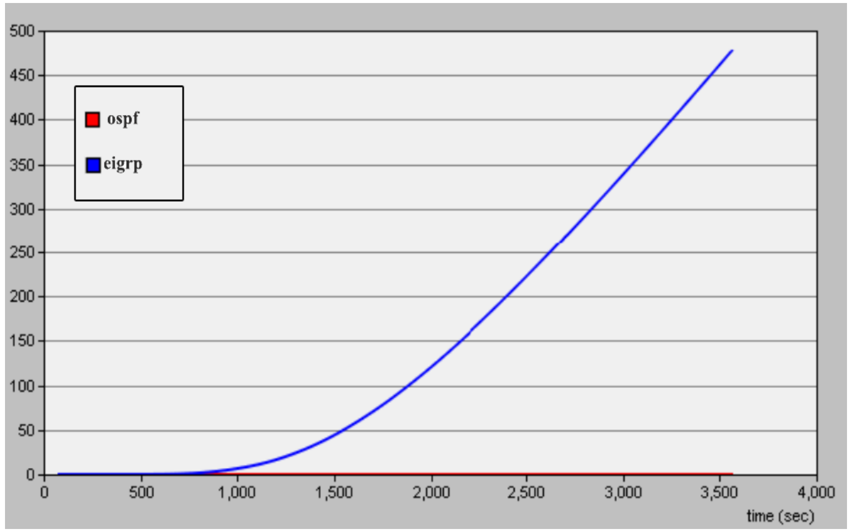


Fig. 500 video calls/hour

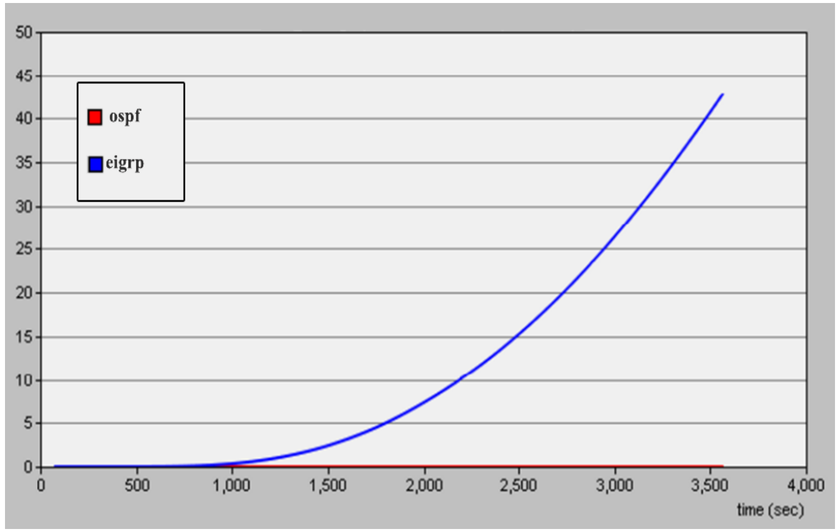


Fig. 2500 video calls/hour

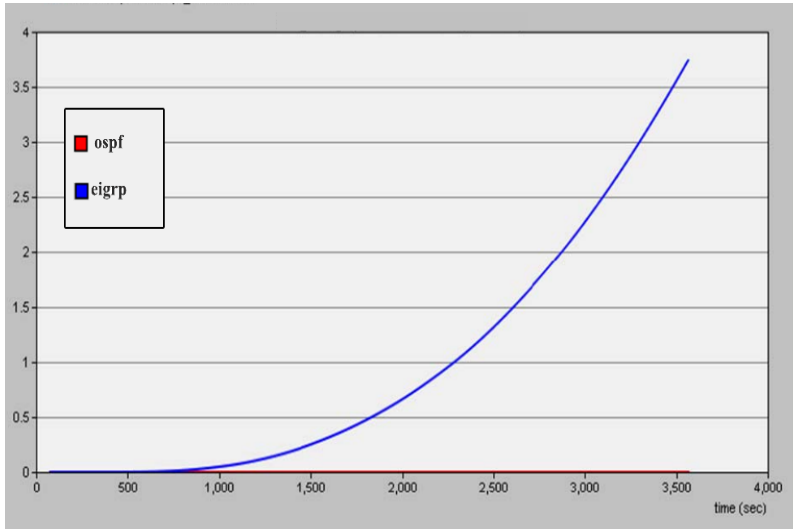


Fig. 4000 video calls/hour

Jitter

Time difference between two frames due to transmission latency is shown in below fig, Jitter for 500 calls per hour is shown in fig where jitter is start to happen from less than 500s for eigrp whereas ospf is remaining unchanged to last the frame.

In the same manner, jitter for 2500 calls per hour is shown in fig where jitter is start to increase from 480s and it became saturated after a while in eigrp protocol, but almost zero jitter is experienced though a little changed happens initially while same setup ran with ospf protocol. Again, last fig is shows the jitter for 4000 calls per hour where jitter goes high quickly at little bit earlier than previous experiment which is 470s whereas ospf is still unchanged.

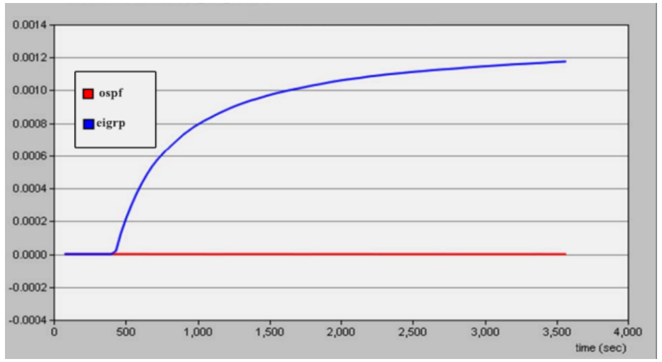


Fig. 500 video calls/hour

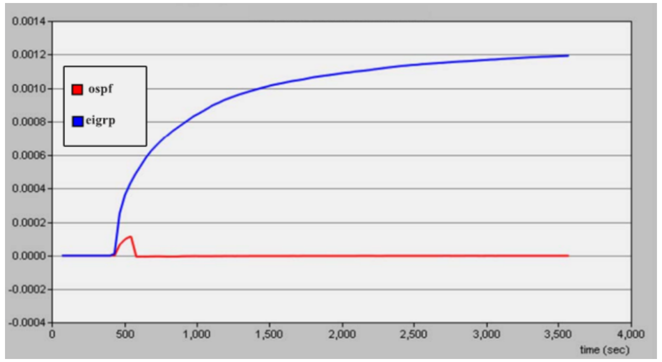


Fig. 2500 video calls/hour

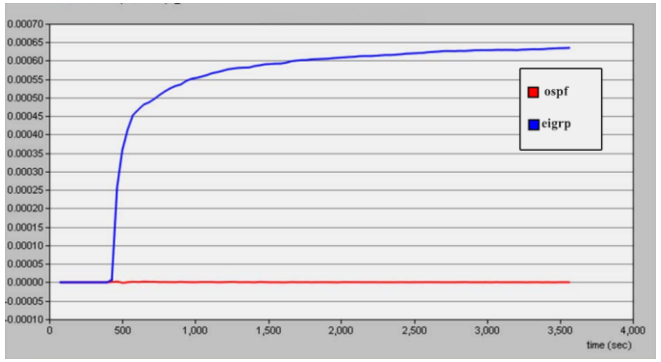


Fig. 4000 video calls/hour

Mean Opinion Score (MOS)

In voice communications, particularly Internet telephony, the mean opinion score (MOS) provides a numerical measure of the quality of human speech at the destination end of the circuit [8]. MOS scores are shown below according to this experimental sequence. However, fig 10 displays the mos score for 500 calls per hour where score is start to drop for both eigrp and ospf at the same time which is less than 500s from 3.7 units of mos and it does not recovered until simulation end.

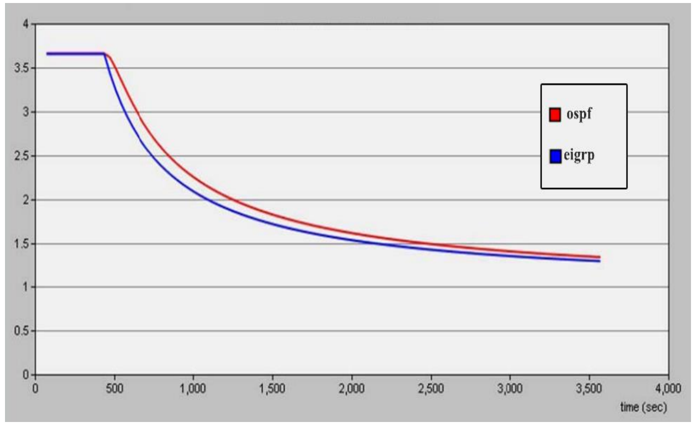


Fig. 500 video calls/hour

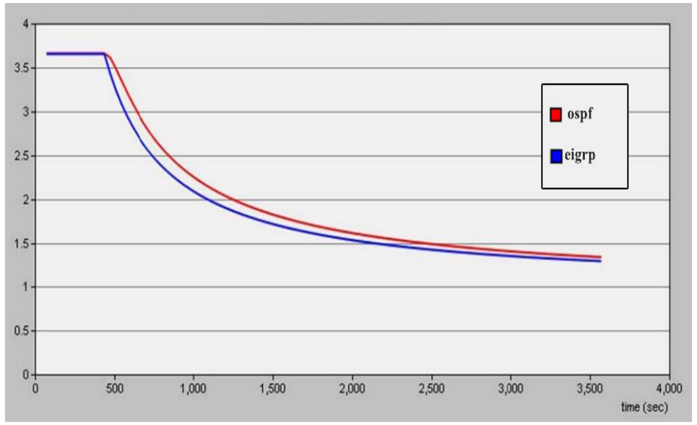


Fig. 2500 video calls/hour

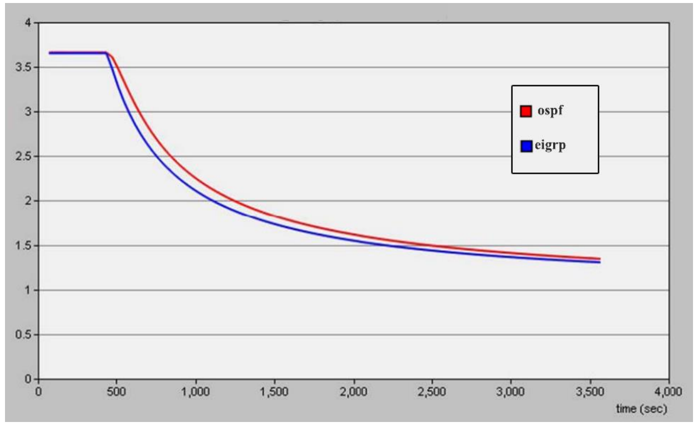


Fig. 4000 video calls/hour

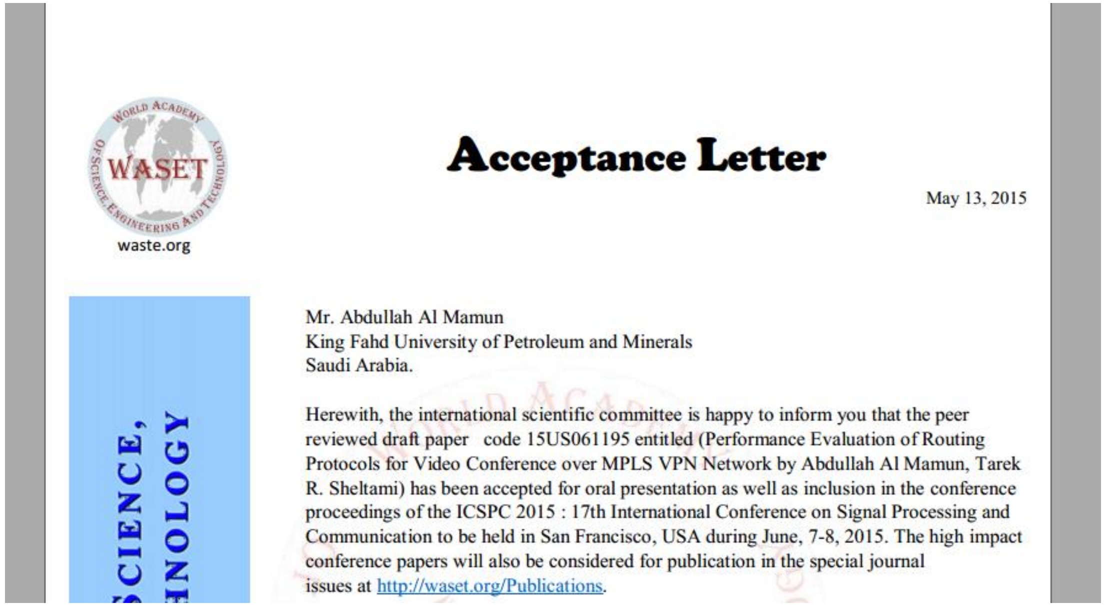
RELATED WORKS

So far many research has been done on video conferencing multi-cast and broadcast over MPLS are [9],[10] and [11] but few of them are comparison study among router protocols in MPLS VPN [1]-[4] and [12]. Relative comparison of network model infrastructure for delivering data over MPLS networks [2]-[4] shows MPLS perform better. Among many performance metric, end to end delay is considered in the paper [4][13], jitter cite5and [14], voice packet delay variation is shown, voice packet send and receive [4], packet loss[6], throughput putc[14] and MOS[15] and [16]. In video conferencing, performance measures shown in case of voice codec in paper [2] and [3]. However, G.711 is used as most popular codec for VoIP call in [17], [18] that is also discussed about security in multimedia communication. How many types of routing protocols is implemented in VoIP application is shown in paper [6]-[13]. Comparison of many well-known routing protocols such as RIP, OSPF and EIGRP is presented in the paper [16]-[19]. Determining the best routing protocol is complex task, here they are discussed how can it does easily based on convergence time and queueing delay in the paper [7] and [13].

Conclusion

This paper introduced a performance evaluation of video conferencing application using two different routing protocol respectively eigrp and ospf over MPLS VPN network. The empirical simulation result shows that router configuration on each provider router is successfully done and it can hide the PE router while data is traversing router to router. Moreover, It is clearly observed that the best performance is recorded in case of ospf protocols in every scenarios. We have plan to continue our research in large scale in future.

Recognition and Achievement



WASET

waste.org

Acceptance Letter

May 13, 2015

Mr. Abdullah Al Mamun
King Fahd University of Petroleum and Minerals
Saudi Arabia.

Herewith, the international scientific committee is happy to inform you that the peer reviewed draft paper code 15US061195 entitled (Performance Evaluation of Routing Protocols for Video Conference over MPLS VPN Network by Abdullah Al Mamun, Tarek R. Sheltami) has been accepted for oral presentation as well as inclusion in the conference proceedings of the ICSPC 2015 : 17th International Conference on Signal Processing and Communication to be held in San Francisco, USA during June, 7-8, 2015. The high impact conference papers will also be considered for publication in the special journal issues at http://waset.org/Publications.

References

[1] Windstream, “Mastering Network Design with MPLS”, whitepaper, 2012, available from http://www.windstreambusiness.com/media/663859/masteringnetwork-design-with-mpls.pdf.

[2] R.S.Naoum and M.Maswady, “Performance Evaluation for VOIP over IP and MPLS”, World of Computer Science and Information Technology Journal (WCSIT), Vol.2 (3), pp. 110-114, 2012

[3] E.S.Jain, "Performance Analysis of Voice over Multiprotocol Label Switching Communication Networks with Traffic Engineering", International Journal of Advanced Research in Computer Science and Software Engineering, Vol.2 (7), pp. 195-199, 2012.

[4] I.S.I Alsukayti and T.J.Dennis, “Performance Analysis of VoIP over BMG/MPLS VPN Technology”, PGNET Conference, 2011.

[5] R Yunos, NM Noor, SA Ahmad, “Performance evaluation between IPv4 and IPv6 on MPLS Linux platform,” International Conference on Information Retrieval & Knowledge Management (CAMP10), pp. 204–208, 2010

[6] A.Chadha and A.K.Gupta, “Review on Enhanced Interior Gateway Routing Protocol”, Global Journal of Computer Science and Technology Network, Web & Secuirty, Vol. 13(6), 2013.

[7] K.Mirzahosein, A.Nguyen and S.Elmasry, “Analysis of RIP, OSPF and EIGRP Routing Protocols using OPNET”, Simon Fraser University, School of Engineering Final Year Project, ENCS 427: Communication Networks, 2013.

[8] S, Ali, and B. Z. Rana. "OPNET Analysis of VoIP over MPLS VPN with IP QoS." Master Thesis, Electrical Engineering, 2011.

[9] N.Aoki, “A Semi-Lossless Steganography Technique for G.711 Telephony Speech”, 2010 Sixth International Conference on Intelligent Information Hiding and Multimedia Signal Processing, pp. 534-537, 2010.

[10] R.Yasinovskyy, A.L.Wijesinha, R.K.Karne and G.Khaksari, “A Comparison of VoIP Performance on IPv6 and IPv4 Networks”, 2009.

[11] E.S.Myakotnykh, R.A.Thompson, “Adaptive Speech Quality Management in Voice-over-IP Communications”, 2009 Fifth Advanced International Conference on Telecommunications”, pp. 64-71, 2009.

[12] T.Huang, P.Huang, K.Chen and P.Wang, “Cloud Skype Be More Satisfying? A QoE-Centric Study of the FEC Mechanism in an Internet-Scale VoIP System”, IEEE Network, pp. 42-48, 2010.

[13] X.Che and L.J.Cobley, “VoIP Performance over Different Interior Gateway Protocols”, International Journal of Communications Networks and Information Security (IJCNS), Vol.1 (1), pp. 34- 41, 2009.

[14] S.G.Thorenoor, “Dynamic Routing Protocol Implementation Decision between EIGRP, OSPF and RIP based on Technical Background Using OPNET Modeler”, Second International Conference on Computer and Network Technology, pp.191-195, 2010.

[15] I.Kaur, “Performance Evaluation of Hybrid Network using EIGRP & OSPF for different Applications”, International Journal of Engineering Science and Technology (IJEST), Vol.3 (5), pp.3950-3960, 2011.

Thank You

?