

CSCI 5160
Introduction to Enterprise Networks
Spring 2024
Final Practical Exam

We have one ISP- Zomcast, ISP has control over backbone; P1-P4 routers and Provider Edge (PEs); PE_1 – PE_99 routers. ISP is only IPv4 Aware. Only PE_99 edge router is aware of IPv6.

Site Specifications:

We have 4 customer Sites, SITE A – SITE D and we they have control over CE routers.

Site A is V4 and V6 capable and CE_A <-> PE_1 link is V4/V6 aware.

Site B is V4 and V6 capable and CE_B <-> PE_2 link is only V4 aware.

Site C is V4 and V6 capable and CE_C <-> PE_3, CE_C <-> PE_5 link is only V4 aware. (multihomed to two PEs)

Site D is V4 and V6 capable and CE_D <-> PE_4 link is only V6 aware.

IP Addressing:

You have to use 2001:AX::/38 for public IPv6 and Public IPv4 block of 6X.0.0.0/8 for all the customer.

(Where X is your student number, Mentioned at the end of pdf)

IPv4:

Site A has 3 private networks– 192.168.1.0/24, 172.16. 0.0/16 and 10.0.1.0/8

Site B has 1 private network – 192.168.2.0/24

Site C has 2 private networks– 192.168.3.0/24 and 10.0.3.0/8

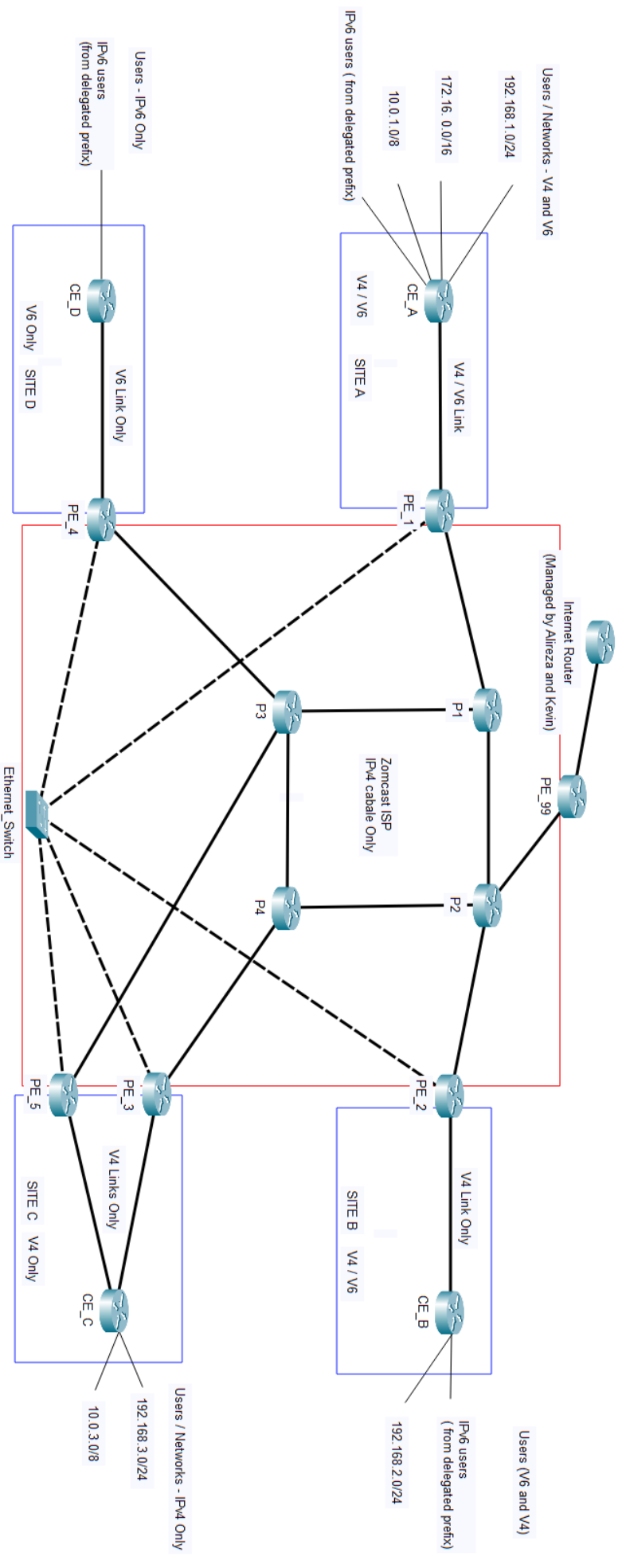
IPv6:

PE4 router delegates IPv6 prefix to all the CEs. (CE_A, CE_B, CE_D)

All the users gets Ipv6 addresses “/64” prefix from their respective CE routers.

Site D uses SLAAC, whereas all other V6 capable site A and B uses DHCPv6.

You can use own IPs unless specified (e.g. for Tunnels, Loopbacks, internal links)



MPLS Tunnels:

ISP backbone will do only MPLS based switching between all PEs. (RSVP and/or LDP where mentioned)

Traffic Between PE should follow:

1st – Use TE Primary Path

2nd – Use TE Secondary Path

3rd – Use LDP over L2 switch - Ethernet P2P links

We have 6 MPLS TE Tunnels between PEs to prioritize the traffic.

PE1 -> PE2 (50MBs)

- Primary - PE1 -> P1 -> P3 -> P4 -> P2 -> PE2
- Backup - PE1 -> P1 -> P2 -> PE2

PE1 -> PE3 (50MBs)

- Primary - PE1 -> P1 -> P2 -> P4 -> PE3
- Backup - Dynamic

PE1 -> PE5 (50MBs)

- Primary - PE1 -> P1 -> P3 -> PE5
- Backup - Dynamic

PE2 -> PE1 (30MBs)

- Primary – PE2 -> P2 -> P4 -> P3 -> P1 -> PE1
- Backup - PE2 -> P2 -> P1 -> PE1

PE2 -> PE3 (30MBs)

- Primary – PE2 -> P2 -> P1 -> P3 -> P4 -> PE3
- Backup - Dynamic

PE2 -> PE5 (30MBs)

- Primary – PE2 -> P2 -> P4 -> P3 -> PE5
- Backup - Dynamic

Tunnels initiating from PE1 uses 50MBs bandwidth for signalling and from PE2 its 30MBs.

TE tunnels uses only required bandwidth, don't use 100% of available physical Link.

Since these tunnels are unidirectional, the path which are not defined above, it uses LDP based switching for sending traffic back or initiating from some sites.

Tunnels where full path is defined, uses strict ERO, else dynamically.

Make sure that labels are seen if a traceroute is done from any customer site.

Traffic between PE routers will always use MPLS, no IP based Routing.

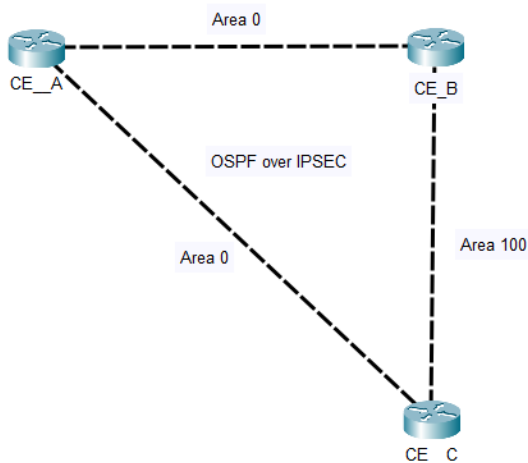
Even when using switch as backup, It will use LDP (No IP based forwarding)

As a backup, we have Ethernet Switch which connects all the PEs, these Ethernet are P2P links which acts as full mesh connections between all PEs. (You are expected to split one switch into multiple point to point connections -wires- between routers)

Hint: vlans+trunking+subinterfaces

To complete this MPLS Tunnel's objective: All your tunnels should be up and operational on primary path, and after failing a used link, they should restore themselves on the backup or dynamic failover option. (eventually restoring all services you run from client to client)

Ipv4 Tunneling+Routing:

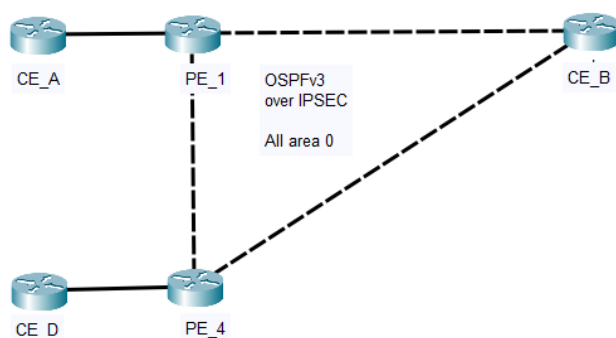


For our private IPv4 networks to communicate with each other, we have OSPF running over the IPSEC Tunnel between all the CE routers.

Refer above diagram to know which Interface is in which OSPF Area.

Once this task is successfully configured, your all private IPv4 addresses of each site should be able to ping each other.

Ipv6 Tunneling+Routing:



For our IPv6 networks to communicate with each other, we have OSPFv3 running over the IPSEC Tunnel.

Note for IPv6, Tunnel ends on CE router for site B. All the links are in Area 0

Once this task is successfully configured, your delegated IPv6 IPs should be able to ping all other site's IPv6 delegated users.

(Full connectivity / ping between all V6 users of each site)

V4 <-> V6 inter communication:

Only IPv4 and only IPv6 devices should be able to communicate with each other via CE_A router. (router used for NAT PT)

This objective will be completed once you can ping from a V4 only to all IPv6 addresses, and vice versa.

E.g. of how to achieve this:

1. V4 users will route to CE-A via IPv4 tunnels/routing.
2. Then NAT_PT will forward/translate the request into the IPv6 domain and send to IPv6 user.
3. Then IPv6 user will route back to destination IPv4 address/host via NAT_PT again.

Default Traffic exiting the topology:

All your customer traffic reaches the CEs.

From CE, Traffic should exit via respective PEs.

Inside backbone, IPv4 and IPv6 traffic exits via PE_99.

P-99 is the router that connects to the IPv4 and IPv6 internet, you must cross MPLS domain to reach them (use MPLS method of your preference) (NAT range is provided at the end for every student)

ISP will not speak dynamic routing protocol with customers, customer must use default routes to send traffic to ISP cloud.

NAT Range:

Before sending traffic to Common router, make sure you use below Pool.

Student Number (X number)	Name	NAT Pool	PE_99 interface IP	Internet Router Interface IP (We will configure this)
1	Ashwin	10.0.0.0 /24	10.0.0.2	10.0.0.1
2	Sneha	20.0.0.0 /24	20.0.0.2	20.0.0.1
3	Scott	30.0.0.0 /24	30.0.0.2	30.0.0.1
4	Aibol	40.0.0.0 /24	40.0.0.2	40.0.0.1
5	Yemi	50.0.0.0 /24	50.0.0.2	50.0.0.1
6	Don	60.0.0.0 /24	60.0.0.2	60.0.0.1
7	Nufais	70.0.0.0 /24	70.0.0.2	70.0.0.1
8	Danny	80.0.0.0 /24	80.0.0.2	80.0.0.1

Additional notes:

P routers should only know ISPs internal routes. (not aware of Private customer IPs, also not aware of IP subnets used between CE-PE,)

CE routers should NOT know ISPs internal routes.

Site C has two uplinks towards ISP and should do ECMP. (tunnels should be able to operate on either PE, if one dies)

Switching/Routing inside the ISP should only be done via MPLS not IP based.

Customer routes are exchanged over IPSEC tunnels only.

All the ISP routers are only IPv4 aware. (IPs inside the Red box)

Only Router PE_99 is IPv6 aware.

V4 and V6 can be enabled on a device w/o a need to VRFs (no VRF's on this exam!)

You can create new tunnels, redistribute routes, run new routing protocols, create static routes if needed or use any other techniques in order to achieve the final goal but you have to follow above requirements also you can't add additional Physical links.

End goal is every end device should be able to talk to all other site's end devices and default traffic should exit via PE_99 router.

If you have any doubt or want any clarification, reach out to us before implementing.

All the Best !!