TLEN 5460: Telecommunications Systems Lab
Final Practical: Spring 2014

Name:

Rack Number:

Instructions:

1. Please read the entire paper before you start.
2. Use of calculators strictly prohibited. No cell phone allowed.
3. Use of commserver is compulsory. (No points for using it, but negative 5 for not using it)
4. Make necessary assumptions; just don't change the network, and addition of extra physical connections is strictly prohibited.
5. Please clean up all the devices before you leave (Negative 10 for not cleaning your devices).
6. Everything will be tested before giving out any perfect points. Try working on all objectives, partials might be granted based on class performance
7. If at all there is any proved discrepancy in the paper then points will be awarded based on ap propriate solution that you have. You can contact a SA if you have doubts in the paper
8. 'Copy Run start' or 'write mem' at regular intervals to ensure that you don't lose your configurations if a device crashes.

Important tip: Keep calm and don't panic! ☺

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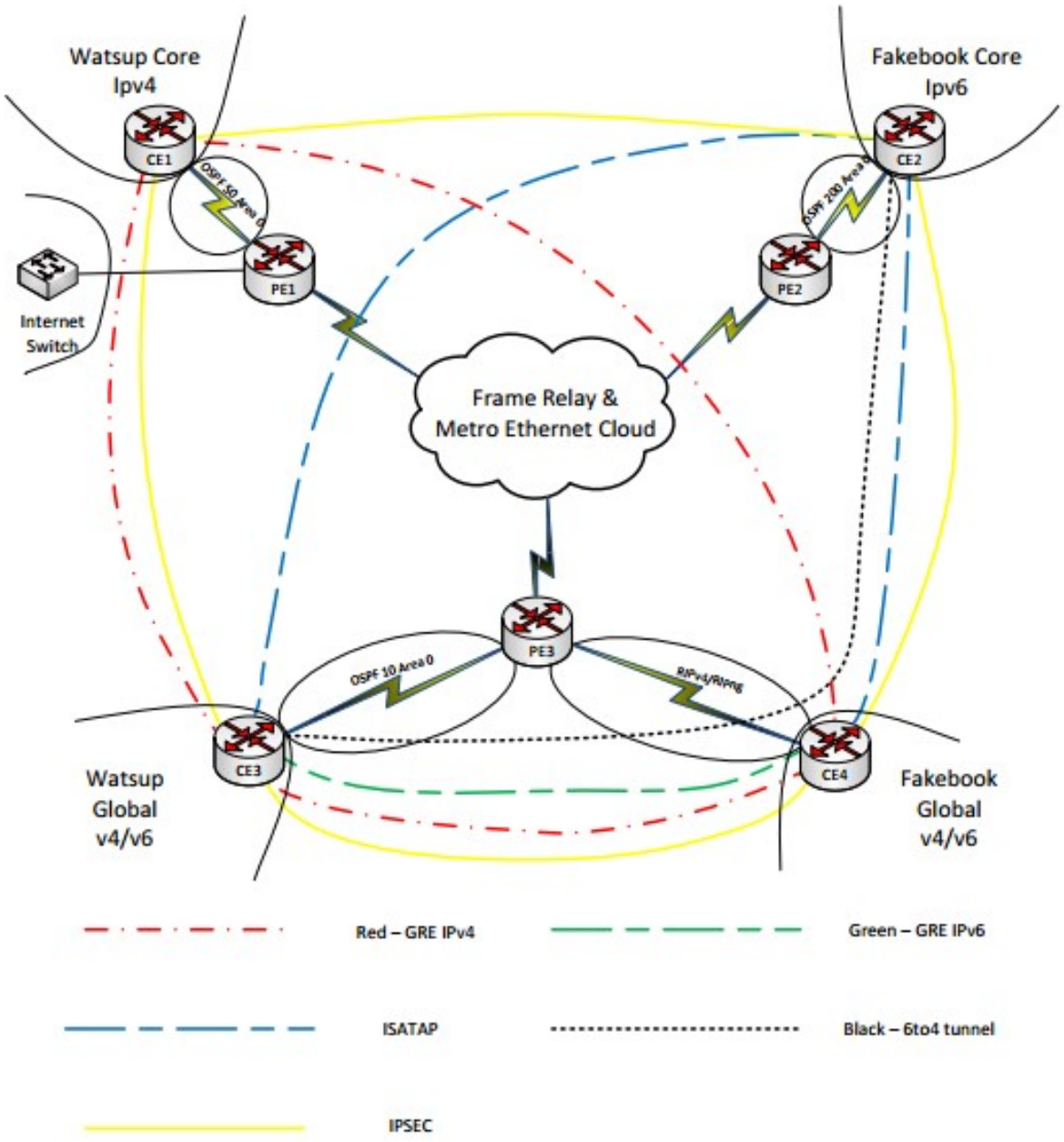

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Background:

On April 1st 2014, Fakebook bought the company Watsup for its large customer base. The merger requires all the four sites between the companies, spanned across various cities to be connected to each other and the. Fakebook planned the topology changes and has a blue print for the interconnection of the four sites.

Well… if only mergers were so simple! All the four sites have to behave like one seamless network under the Fakebook administration. Fakebook has hired you to make all of this happen!

On your first day as a network administrator, you realize that some of the Fakebook and Watsup sites are incompatible as they either support Ipv4 or Ipv6 only. However the edge routers for those sites still talk both v4/v6. In addition all the sites are located at various locations and need to connect to each other via the ISP Level 5.

For configuring this network, Level 5 has provided you access to its core and edge equipment. You find that Level 5 believes that its core needs to be redundant which is why Level 5 has separated its core into two redundant clouds. One cloud is the MPLS over Frame Relay network while the back-up is the Metroethernet network.

Design the network in such a way that all users are able to connect with each other on all sites and there is a level of redundancy inside the ISP core. If the MPLS Tunnel network of the core fails as per the SLA with Fakebook, traffic should still pass between all sites via Frame Relay. If Frame Relay fails then the traffic should get routed through the MetroEthernet cloud. The best network will be the one where users on all three sites can keep their connections intact even after a series of “unfortunate events” take down your MPLS and Frame Relay network. You will be rewarded with marks that you can cash in for a grade.

Best of Luck!

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The "Merged" Topology:

1. **Global IP Addressing:**
   - ARIN has assigned Level-5 Telecom an IPv6 block of 222X:XX::/32 and a IPv4 block of 9.0.0.0/8. Level-5 Telecom decides to use an IPv4 space of 4.X.0.0/16 for its Frame Relay, MetroEthernet and MPLS network and an IPv6 block of 222X:XX::/48 inside their Core network.
   - Fakebook has been assigned an IPv6 block of 222X:XX:X::/48 from the ISP where X is your rack number. The IPv6 block must be sub-netted and distributed across the four merged sites of Fakebook.
   - Level-5 Telecom is running out of IP space and has decided to assign the block of IPv4 address space to Fakebook in the following fashion: 9.2X.1.0/29 to the Watsup Core Site, 9.2X.2.0/29 to Fakebook Core site, 9.2X.3.0/29 to Watsup Global site and 9.2X.4.0/29 to Fakebook Global site. All CE's on all sites are Dual stack routers. Since the public IP space is a valuable resource, use it in an optimum manner for Interfaces and Loopbacks.
   - Use optimal IPV4 sub-netting on point to point links especially on the CE to PE link. You are free to allocate a /64 IPV6 network on each P2P link and user and admin networks

2. **Fakebook and Watsup Internal network:**
   - Watsup Core Site [v4 only]:

IPv4 Address:
Uses a private IPv4 address space of 10.1X.0.0/21 where "X" is the rack number and the groups of IPv4 users are as follows:

S/N	Unit	Number of Users	Address Assignment
1	Users	512	Static
2	Administration	271	Static

   - Watsup Global Site [v4/v6]:
   - IPv4 Address:
     Use a private IPv4 address space of 10.2X.0.0/19 where "X" is the rack number and the Groups of IPv4 users are as follows:

S/N	Unit	Number of Users	Address Assignment
1	Users	1411	Static
2	Administration	420	Static

IPv6 addressing:

#	Unit	Address Assignment
1	E-mail Server	DHCPv6
2	Database Server	DHCPv6

- Fakebook Core [v6 only]

#	Unit	Address Assignment
1	E-mail Server	DHCPv6
2	Database Server	DHCPv6

- Fakebook Global [v4/v6 only]

  IPv4 Addressing:

  Use a private IPv4 address space of 10.3X.0.0/17 where "X" is the rack number and the groups of IPv4 users are as follows:

S/N	Unit	Number of Users	Address Assignment
1	Users	1023	Static
2	Administration	165	Static

  IPv6 Addressing:

#	Unit	Address Assignment
1	E-mail Server	DHCPv6
2	Database Server	DHCPv6

Page for IP Addressing (Note 5 marks for the v6 addressing. 0 points for v4. Negative marks if you get v4 addressing wrong)

Please indicate the global and private addressing used in the global and private networks of Level 5 and the Fakebook/Watsup Company

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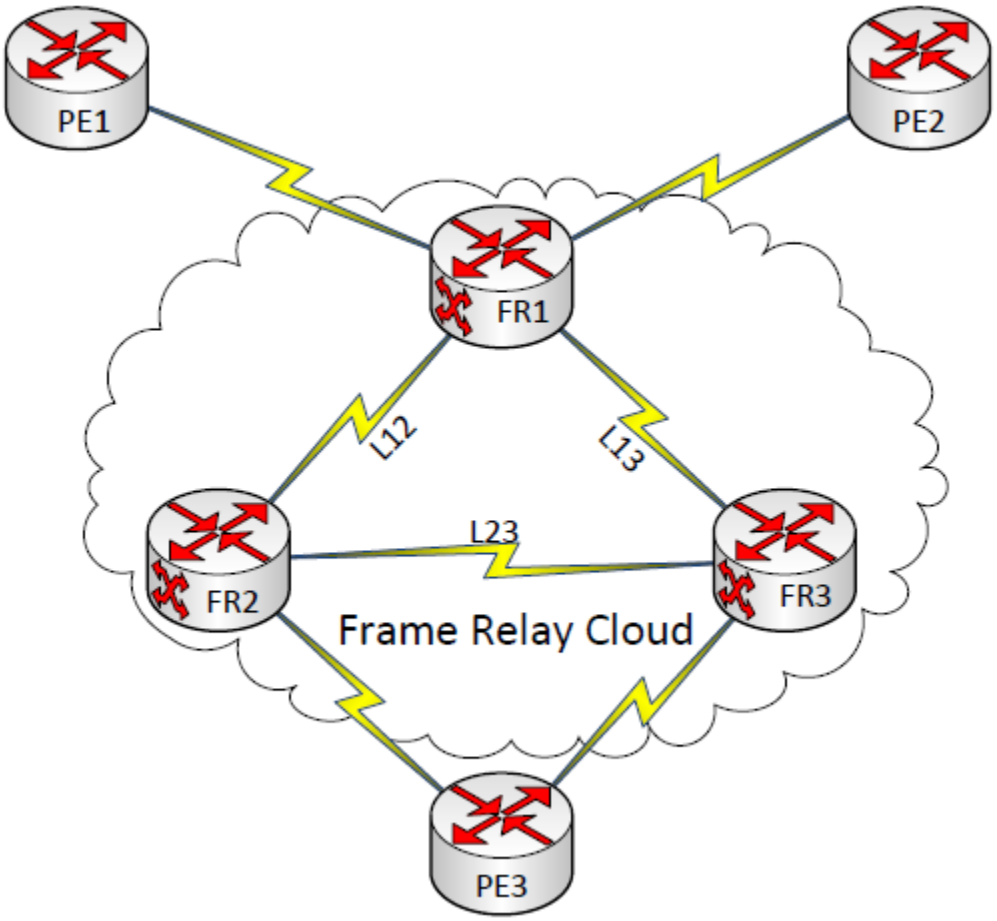
3. **DHCPv6 [5 points]:**
   - All the users and servers on all the sites get the IPv6 address dynamically from their respective CE routers. All the CE routers should get their IPV6 prefix from PE2 only. Use IPv6 blocks assigned for dynamic addressing

   Checklist:
   - Use an appropriate DHCPv6 prefix delegation
   - Only PE2 should be delegating prefixes
   - Loopbacks or users connected to the CEs should have a dynamically learned IPv6 along with the public interfaces of the CEs

4. **Frame Relay [10 points]**



- The Frame Relay topology is provided to you for the Level 5 core. Implement the network as follows:
  - P1: Point to Point between PE1 and PE3 using links L12
  - P2: Point to Point between PE1 and PE2 via FR1

- M: Full Mesh using L13 and L23 to connect PE3 with PE1 and PE2. PE1 →PE2 using FR1
- H: Hub and Spoke where PE3 is the hub and PE1 and PE2 are the spokes using L13
- P3: v6 point to Point between PE2 and PE3 using link L13 and L23

Checklist:

- All the frame relay circuits should be working
- All the networks should be able to reach each other
- At this point if you are unable to make Frame Relay work and are running out of time, reduce the topology with just one FR switch and implement the PVCs and move on with MPLS to obtain marks for MPLS and above protocols

5. MPLS [15 points]

- Level 5 Telecom is trying to provide traffic engineering towards it customers by utilizing all of its available circuits. Level 5 runs its MPLS TE network on top of its Frame Relay due to limitations with equipment.
- Level 5 has a SLA with Fakebook to provide it a dedicated link for its traffic between its sites. Only Fakebook site traffic should pass through these tunnels. Remember no traffic from Fakebook destined to the Internet or the Level 5 core traffic should not pass through these Tunnels
- In addition to providing dedicated links to Fakebook, Level 5 also has an SLA to provide bandwidth of 200kbps for all Fakebook sites
- The three edge routers of Level 5 have 6 tunnels between them to create a full mesh connectivity between the Fakebook Sites. Level 5 has also provided Fakebook with a high priority tunnel **Tunnel 7** with a 200kbps guaranteed bandwidth that follows the same path as Tunnel 1. When Tunnel 7 is signaled, it should tear down Tunnel 1 and the traffic should pass through Tunnel 7. Tunnel 7 should NOT have a dynamic path.
- There are a few restrictions made by Level 5 to you when designing this topology.
  - The total bandwidth that is the bandwidth of the sum of all interfaces on a PE router should not exceed 800kbps. Eg. On the PE3 router, the sum of the bandwidth assigned to the two interfaces and their sub-interfaces connecting to the frame relay cloud should not exceed 800kbps
  - The use of static routes are permitted to route traffic through the tunnel
  - The PE routers should not form LDP neighborship with each other in order to reduce the CPU utilization on them
  - All MPLS tunnels should automatically check for better paths available and optimize to them every 150 seconds
  - Do not use random IP addresses to source you MPLS tunnels, use IPs from the block assigned to Level 5
  - All MPLS should be signaled by RSVP and should have static strict EROs. No backup or loose EROs will be considered
  - Make sure that labels are seen if a traceroute is done from any customer site

- The 6 MPLS tunnel paths are as follows:

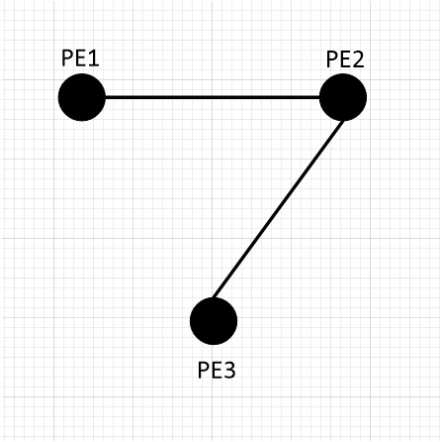
Tunnel 1

Path: PE1- PE2 - PE3

PE1 – PE2: P2

PE2 – PE3: Full Mesh

Bandwidth Requested: 200Kbps



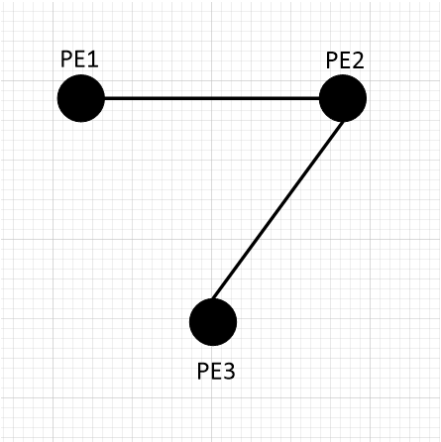
Tunnel 2

Path: PE3- PE2 – PE1

PE3 – PE2: H

PE2 – PE1: P2

Bandwidth Requested: 200Kbps



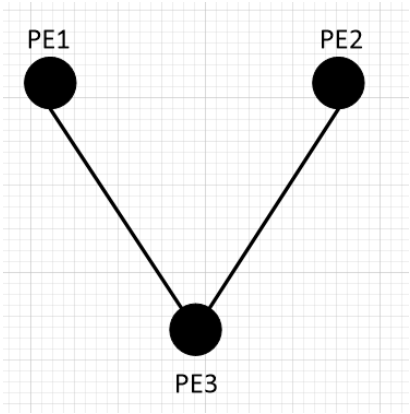
Tunnel 3

Path: PE1- PE3 – PE2

PE1 – PE3: H

PE3 – PE2: Full Mesh

Bandwidth Requested: 200Kbps



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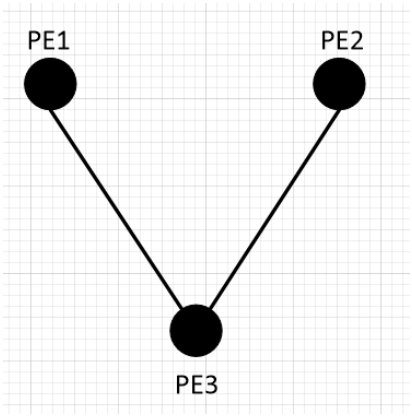
Tunnel 4

Path: PE2 - PE3 – PE1

PE2 – PE3: H

PE3 – PE1: P1

Bandwidth Requested: 200Kbps



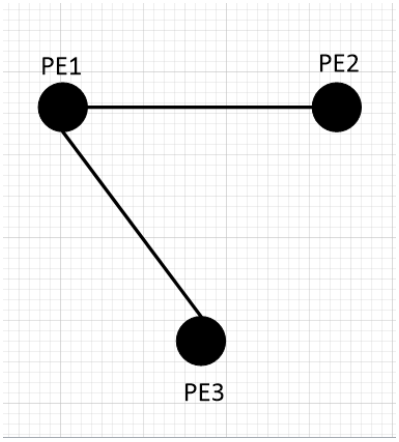
Tunnel 5

Path: PE2 – PE1 – PE3

PE2 – PE1: P2

PE1 – PE3: P1

Bandwidth Requested: 200Kbps



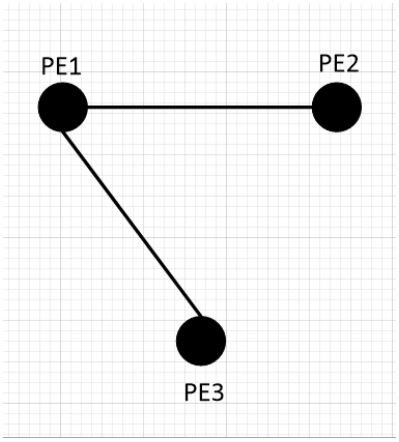
Tunnel 6

Path: PE3 – PE1 – PE2

PE3 – PE1: H

PE1 – PE2: P2

Bandwidth Requested: 200Kbps



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Checklist:

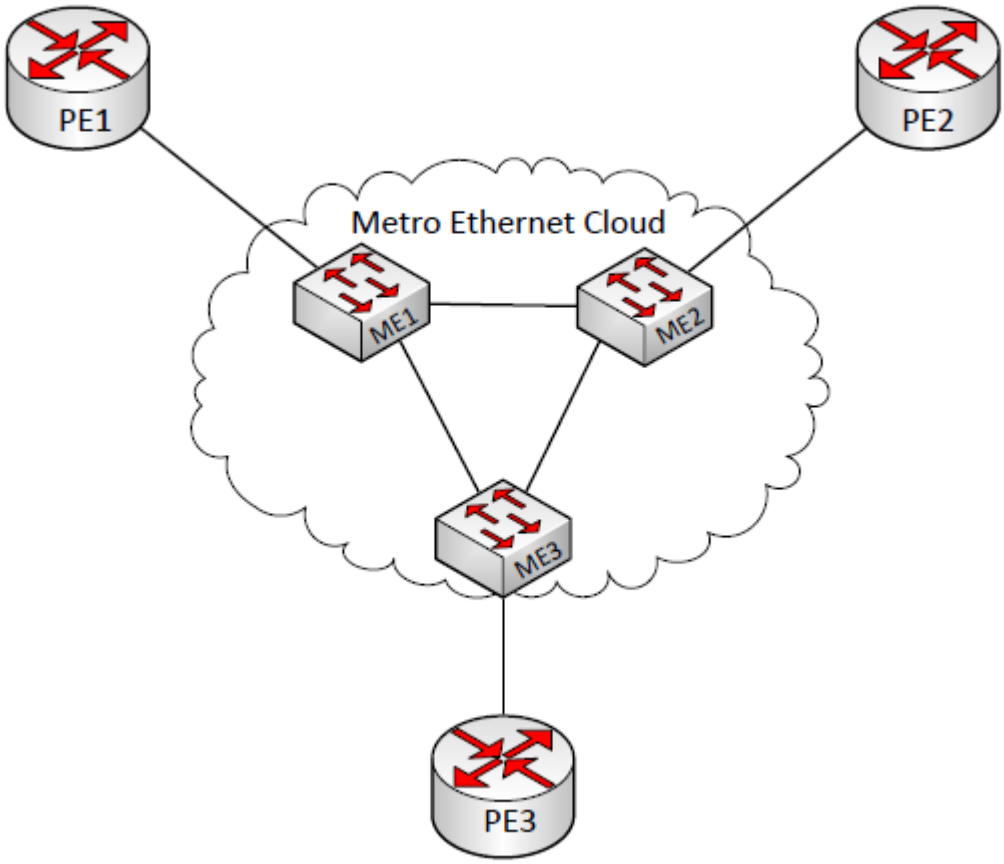
- MPLS tunnels should be up/up with static EROs
- The bandwidth at the interfaces should be within the limits for the SLA
- Only Fakebook site to site traffic should pass through the tunnels
- Each tunnel should have a backup dynamic path but should not use it unless the static one fails
- At this point if you are unable to make explicit path work then switch over to dynamic and continue the paper for the remaining marks
- If you are unable to make MPLS work move towards metro to grab those marks

6. MetroEthernet [5 points]:

- Level 5 has chosen a MetroEthernet QinQ cloud to provide a backup to its FR/MPLS cloud such that the traffic for its customers is not dropped if the primary cloud fails.
- The PE routers are connected to Metro switches in the core and the topology for that has been shared with you.
- The PE router interfaces that connect to the MetroSwitch tag the packet with a Vlan tag of 5X where X is the number of your rack. The Metro Switches add a metro tag of 1X and pass it between them.

Checklist:

- The metro tag should show if traffic is sniffed in the core netwok
- Assign IPv4 addresses appropriately
- If MPLS and Frame Relay are not working at this stage, make the rest of the network run on Metro to get marks for that



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7. IGP [15 points]:

<u>IPv4 GRE tunnels between Fakebook and Watsup sites:</u>

- Fakebook's global site is the backbone area of the OSPF process 150 and all the networks behind the router are in the backbone area. Watsup's core and global sites are present in area 1 of the OSPF 150 process. Make use of GRE tunnels for the Watsup sites to be able to connect to the Fakebook backbone OSPF area. The security restrictions that Fakebook has for this method of tunneling is that all the traffic that passes through the GRE tunnel should be encrypted including the OSPF traffic that passes through it
- Refer to the topology provided to you for implementing the OSPF process

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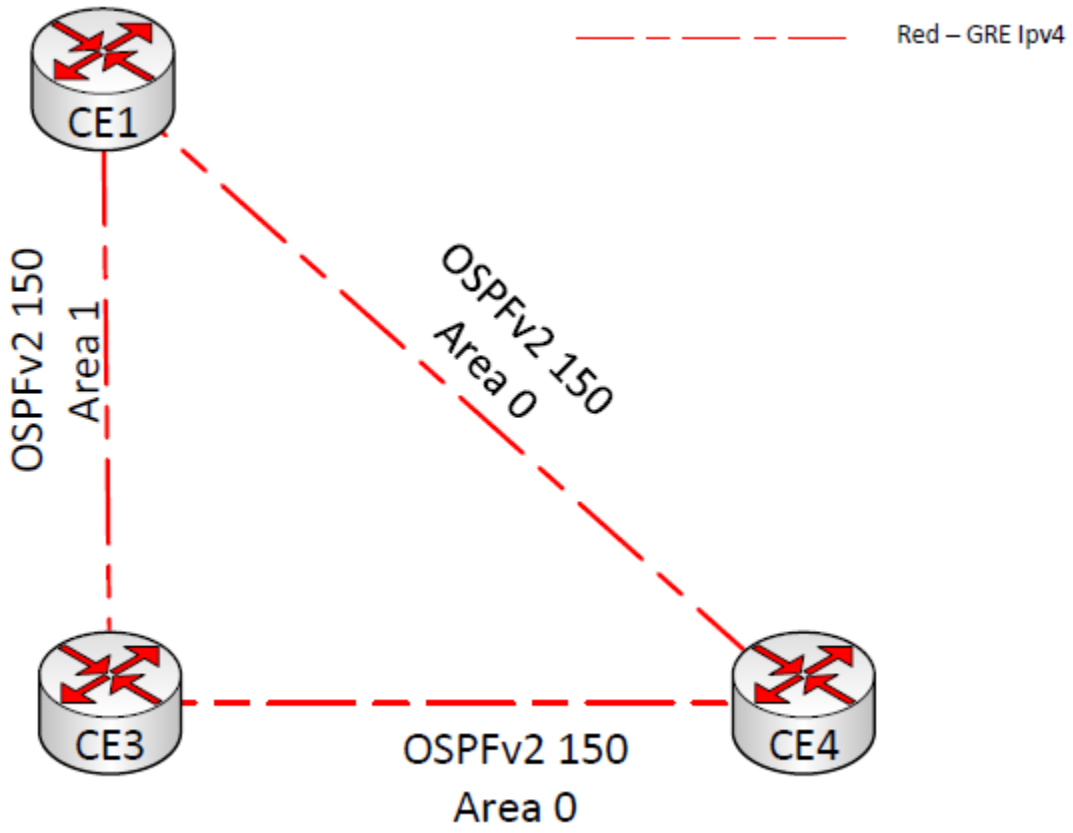

IPv6 Tunnels between Fakebook and Watsup Sites:

- Fakebook's core site is in the backbone area of the OSPF v3 process 150. The Watsup global and Fakebook global sites are in area 1 and connect to it via OSPF v3 process 150
- Refer to the diagram provided to you to implement the topology

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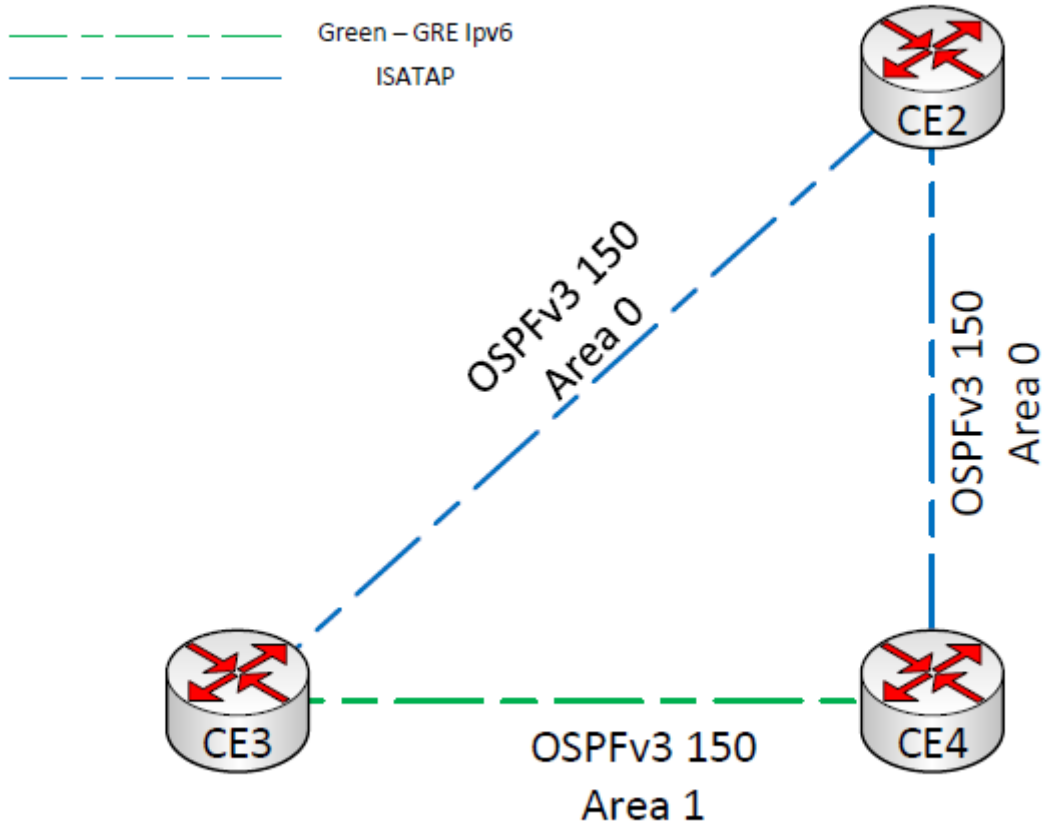

Routing Between Level 5 and the Fakebook network:

Devices	**Routing Protocol v4**	**Routing Protocol v6**
CE1 – PE1	OSPF 50 area 0	OSPF 50 area 0
CE2 – PE2	OSPF 200 area 0	OSPF 200 area 0
CE3 – PE3	OSPF 10 area 0	OSPF 10 area 0
CE4 – PE3	RIP v2	RIPnG

Routing inside the Level 5 Core:

- The Frame Relay MPLS core uses OSPF process ID 100 for all the PE routers to communicate with each other
- The PE1 router provides the core a route to reach the Internet
- The CE routers send all their traffic to the PE router they are connected to in order to be able to reach outside their network
- The MetroEthernet cloud acts as a backup to the Frame Relay/MPLS cloud. Design it in such a method that the traffic should pass through the MetroEthernet cloud only if the Frame Relay Cloud fails.

8. Redistribution [8 points]

- Enable redistribution at specific points inside the network topology to obtain reachability. The redistribution should be optimum

Checklist:

- Redistribution should not be forming loops
- There should be full end-to-end connectivity
- The metrics for redistribution should be appropriate
- The private networks of Fakebook/Watsup and Level 5 should not be seen in each other's route table

9. IPv6 Tunnelling: [15 points]

- The email and database servers located at the Fakebook core and Watsup Global site should be able to connect to each other via a 6 to 4 tunnel
- A hub and spoke ISATAP tunnel should be present between the Fakebook Core site and the Global sites for both companies with the core site as the hub
- Create a point to point GRE tunnel for ipv6 between the two global sites
- IPv6 users at the Watsup global and the Fakebook Core office should use the a backup path for the IPv6 via the native IPv6 point to point link in the Level 5 core. This path should be taken if 6to4 and ISATAP fail
- IPv4 Users at the Watsup Core office should be able to access the IPv6 Email and Database servers at the Fakebook core site via the Fakebook Global router

Checklist:

- All tunnels should be up/up
- Use appropriate IPv4 and IPv6 addresses for tunneling
- The traffic should be going over the primary tunnels and the backup should be in the order provide to you
- IPv6 traffic should be encrypted
- NAT-PT translations should be appropriate
- The routing inside the GRE and ISATAP tunnels should be as specified in the IGP objective

10. IPSec [10 points]

- The hosts in the User networks across all the Fakebook sites should send encrypted traffic via policy based IPSec
- The Administration across all the four sites should be able to communicate securely to each other via route based IPSec passing through the GRE tunnels already created
- Secure IPv6 traffic also between all the three sites that are IPv6 capable
- Administration Employees who work from home connect via the wireless Internet (Refer Obj 13). They are provided Easy VPN access to the internal resources via the CE 1 router.

Checklist

- Access-lists should be configured properly for appropriate users to take the correct tunnel.

- Crypto-maps should be implemented at the right place. Hint: Consider link failures
- Security Associations should be appropriate
- Encrypted traffic should flow inside the MPLS tunnels
- Ensure the Policy based tunnel is configured correctly

11. NAT [5 points]:

- Only administration department host should be able to connect to the Internet via the public IP discovered on the PE1 interface

12. Access Lists [5 points]:

- Only IPv4 users inside Fakebook's Administration network should be able to remotely manage all the network devices.
- Any incoming request except ICMP from the Internet should be blocked at all PE and CE routers. Punch holes for necessary connectivity for IPsec etc. Hint: Do this at the end or you might take your network down!
- Only an IT head can access the devices in the Level 5 network. Hint: You can create loopbacks on the devices to emulate an IT network.

13. Internet [5 points]:

- The Internet service is provided to Fakebook via Level 5's PE1 router.
- The Level 5 provider buys transit from a local Internet service provider. The local provider has installed their equipment in your lab. There is a common switch provided for all of you. Do not MESS with this switch.
- To provide Internet access you will just need plug your device in the equipment provided to you by the local ISP and assign an IP of 100.64.X.2/29. Use 100.64.X.1 as the gateway. The ISP also provides you with a wireless connection for home users (Look for an SSID marking your rack!)
- The wireless device of the Administration users connects to this SSID for EasyVPN access.
- Use the DNS server 128.138.130.30 for resolving IP addresses

14. SSH [5 points]:

- For security reasons Fakebook does not manage its devices on the traditional port 22 assigned for SSH
- Use SSH port-forwarding at port 5640 to remotely access devices that support it
- The Admin for Fakebook uses SSH to remotely manage devices on the IPv4 and IPv6 networks (where possible).
- Use other forms of remote management where SSH is not possible