



Performance Analysis of MPLS over IP Networks using CISCO IP SLAs

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M. Eng. Presentation

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Roadmap

- Introduction
- Related work
- Project objective
- Project setup and implementation
- Emulation results
- Summary and conclusion
- References



Introduction

Internet users (2013-14)	: 3.12 billion
Google searches (2013-14)	: 1.2 trillion
Websites (2013-14)	: 1 billion
Internet traffic (per sec)	: 27,233 GB
Skype calls (per sec)	: 1,739
You tube videos (per sec)	: 100,235
Instagram photos (per sec)	: 2,049

Reference: Internet Society – facts and statistics (2013-14)



Comparison of IP and MPLS Networks

IP network:

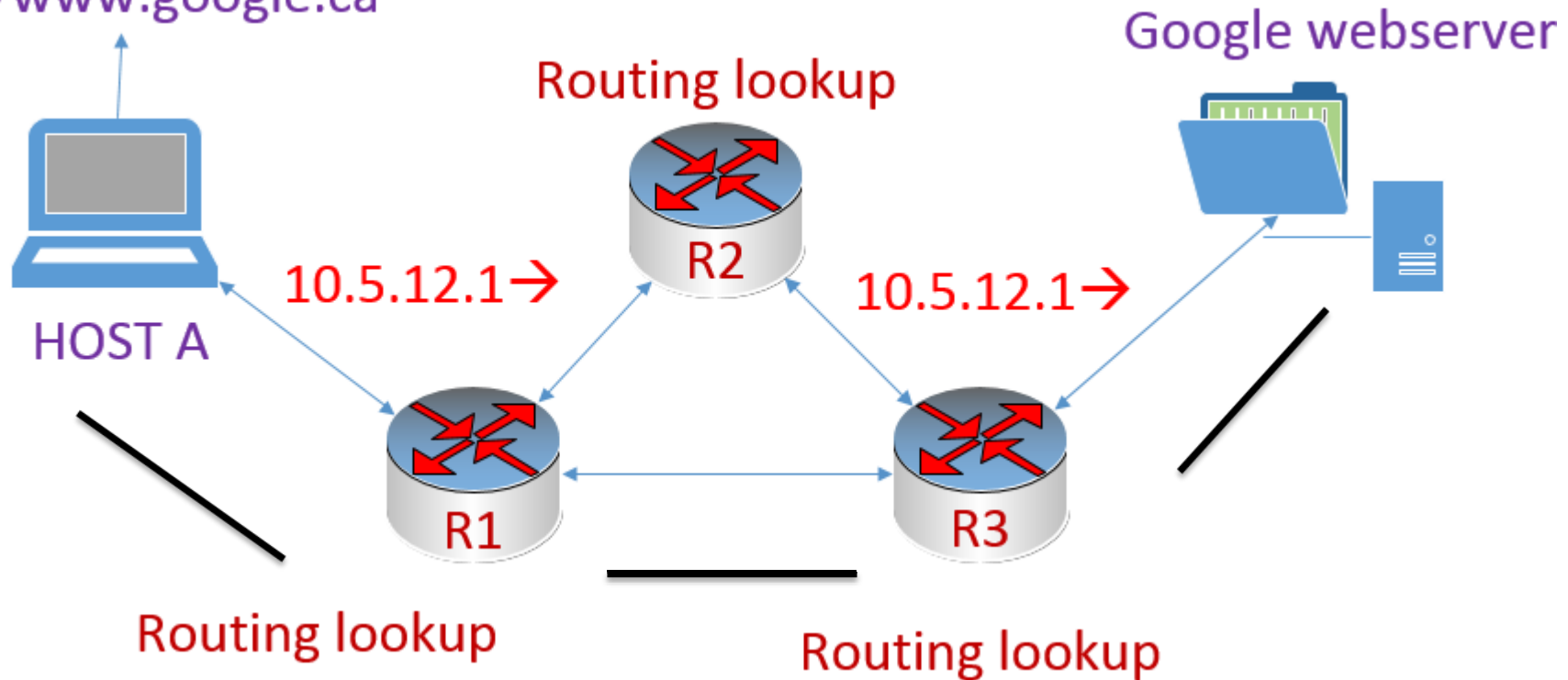
- Internet Protocol (IP)
- Each router performs an IP lookup (routing) and forwards the packet to the next hop
- Forwarding is based on IP address only

MPLS network:

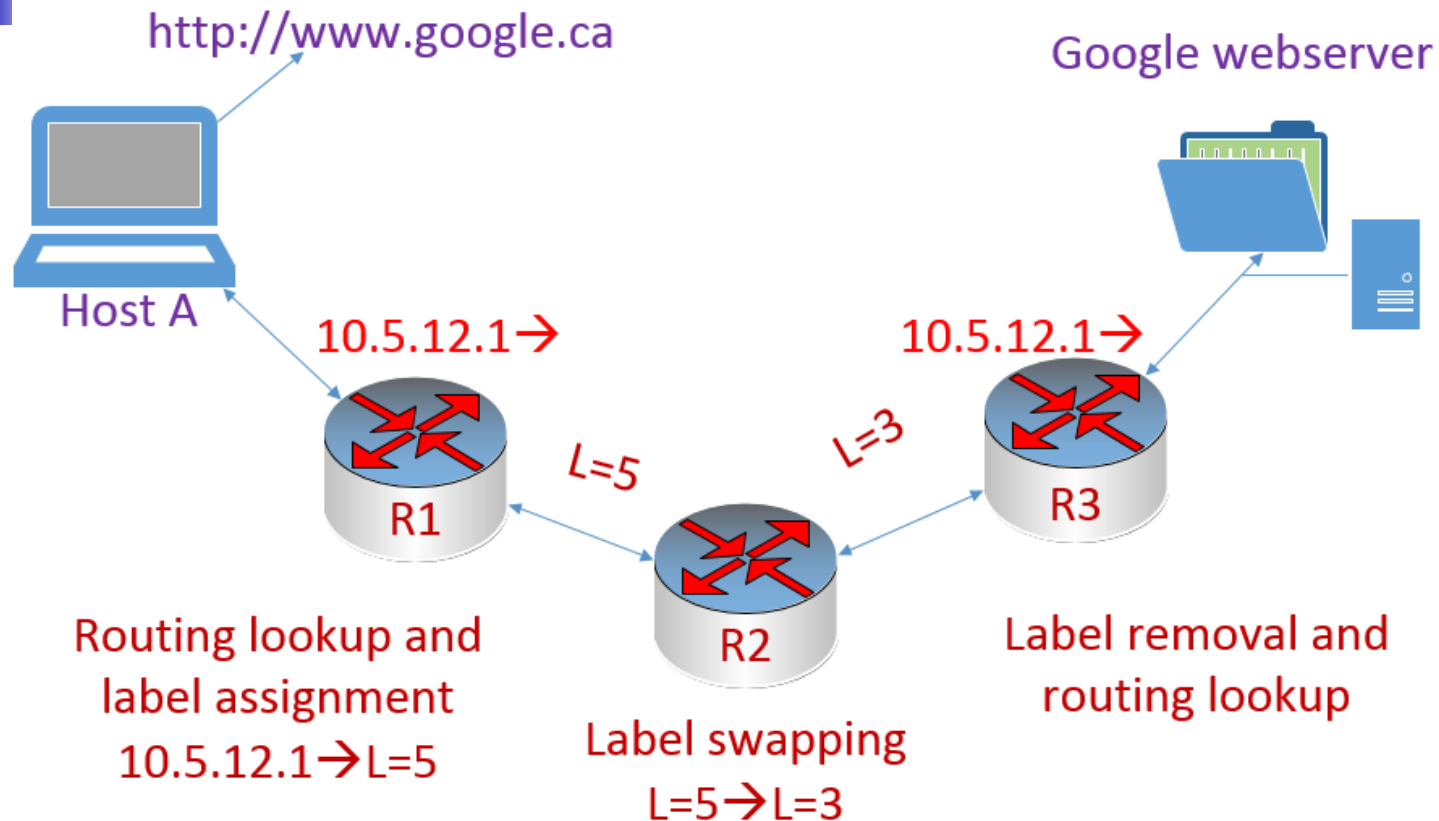
- Multi-Protocol Label Switching (MPLS)
- Only the source and destination routers perform IP lookup
- Forwarding is based on IP address and label

Packet Forwarding in IP Network

<http://www.google.ca>



Packet Forwarding in MPLS Network



- Only edge routers perform a routing lookup
- Core routers switch packets based on simple label lookups and swap labels

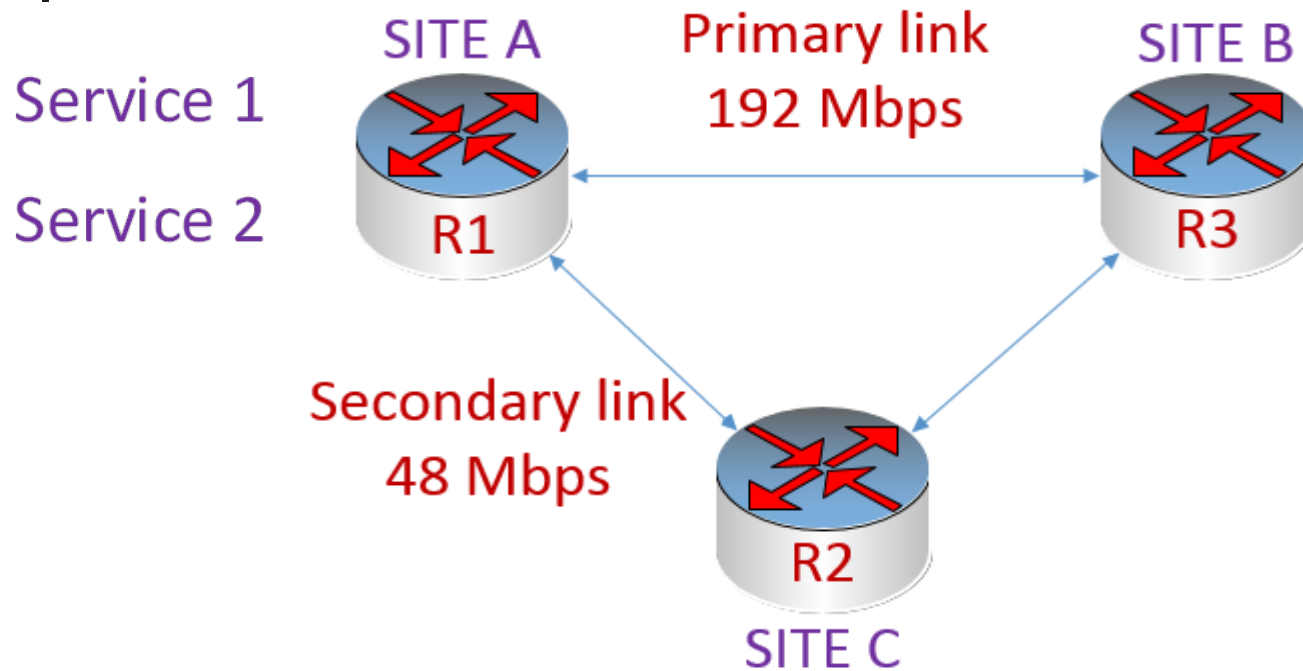


Traffic Engineering

Definition: Transport traffic flows across a network based on the type of traffic and the availability of network resources.

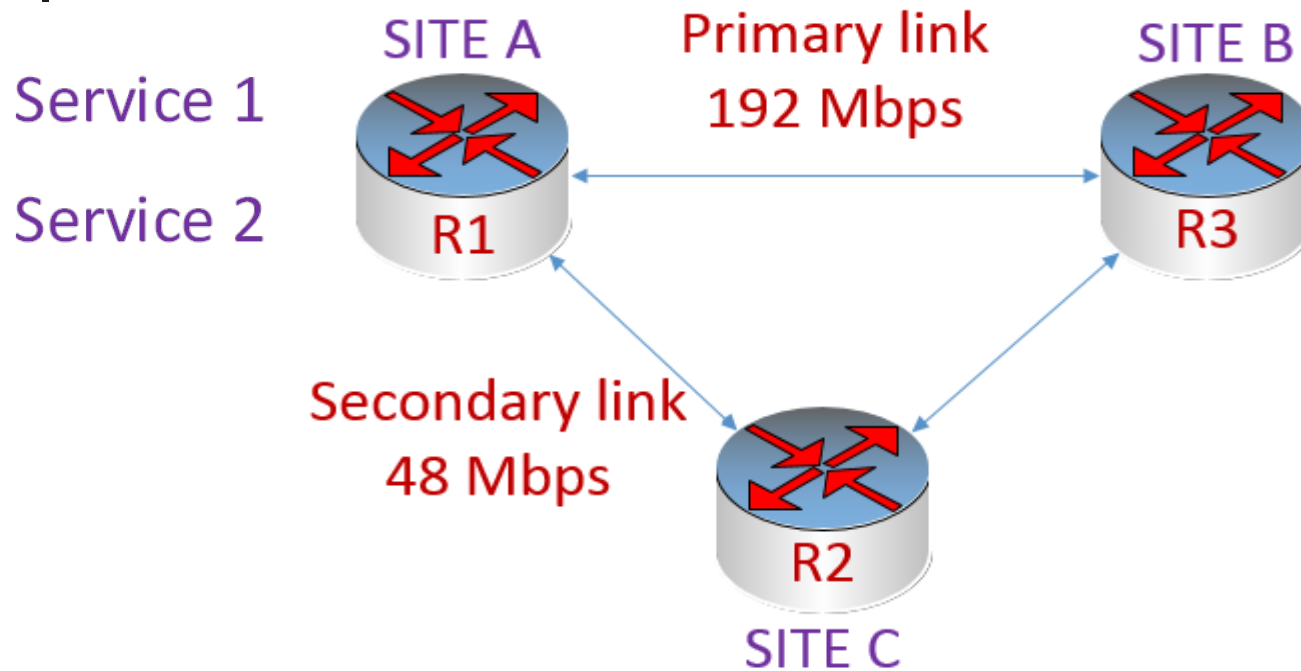
Reference: Basics of Traffic Engineering, Cisco press.

Traffic Engineering in IP network



- Most traffic goes between sites A and B and only uses primary link
- Destination-based routing does not provide any mechanism for load balancing across unequal paths

Traffic Engineering in MPLS network



- Traffic may be forwarded based on other parameters: QoS, source based
- Load sharing across unequal paths may be achieved



Related work

- MATLAB simulation tool (N. Aslam, 2010)
- GNS3 simulator is used and MPLS performance is measured (Deshmukh et al., 2013)
- RSVP-TE network simulator (D. Adami et al., 2005)

Resource Reservation Protocol

- The performance is measured in a simulated environment
- Failed to consider genuine network traffic
- Data file is a not a sensitive traffic



Project Objective

- Emulate a network architecture
- Configure routers to permit background traffic
- Two scenarios:
 - with background traffic
 - without background traffic
- Generate traffic using **CISCO IP SLAs**
- Performance measurement:
 - Round Trip Time (RTT)
 - Latency, and Mean Opinion Score (MOS)

IP SLA : IP service level agreement



Project Setup and Implementation

- Network architecture is designed using Graphical Network Simulator (GNS3)
- Emulator that implements functions of:
 - various vendor routers
 - network interface card
- Requires an **Internetwork Operating System (IOS)** of the specific router to mimic its function
- Advanced IOS images are available only to vendor customers



IP Network Configuration

```
10.0.0.0/8 is variably subnetted, 15 subnets, 2 masks
O    10.0.10.0/24 [110/2] via 10.0.11.1, 00:00:09, FastEthernet3/0
C    10.0.11.0/24 is directly connected, FastEthernet3/0
O    10.0.14.0/24 [110/4] via 10.0.11.1, 00:00:09, FastEthernet3/0
O    10.0.15.0/24 [110/4] via 10.0.11.1, 00:00:09, FastEthernet3/0
C    10.0.12.0/24 is directly connected, FastEthernet2/0
O IA 10.0.24.0/24 [110/5] via 10.0.11.1, 00:00:09, FastEthernet3/0
O IA 10.0.18.0/24 [110/6] via 10.0.11.1, 00:00:09, FastEthernet3/0
C    10.0.16.0/24 is directly connected, FastEthernet1/0
```

Screenshot from Router4, April 14, 2015



MPLS network configuration

```
R5#sh mpls forwarding-table
Local   Outgoing   Prefix          Bytes tag  Outgoing     Next Hop
tag     tag or VC  or Tunnel Id   switched  interface
16      Pop tag    10.0.23.0/24    0         Fa0/0        10.0.22.1
17      Pop tag    10.0.14.0/24    0         Fa0/0        10.0.22.1
18      16        10.0.12.0/24    0         Fa0/0        10.0.22.1
19      17        10.0.13.0/24    0         Fa0/0        10.0.22.1
20      Pop tag    10.0.15.0/24    0         Fa0/0        10.0.22.1
21      Pop tag    10.0.21.0/24    0         Fa0/0        10.0.22.1
22      19        10.0.17.0/24    0         Fa0/0        10.0.22.1
```

Screenshot from Router5, April 14, 2015



CISCO IP SLAs

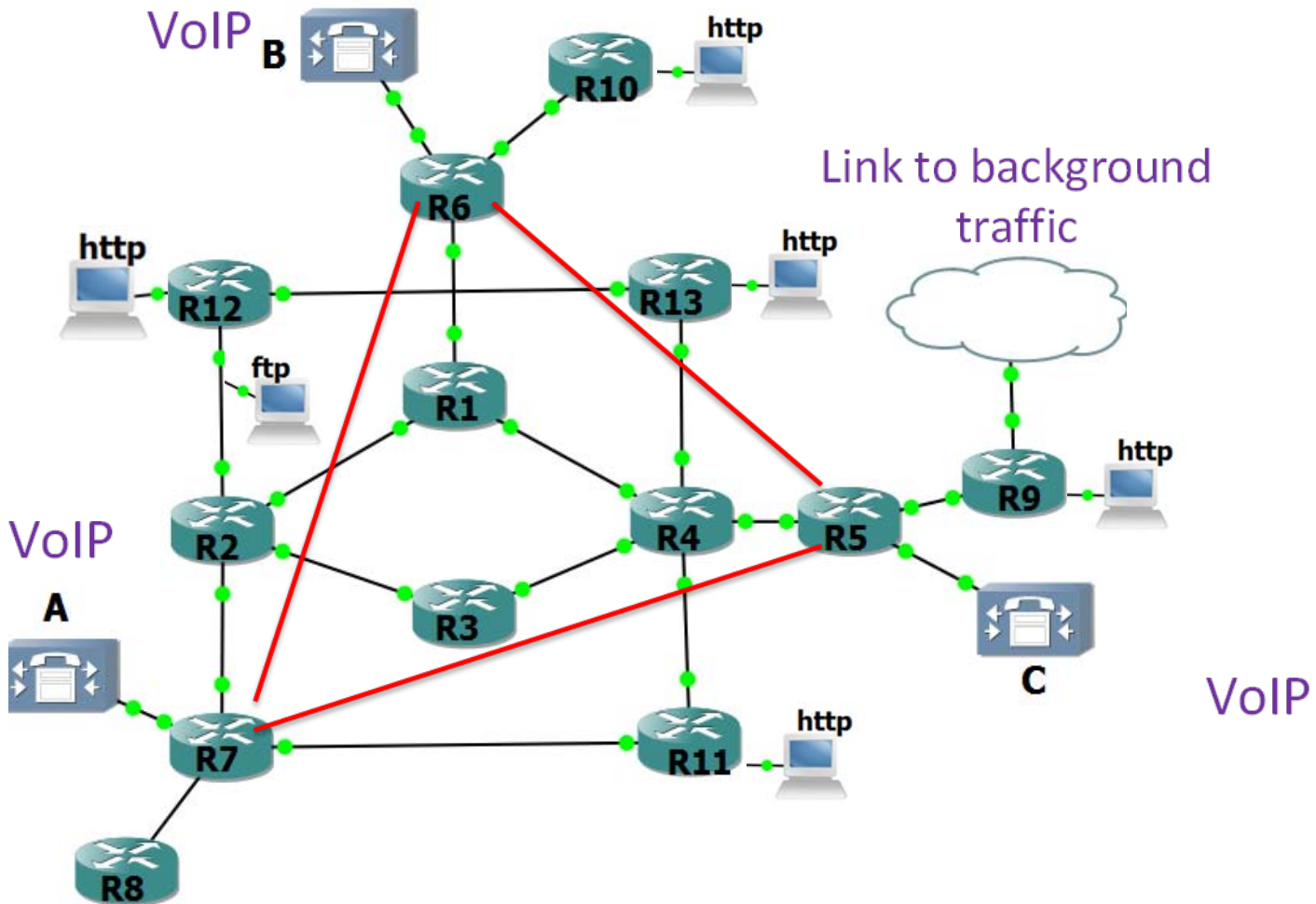
- CISCO IP Service Level Agreements (SLA)
- Used as a routine traffic generator within the system
- Capable of initiating different types of traffic within the network environment
- Analyzes performance
- IP SLAs are unique to each vendor



CISCO IP SLAs Parameters

- Generates Voice over Internet Protocol (VoIP) traffic:
 - Codec: G.711 A-LAW
 - Packet payload: 180 bytes
 - Number of packets: 1,000
 - Inter-packet-arrival: 20 milliseconds
 - Repeated: 1 minute
 - Operation performed between links: R7-R6, R6-R5, and R5-R7 (refer to handout)
- Generates background traffic:
 - Webserver traffic: <https://www.facebook.com>,
<https://go.sfu.ca>
 - FTP traffic: <ftp://username:password@domain/file>

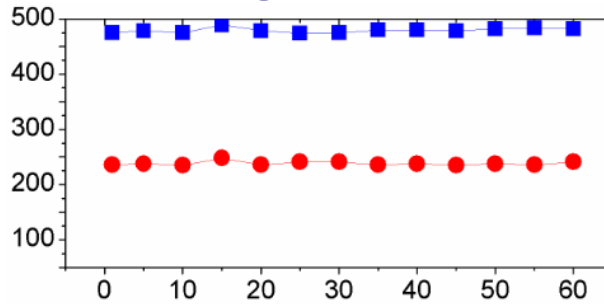
Emulation Results – MPLS network



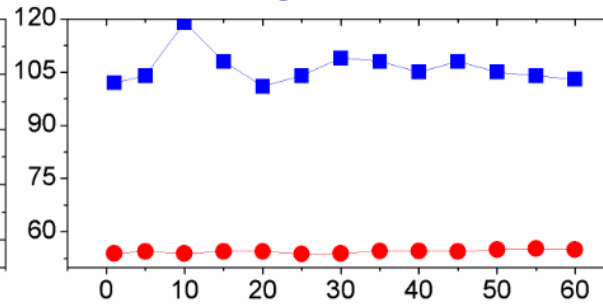
Latency

R7 – R6

Background traffic



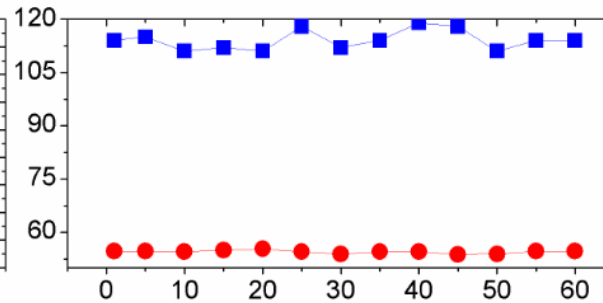
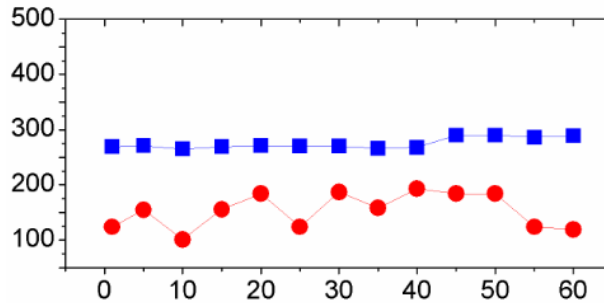
No Background traffic



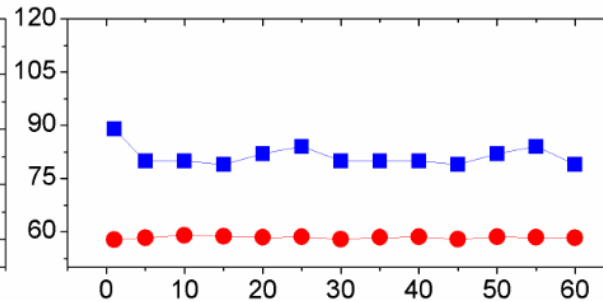
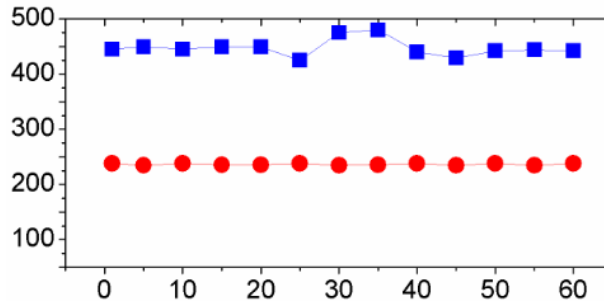
● MPLS
■ IP

Latency (ms)

R6 – R5



R5 - R7

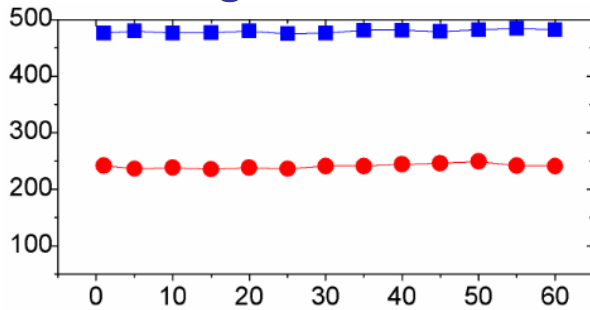


Simulation time (min)

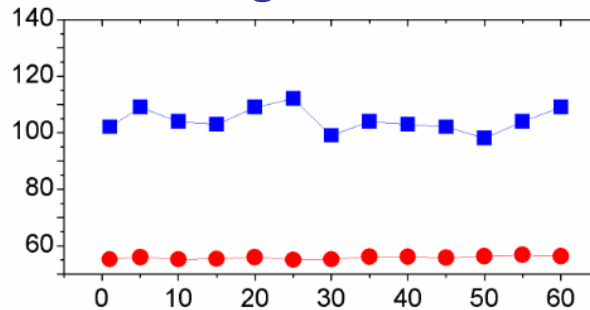
Round Trip Time

R7 – R6

Background traffic



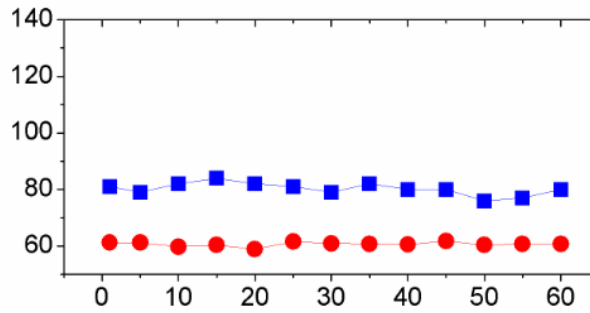
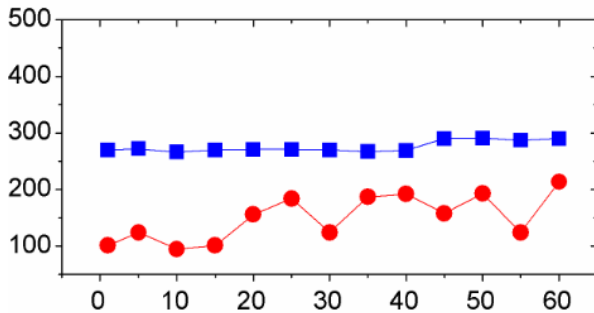
No Background traffic



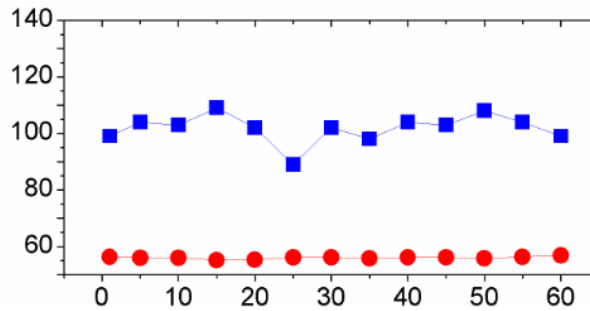
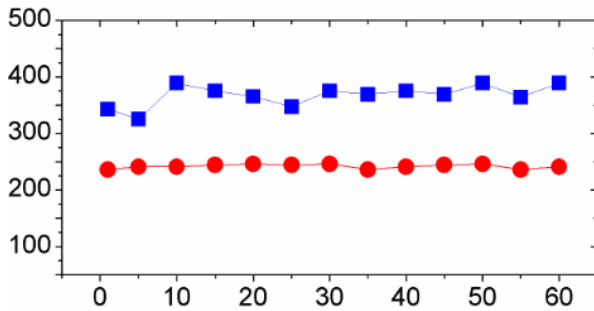
● MPLS
■ IP

RTT (ms)

R6 – R5



R5 – R7



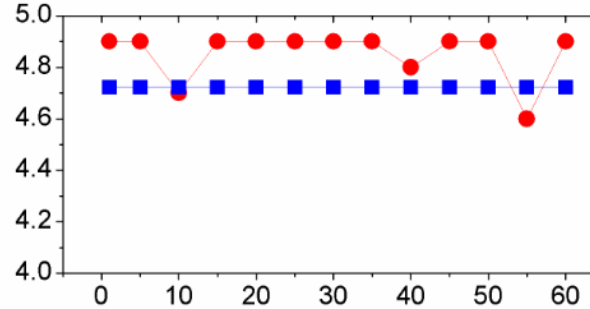
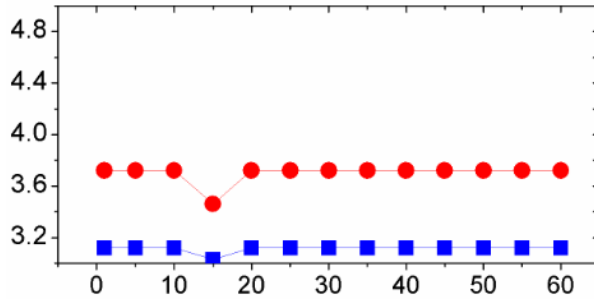
Simulation time (min)

Mean Opinion Score

Background traffic

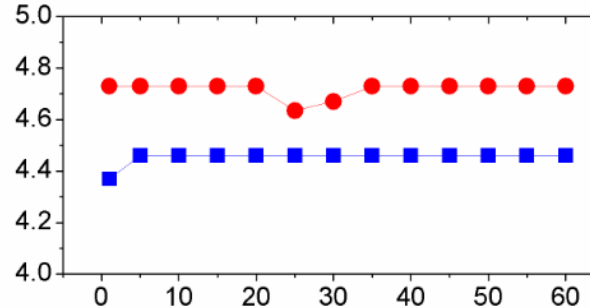
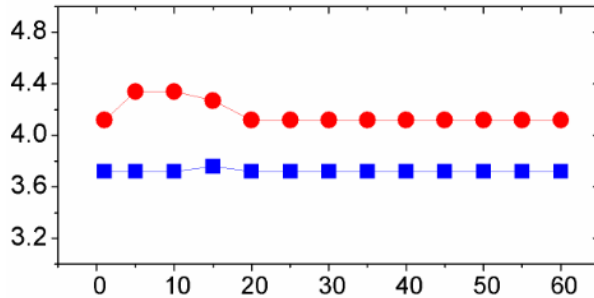
No Background traffic

R7 - R6



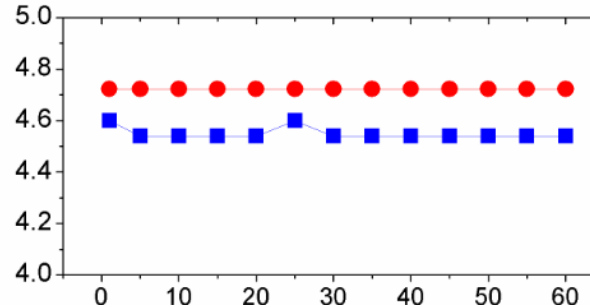
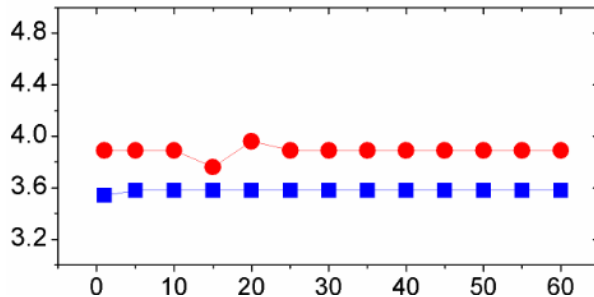
● MPLS
■ IP

MOS



R6 - R5

R5 - R7



Simulation time (min)



Summary and Conclusion

- IP network is affected by latency, RTT, and MOS value
- MPLS forwarding technique is faster than IP forwarding
- MPLS network labels the traffic at the source
- MPLS network is able to assign priorities to the different data packets based on their labels
- MPLS with TE minimizes the congestion in the network
- Cisco IP SLA technology is used to analyze the network performance
- MPLS = improved technique for traffic engineering



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