

iNET ZERO

Huawei HCIE-R&S

Lab exam preparation workbook

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For Huawei Technologies Co, Ltd - HCIE R&S Lab exam 2016

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Target audience

This workbook is developed for experienced network engineers who are preparing for the Huawei Certified Internet Expert - Routing and Switching lab exam. Although not required it is highly recommended that you have passed the HCNP Routing and Switching written exam.

How to use this workbook

We recommend that you start your HCIE lab preparation by completing the first 7 chapters only. Always take a note on the time spent for each chapter/ task to see if you improved once you go over the chapters again. Ensure that at least you perform the first 7 chapters twice before you start with final chapter (the super lab). You are ready to try the 8-hour super Lab if you are able to configure the chapter's tasks without the need to look at the answers presented in the appendix. The superlab must be completed within 8 hours as it simulates a full day HCIE lab experience. Good luck!

iNET ZERO support

Always feel free to ask us questions regarding the workbook. You can reach us at info@inetzero.com. We love to hear from you regarding your preparation progress. Your feedback regarding our products is also appreciated!

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Huawei eNSP network simulator

eNSP introduction

Huawei Enterprise Network Simulation Platform (eNSP) is a free GUI based network simulation platform. It simulates enterprise routers, switches and external hosts. eNSP supports large-scale network simulation and allows you to implement experimental tests and learn network technologies without using actual devices.

HCIE candidates can use the eNSP simulator in combination with iNETZERO HCIE R&S workbook to learn the HCIE blueprint network technologies and simulate HCIE lab exam topologies. The eNSP simulator helps HCIE candidates conveniently learn the network features and protocols as found on the HCIE lab exam blueprint.

With this workbook you have received initial and final configurations, which can be used in the eNSP simulator. For example if you would like to practice the chapter5 tasks you can load the chapter5 initial eNSP configurations. Also If you are stuck in solving certain tasks you can use our final eNSP configurations for a particular chapter to view the answer.

eNSP hardware requirements

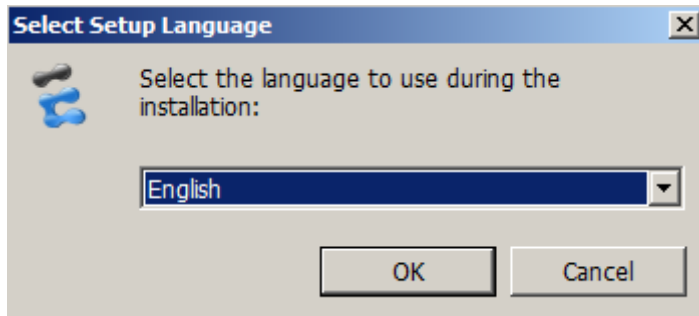
iNETZERO recommends the following hardware requirements to support the topologies and features used in this workbook:

Recommended: **Windows 7 Ultimate, CPU Intel Xeon or Intel i7, RAM 16GB**

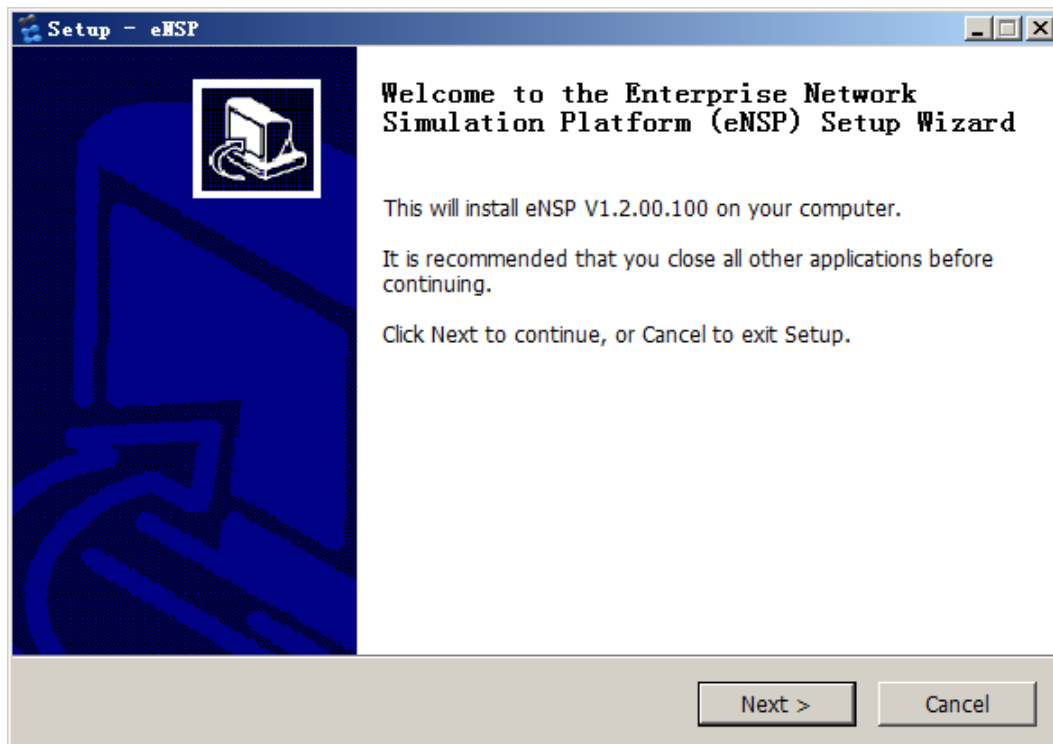
eNSP download and installation

This chapter briefly describes the installation procedure for Huawei's eNSP network simulator. On a regular basis Huawei publishes eNSP updates on their website, that include product bugfixes and new features. So please check for updates on a regular basis.

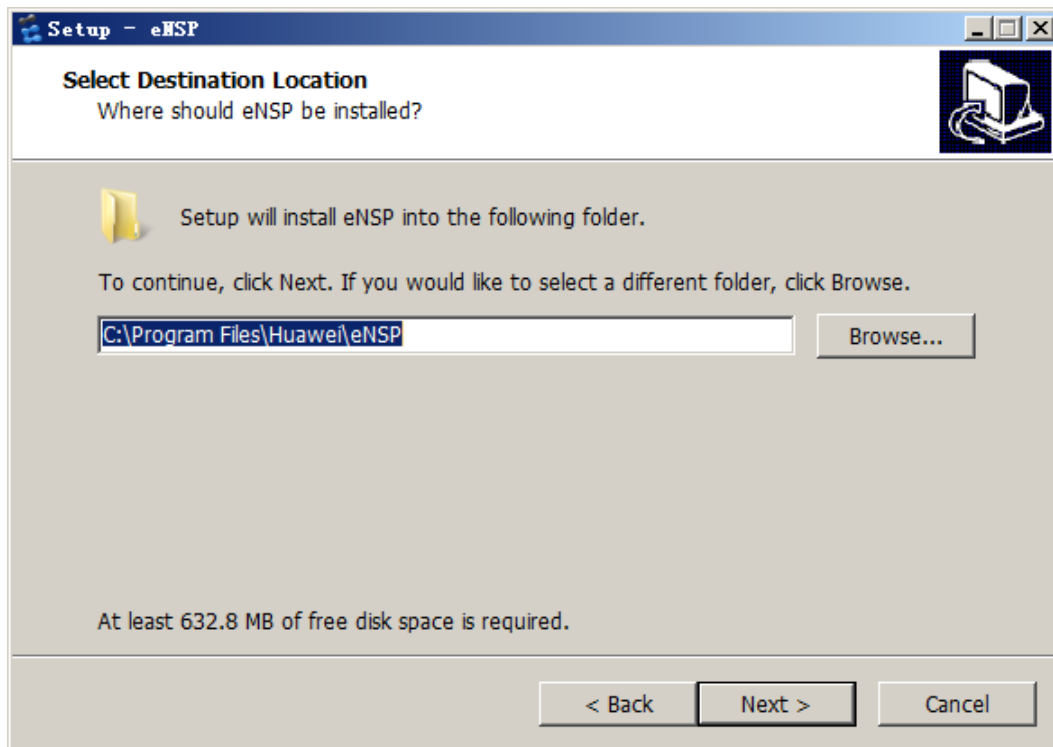
1. Download the latest version of Huawei eNSP simulator at www.huawei.com
2. Once downloaded double click the installation program and open the installation wizard.



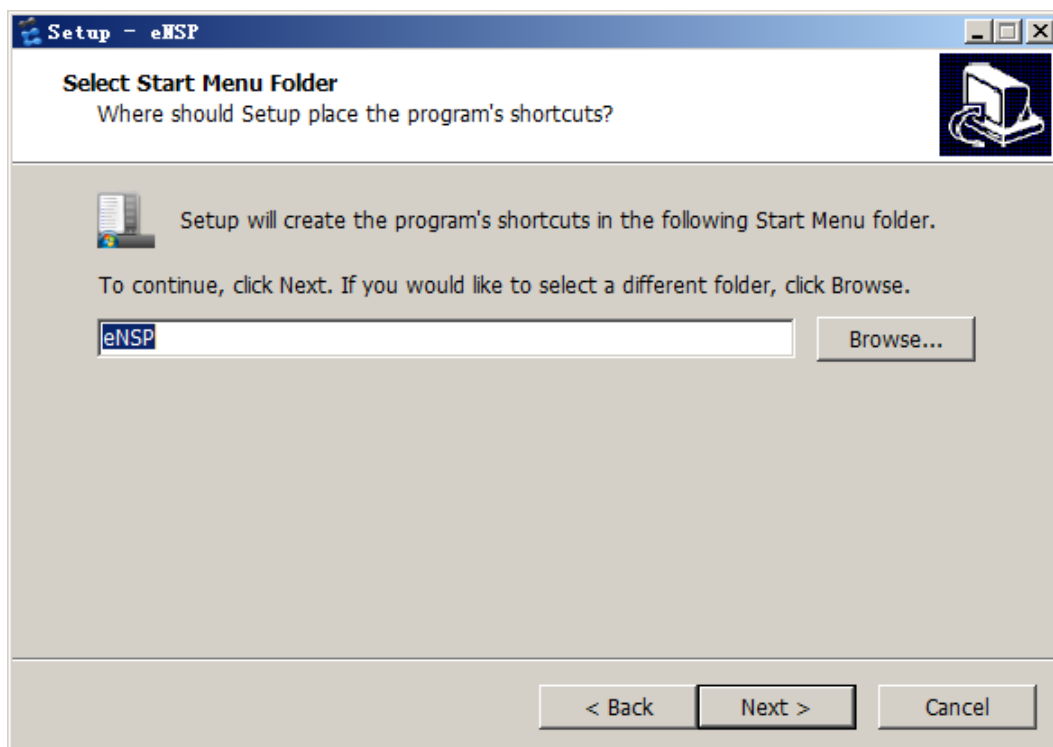
3. Select English and click OK, the welcome window is displayed.
4. Click Next.



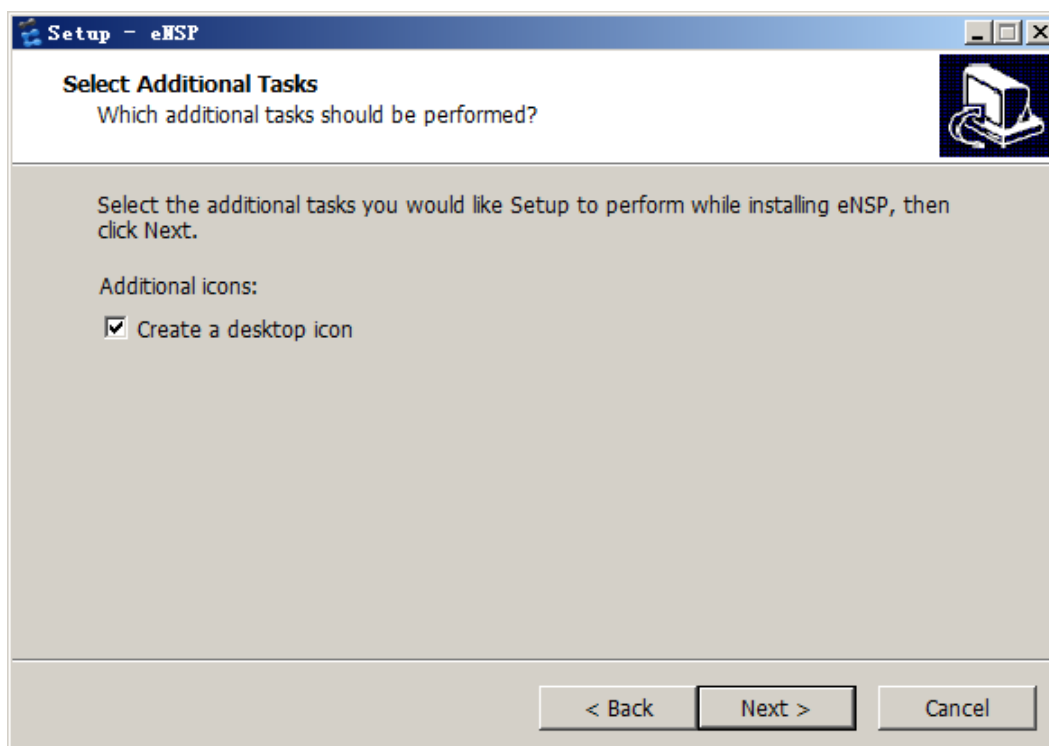
5. Set the installation folder and click Next.



6. Set the name of the eNSP program shortcut displayed in the Start menu and click Next.

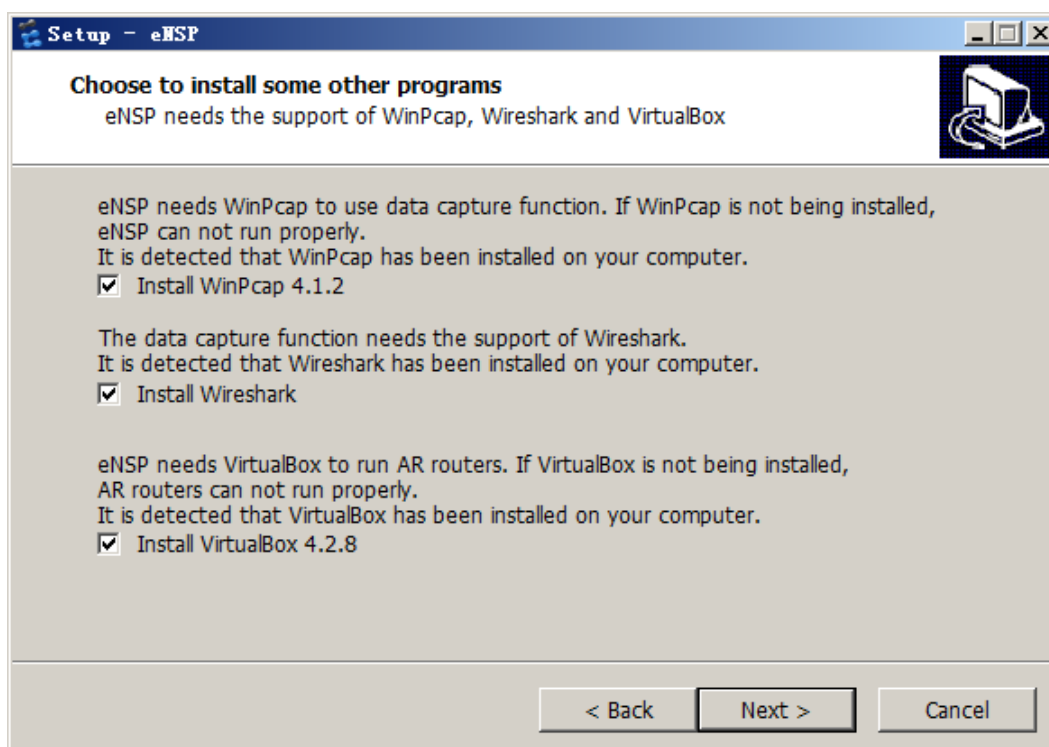


7. Choose whether to create the program shortcut on the desktop and click Next.

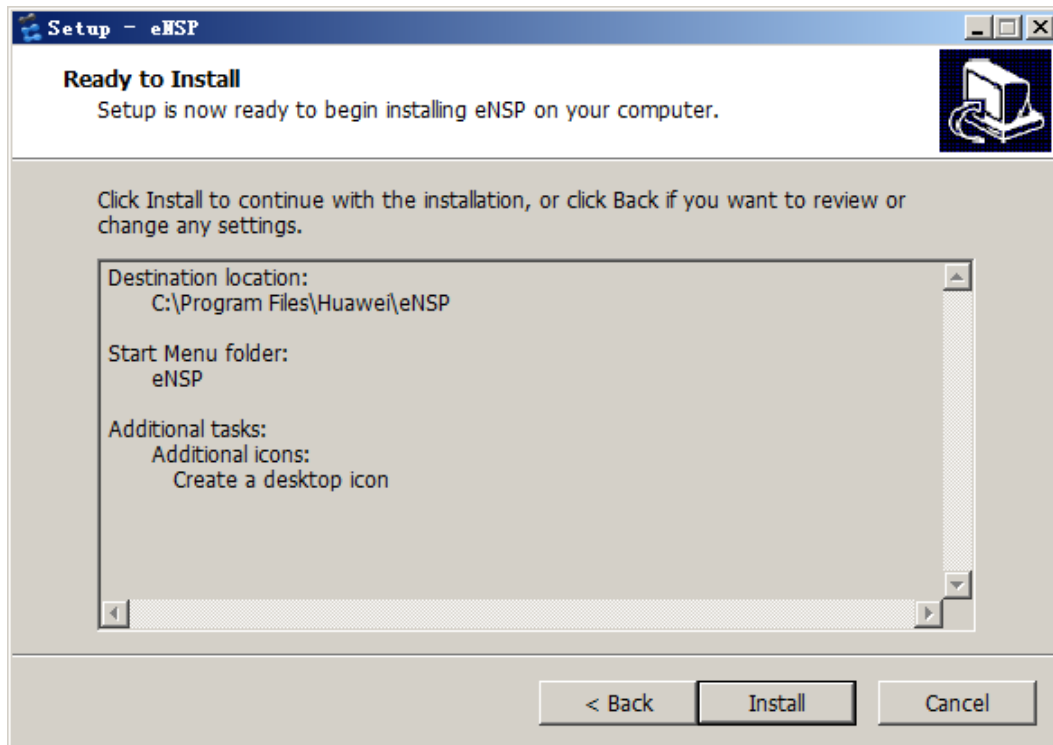


Ensure that

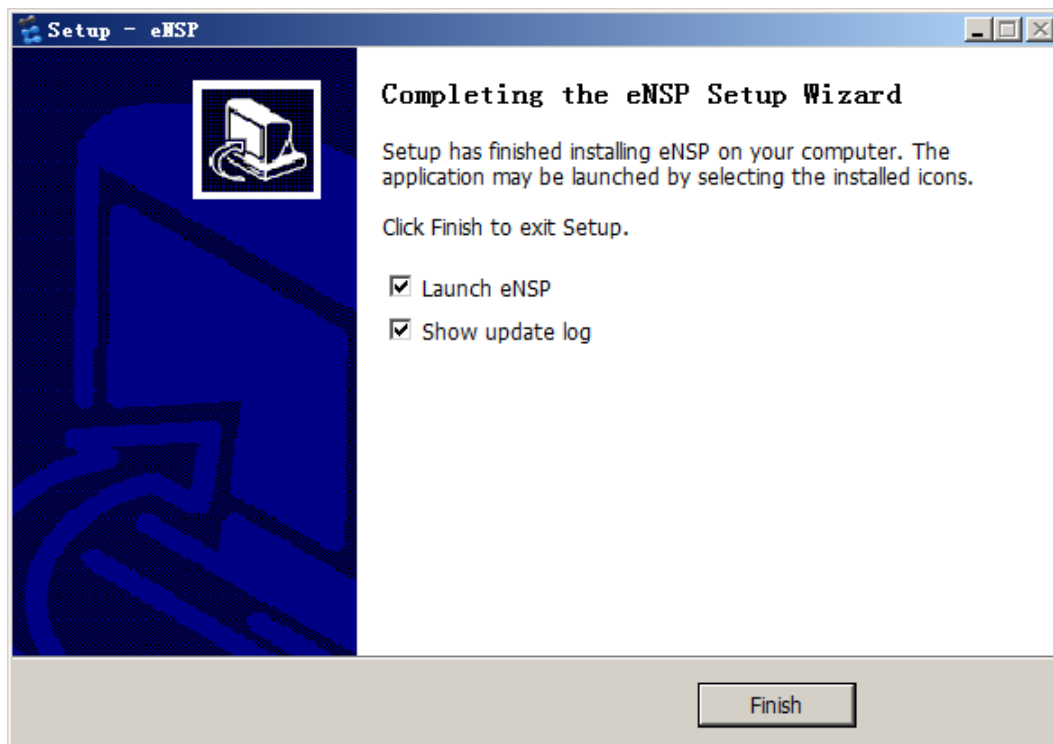
8. Ensure that you select WinPcap, Wireshark and Virtual Box to be installed and click Next.



9. Confirm installation information and click **Install** to start the installation.

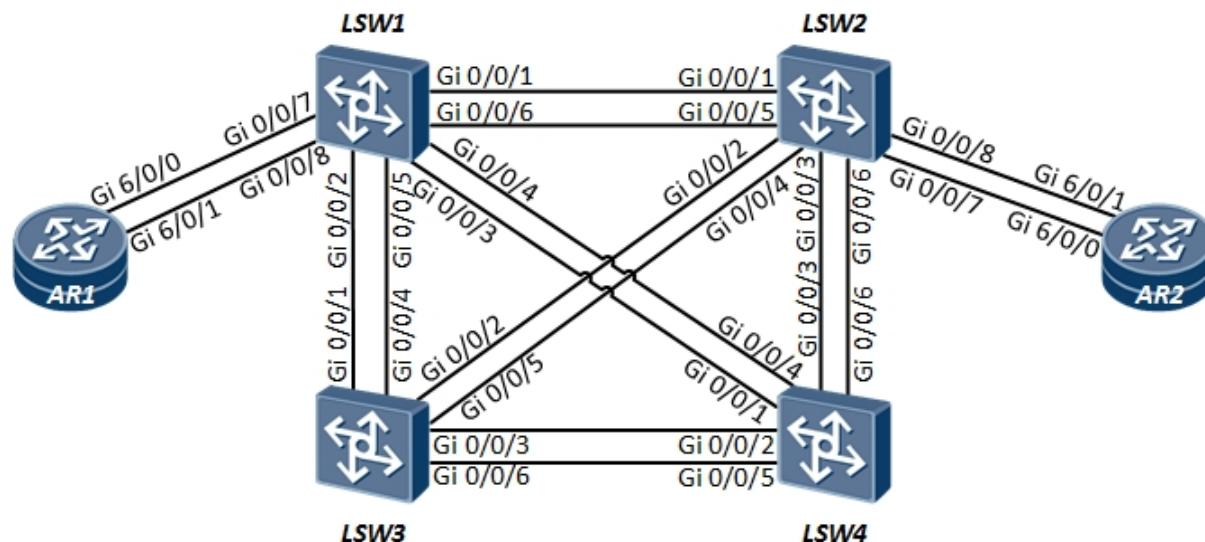


10. After the installation, if you do not want to open eNSP immediately, do not select Launch eNSP and click Finish to end the installation.



Chapter 1: L2 switching and L2 features

Note: Load topology with name – *L2Switching_STP* in eNSP simulator



Task 1.1: Link Aggregation

1.1.1. Manual mode

- Configure Manual mode Link Aggregation between AR1 and LSW1. Bond interface GE6/0/0 and GE6/0/1 on AR1 with interface GE0/0/7 and GE0/0/8 on LSW1:

1.1.2. Link Aggregation in LACP mode

- Configure LACP mode Link Aggregation between AR2 and LSW3. Bond interface GE6/0/0 and GE6/0/1 on AR2 with interface GE0/0/7 and GE0/0/8 on LSW3:

Task 1.2: Rapid STP configuration and features

1.2.1. RSTP timers.

- Configure all LSW devices for RSTP and verify which device has the role of root bridge. Disable the STP protocol on the AR routers.

1.2.2. Root bridge configuration

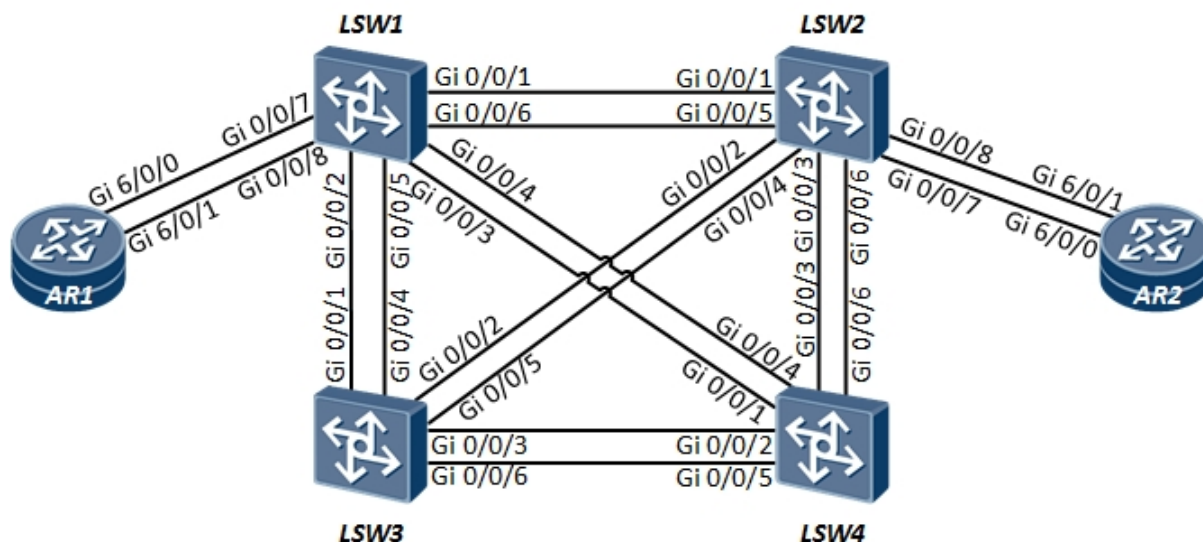
- Configure LSW1 as a primary root bridge and LSW3 as a secondary root bridge.

1.2.3. STP timers and parameters.

- Ensure that the maximum number of bridges between any two points of attachment of end stations is set to 4.
- Configure the time whether the received BPDU expires to 10s.
- Configure the forwarding-delay timer to 4s.
- Configure the LSW devices to shut down the edge port if the edge port receives a BPDU. The ports should recover automatically from shutdown state after 5 min.
- Configure LSW1 and LSW3 for Root protection on the interfaces towards LSW2 and LSW4.
- Configure all Alternate ports for loop protection.

Task 1.3: MSTP Configuration and features

NOTE:

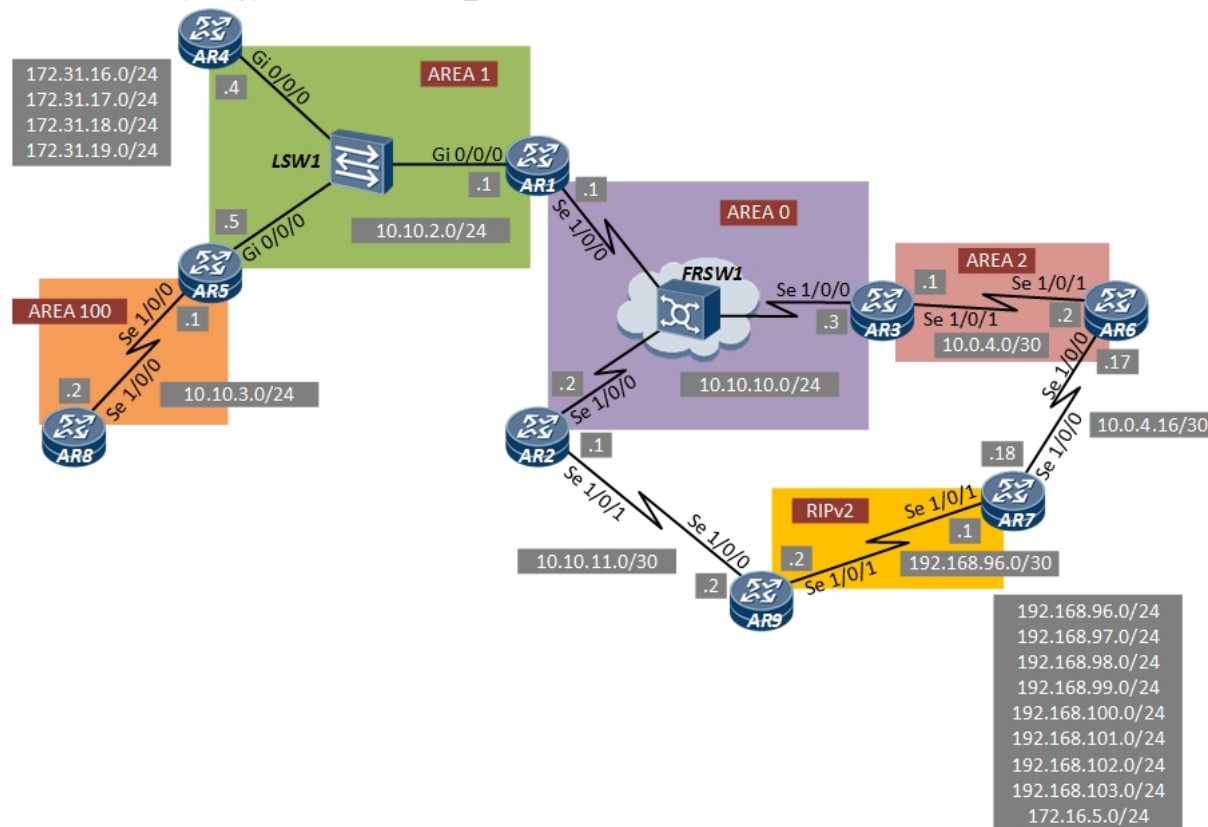
**1.3. MSTP configuration.**

- Configure VLANs 10, 30, 50 in instance 1
- Configure VLANs 20, 40, 60 in instance 2
- Configure LSW1 as root bridge for CIST and MSTI 1, whereas LSW3 backup root bridge for CIST and instance 1.
- Configure LSW3 as root bridge for MSTI 2 and LSW1 as a backup root.
- Configure interfaces GE6/0/0 on AR1 and AR2 to be Alternate ports for all MSTIs. Using only port priority setting.
- Make sure that the direct interfaces between the LSW2 and LW4 are least preferred for path to the root bridge in all MSTIs. Use port cost to accomplish that.

Chapter 2: IGP configuration and features.

Task 2.1: Layer 2 configuration

NOTE: Load topology with name – *IGP_OSPF*



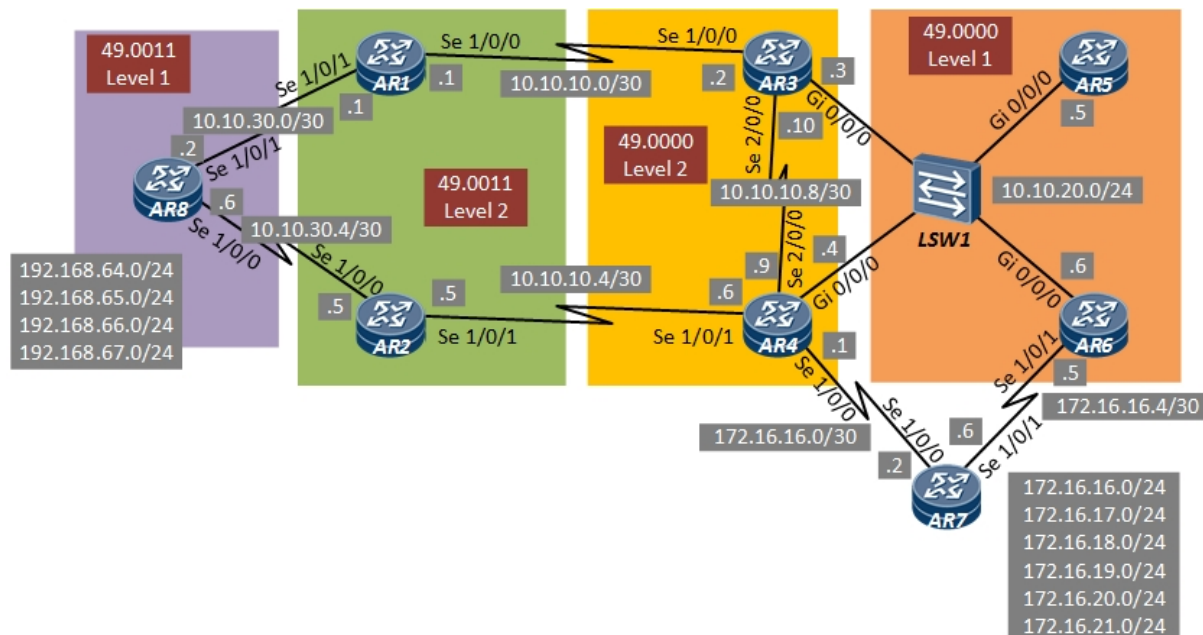
- Configure Frame-Relay encapsulation AR1, AR2 and AR3 Serial1/0/0 interfaces. Disable inverse ARP on AR3 interface.
- Configure static mapping where needed. Do not allow transmitting of broadcast.
- Configure the IP addresses as shown on the diagram.
- Configure GE 0/0/0 interfaces on AR1, AR4 and AR5.
- Use the IP addresses shown on the diagram.
- Configure HDLC encapsulation on the link between AR5 and AR8.
- Use the IP addresses shown on the diagram.
- Configure the serial link between AR3 and AR6 with PPP encapsulation. AR3 should authenticate AR6 using user *lab@huawei* and password *workbook*.
- Configure the IP address as shown on the diagram.
- Configure the link between AR6 and AR7, AR7 and AR9, AR9 and AR2 with IP addresses shown on the diagram using the default link encapsulation.

Task 2.2: OSPF and RIP configuration

- Configure OSPF on AR1, AR2 and AR3 Serial 0/0/0 interfaces in Area 0.
- Configure OSPF on AR1, AR4 and AR5 GE0/0/0 interfaces in Area 1. Make sure that AR1 is DR for the segment, where AR4 is BDR and ensure that AR5 does not participate in the DR election process.
- Configure the Serial link between AR3 and AR6. Make sure that no LSA 4 and LSA 5 types are allowed.
- Configure the serial link between AR5 and AR8 in Area 100.
- Configure RIPv2 on AR2, AR9, AR7 and AR6. Make sure that all subnets are advertised by AR7.
- AR2 and AR6 should send RIP updates only on the interfaces to AR9 and AR7 respectively.
- Redistribute all shown routes as External from AR4 to the OSPF domain.
- Summarise the External routes advertised by AR4 entering Area 0. Make sure that AR5 has only the summary route.
- Advertise all OSPF routes to RIPv2 from AR2 except any routes which start with 172.
- Advertise a default route from AR2 instead.
- Advertise all OSPF routes to RIPv2 domain from AR6.
- Redistribute all RIPv2 routes to OSPF domain on AR2 and AR6.
- Make sure that the direct interface routes on AR2 and AR6 to RIPv2 domain are advertised as internal for the OSPF domain only.
- Configure AR3 to advertise only a summary route of RIP routes to Area 0.
- To avoid load balancing the traffic to the RIP destinations ensure that each router calculates the shortest path based on cost towards the RIP domain.
- Increase the cost of interface Serial 1/0/0 on AR1, AR2 and AR3 with 100.
- Ensure that AR6 prefers the path through AR3 to reach rest of the network.
- Eliminate any potential routing loops in the network.
- You are allowed to use a single command line to accomplish that.
- Configure interface Loopback 100 on AR8 and set IP address 10.10.100.1/24.

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- Assign interface Loopback 100 to Area 100. Ensure that interface route is advertised with correct subnet mask.
- Make sure that all routers can ping the Loopback 100 IP address.

Task 2.2: IS-IS configuration and features.**NOTE:** Load topology with name – *IGP_ISIS*

- Configure the interface with IP addresses shown on the diagram.
- Configure IS-IS adjacency as shown on the diagram. You can use the device number for building the NET.
- Make sure that all Level 2 only Hello messages are authenticated. Use MD5 password *workbook*.
- Configure BFD session detection on the broadcast domain shared by AR3, AR4, AR5 and AR6.
- Configure RIPv2 sessions between AR4 and AR6 to AR7.
- Advertise the routes shown on the diagram (besides AR7) into RIPv2.
- Configure mutual redistribution between IS-IS and RIPv2 domains on AR4 and AR6.
- Make sure that the RIPv2 routes are imported as internal in IS-IS.
- Use route tags to prevent any routing loops between IS-IS and RIPv2 domains.
- Advertise the routes shown on the diagram from AR8 to IS-IS domain.
- Make sure that only summary route 192.168.64.0/22 is advertised to Area 49.0000.

- Ensure that AR8 does not have a default route in the routing table. AR8 must have knowledge of all routes. You are allowed to make changes only on AR1 and AR2 for this requirement.

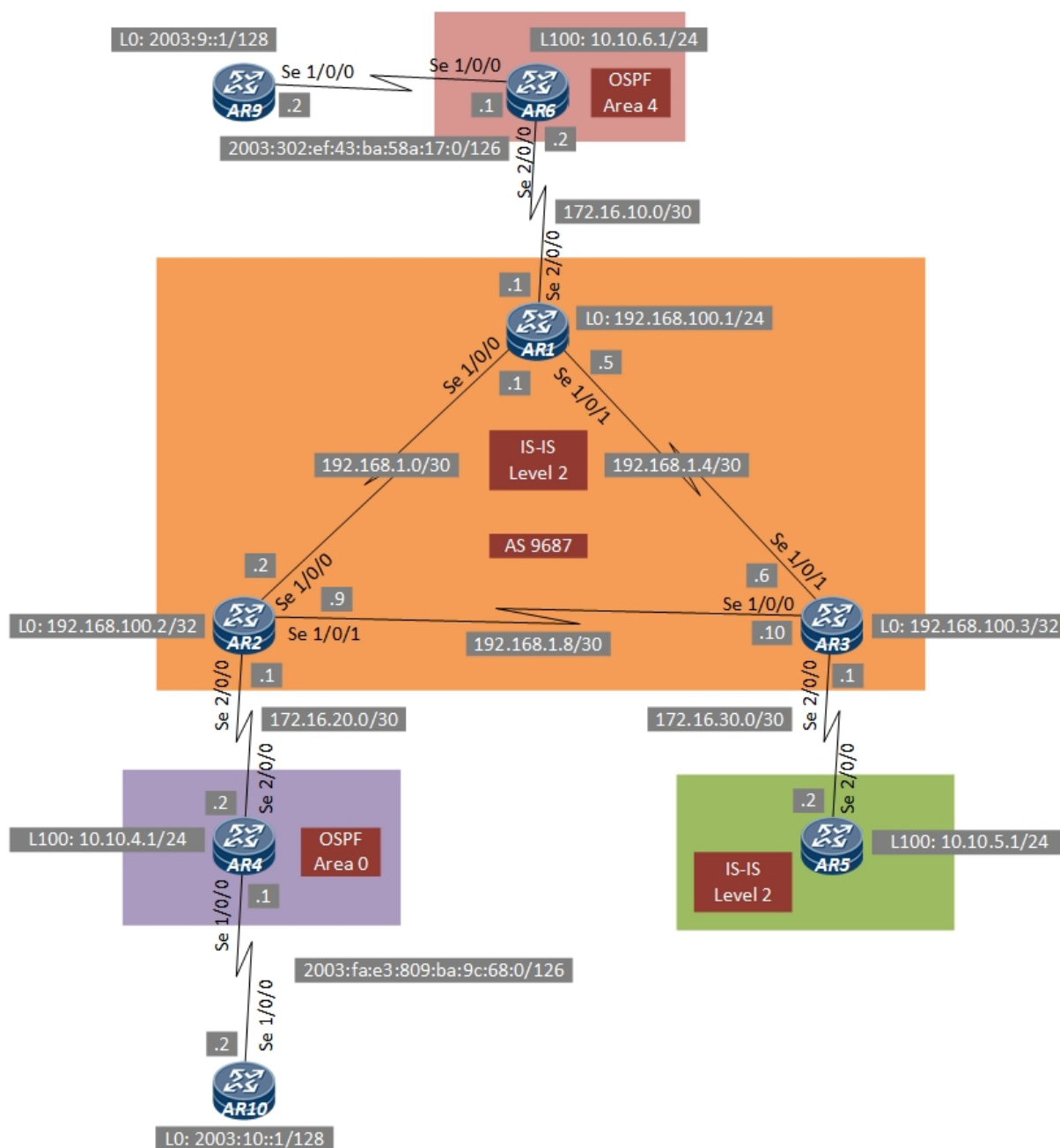
- Configure eBGP sessions between AS 888, AS 2222 and AS 7685. Ensure all eBGP sessions state is logged and communities could be send and received across.
- Configure eBGP sessions between AS 888 and AS 3245. Use two separate sessions with BGP load balancing across both. Enable logging of the state of the sessions. Ensure that 8 routes are received from AS 3245.
- Configure eBGP sessions between AS 2222 and AS 7685 with AS 18234 router AR10. Enable logging of the state of the sessions. Ensure that 8 routes are received from AS 3245.

3.2. BGP route manipulation

- Make sure that AS 18234 routes are advertised to AS 3245 in redundant fashion. To resolve the next-hop addresses in AS 2222 you must not configure anything under bgp configuration mode. To resolve the next-hop addresses in AS 888 you must use configuration only under bgp mode. To provide connectivity through AS 7685 you can configure iBGP session only between AR5 and AR6. Assume that AR7 does not support the BGP protocol.
- Configure AR8 and AR9 to advertise only aggregate route 132.12.12.0/22 and adding *as-set* attribute to the route.
- Make sure that AS 18234 is not transit for routes originated from AS 3245. Use *as-path* attribute to accomplish that.
- Make sure that the summary route originated from AS 2222 is send to AS 3245 without any communities attached. But the route with original community should be present in the AR1 routing table.
- Make sure that AS 2222 receives and send traffic from AR9 when network is fully converged and all links are operational. You are allowed to do changes only on AR8 to accomplish that.
- Prefixes advertised from AS 3245 have set metric of 150. Make sure that AS 7685 prefers to send traffic to AS 3245 via AR4. You are allowed only to change metric BGP attribute on AR2 and AR4.
- Ensure that AR7 can reach routes 132.12.12.0/22 advertised by AR8. AR7 should prefer the shortest path in terms of hop count.

Chapter 4: MPLS and IPv6 configuration and features

NOTE: Load topology with name – *MPLS_IPv6*



4.1. MPLS configuration.

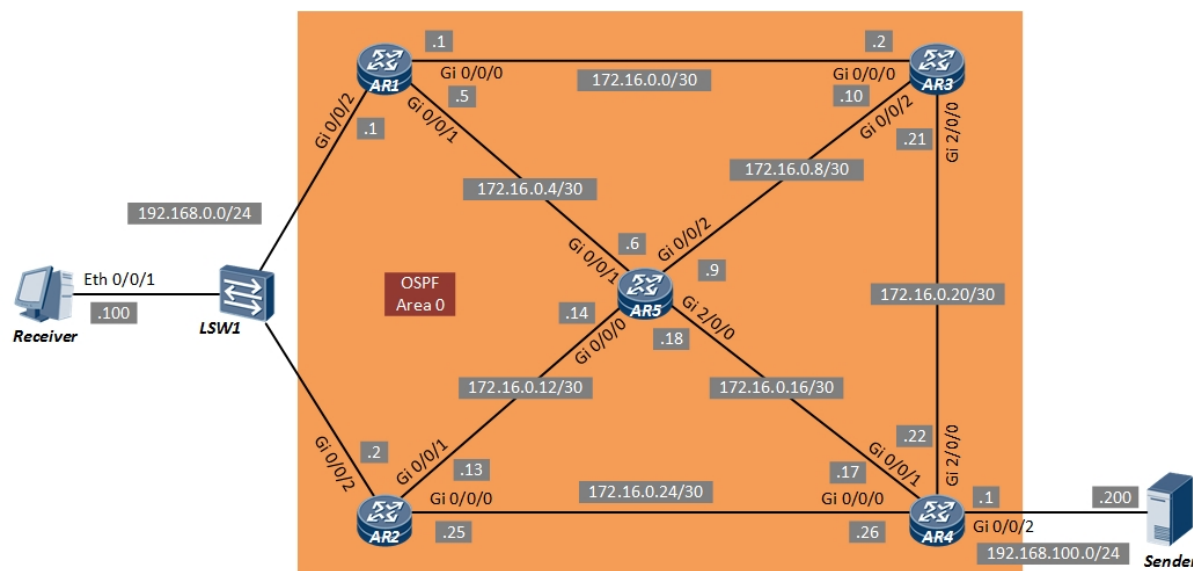
- Configure the interfaces from the diagram with shown IP addresses.
- Configure IS-IS Level 2 routing protocol on routers in AS 9687.
- Enable MPLS protocol across AS 9687. Configure LDP as label distribution protocol.
- Configure full-mesh iBGP across AS 9687. Make sure that BGP supports transport of routes with labels.
- Configure routers AR4, AR5 and AR6 connectivity to the MPLS core network. Use the IP addresses shown on the diagram including interfaces Loopback 100 on each router.
- Configure a L3VPN across the MPLS core network. Use the appropriate pe-ce routing protocol as shown on the diagram. Make sure there is full reachability between the CEs Loopback 100 interfaces.

4.2. IPv6 configuration

- You have to provide connectivity between AR9 and AR10. Configure Manual IPv6 over IPv4 tunnel. Use IPv6 subnet 2003:15::/64 for addresses over the tunnel.
- Configure OSPFv3 across the tunnel connecting the IPv6 islands.
- Configure connectivity to the IPv6 only enabled routers AR9 and AR10. Make sure full reachability is available between the L0 interfaces on AR1 and AR10.

Chapter 5: Multicast configuration and features

NOTE: Load topology with name – *Multicast*



5.1. Multicast configuration.

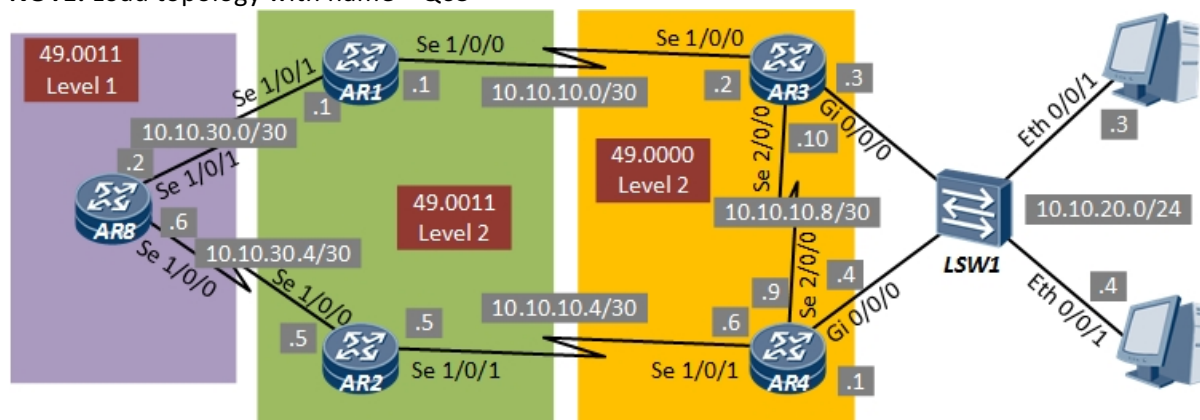
- Configure the interfaces from the diagram with IP addresses shown.
- Configure OSPF routing protocol in Area 0 on all routers.
- Configure PIM sparse mode on all routers.
- Configure the Loopback interfaces from the Table below. Make sure that they are reachable by other routers.

Device name	Loopback 0 IP address	Loopback 10 IP address	Loopback 100 IP address
AR3	172.16.16.3/32	10.1.1.3/32	10.10.10.1/32
AR5	172.16.16.5/32	10.1.1.5/32	10.10.10.1/32

- Configure 10.10.10.1 as Anycast RP for the PIM-SM domain. Use MSDP to accomplish that using the Loopback 10 for peering interface. Other PIM routers should use AR3 and AR5 for BSR for dynamic RP selection.
- Configure IGMP on AR1 and AR2 on the interface towards the Receiver. Make sure that the AR2 is the Designated Router for the segment.
- Configure the Receiver to receive multicast traffic from Sender server. Use multicast group address 239.1.1.1

Chapter 6: Quality of Service

NOTE: Load topology with name – QoS

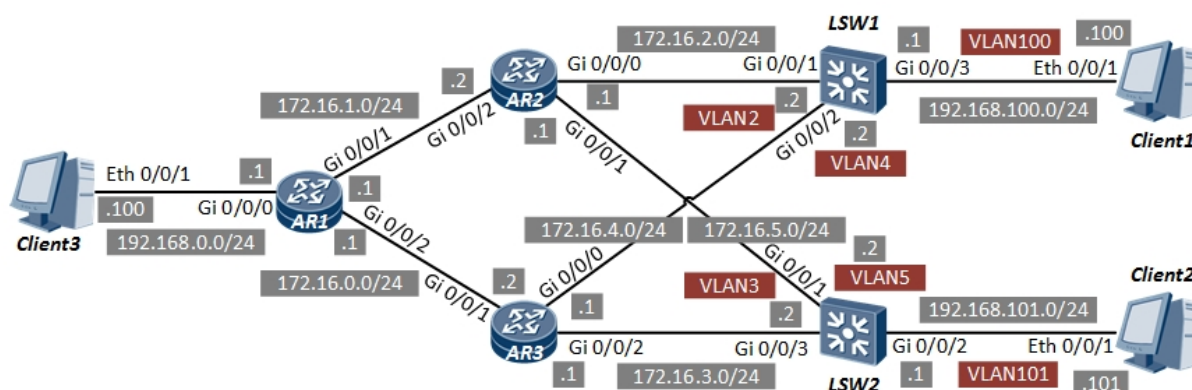


6.1. QoS

- Make sure that LSW1 is preserving the traffic markings send by Client1 and Client2.
- Configure the AR3 to remark traffic DSCP priorities on traffic received from interface GE 0/0/0 to 46. You are not allowed to use traffic policy to accomplish that.
- Configure AR4 to remark the traffic received from Client1 with DSCP value of 46 whereas traffic received from Client2 with DSCP value 23. Ensure traffic statistics are collected for the packets matching the rules.
- Configure traffic policer on WAN interface on AR3 limiting the traffic to the rest of the network to 1500kbps.
- Configure drop profiles with WRED parameters based on DSCP. Configure traffic marked with DSCP 46 with low drop probability, whereas traffic with DSCP 23 with higher drop probability. Configure WFQ scheduler for those two queues. Apply the queue profile on WAN interface on router AR4.
- Use a traffic policy on AR1 and AR2 to restrict the traffic received from Client1 and Client2 in such a way that Client 1 should not be able to send more than 2Mbits and Client2 not more than 1Mbits. Make sure that shaped but not policed.
- To limit the packet discarded over the FR interfaces received from AR5, configure FR shaping to not allow more than 2,5Mbits of traffic send to AR1 and AR2.

Chapter 7: Security and System Management

NOTE: Load topology with name – *Security_IPfeatures*



7.1. IP features

- Configure the interface with the IP addresses as shown on the diagram.
- Configure switches LSW1 and LSW2 to allocate IP addresses on respective segments VLAN100 and VLAN101. Use DHCP protocol to accomplish that task. Client1 and Client2 need fixed addresses allocated by DHCP also.
- Configure static routing to provide full reachability in the network. Use all available links to provide redundancy. Make sure that AR1 use path through AR2 for reaching VLAN100 subnet and AR3 for reaching VLAN101 subnet. For faster detection of link faults use NQA on AR1 to switch over to the redundancy paths.
- Make sure that subnet 192.168.0.0/24 is masked using NAT when sending traffic beyond the AR1 gateway. Ensure that failure of any uplink interface on AR1 would not cause disruption in communication.

7.2. Security

- Configure on all devices users and privileges shown in the table below.

User	Password	Privileges
super	admin123	System maintenance commands
operator	oper123	Configuration and debugging commands

- Make sure that those user can access the devices via Telnet. Ensure that 15 simultaneous Telnet connection are available.
- Configure storm control protecting rest of the network from VLAN100 and VLAN101 excessive broadcast traffic. Limit the broadcast traffic not more than 30 percent from

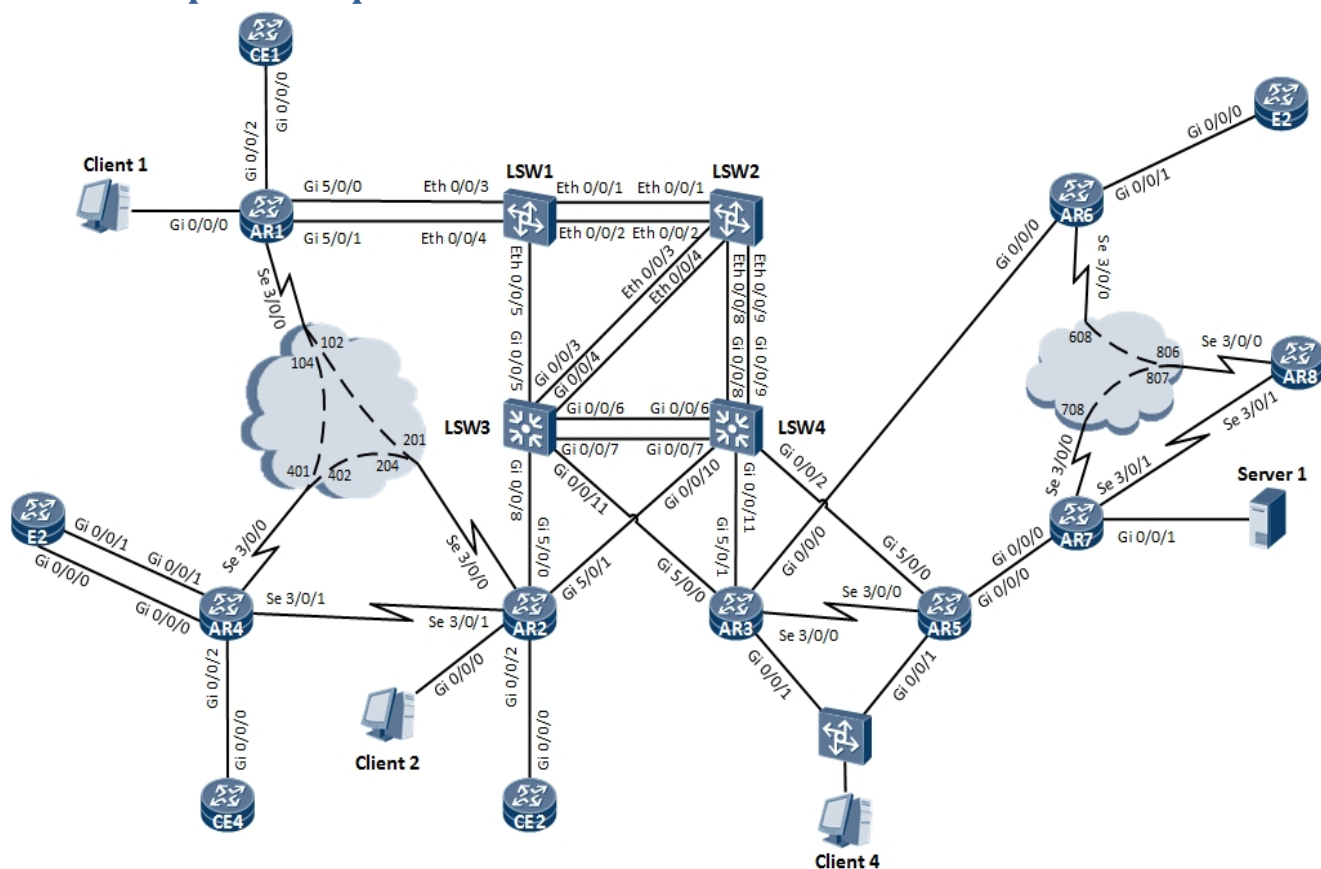
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the bandwidth of the interface. Block the rest of the broadcast traffic received on the interface and log during storm control event.

- Configure strict ARP learning on LSW1 and LSW2 protecting the switch resource for ARP flood attack from VLAN100 and VLAN101. Limit the maximum rate of ARP miss messages to 15 pps.
- Configure IP address spoofing attacks initiated from subnet 192.168.0.0/24. Make sure that there strict interfaces matches.

Chapter 8: Superlab - 8 hour exam



Part 1: L2 switching

8.1. L2 interface configuration and VLAN assignment.

- Configure link aggregation interface between LSW1 and AR1 using both physical interface between them. Make sure that if additional physical interfaces are added will function as backup. LACP keepalive messages should be exchanged every second.

- Create the VLAN as follows on Table 1.

VLAN	Name
600	engineering
610	accounting
620	administration
500	servers
700	terminals
710	users
300	redundant
11	ar1_lsw1
12	lsw1_lsw2
13	lsw1_lsw3
23	lsw2_lsw3
24	lsw2_lsw4
34	lsw3_lsw4
26	ar6_lsw2
32	ar2_lsw3
33	ar3_lsw3
42	ar2_lsw4
43	ar3_lsw4
45	ar5_lsw4
47	ar7_lsw4

- Build the L2 network show on Figure 1. The interface parameters can be found on Table 2.

Device	Interface Name	Interface Type	VLANs
LSW1	Eth-trunk 1	L2, trunk	11
	Eth 0/0/1	L2, trunk	all
	Eth 0/0/2	L2, trunk	all
	Eth 0/0/5	L2, trunk	all
LSW2	Eth 0/0/1	L2, trunk	all
	Eth 0/0/2	L2, trunk	all
	Eth 0/0/3	L2, trunk	all
	Eth 0/0/4	L2, trunk	all
	Eth 0/0/8	L2, trunk	all
	Eth 0/0/9	L2, trunk	300
LSW3	Gi 0/0/3	L2, trunk	all
	Gi 0/0/4	L2, trunk	all
	Gi 0/0/5	L2, trunk	all
	Gi 0/0/6	L2, trunk	all
	Gi 0/0/7	L2, trunk	300
	Gi 0/0/8	L2, trunk	32
	Gi 0/0/9	L2, trunk	33
LSW4	Gi 0/0/2	L2, trunk	45
	Gi 0/0/6	L2, trunk	all

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	Gi 0/0/7	L2, trunk	300
	Gi 0/0/8	L2, trunk	all
	Gi 0/0/9	L2, trunk	300
	Gi 0/0/10	L2, trunk	42
	Gi 0/0/11	L2, trunk	43
AR1	Eth-trunk 1	L2, trunk	11
AR2	Gi 5/0/0	L2, trunk	32
	Gi 5/0/1	L2, trunk	42
AR3	Gi 5/0/0	L2, trunk	33
	Gi 5/0/1	L2, trunk	43
AR5	Gi 5/0/0	L2, trunk	45

- Configure Smart Link on LSW4 for interfaces Eth 0/0/7 and Eth 0/0/9. Make sure that only VLAN 300 is protected and Eth 0/0/7 is master interface. Ensure that master interface stays at least 5 sec. in Down state, only then Smart Link switchover to be performed.

8.2. Spanning Tree configuration.

- Configure LSW1, LSW2 and LSW3 in MSTP region *primary* with two instances. Following VLANs are mapped to each of the instances.

Instance	VLANs
Instance 1	600, 620, 700, 11, 12, 13, 23, 24, 26
Instance 2	610, 500, 710, 32, 33, 34, 42, 43, 45, 47

- Make sure that root bridge for Instance 1 is LSW1, whereas for Instance 2 the root bridge is LSW2. LSW2 must be also nominated for CIST root bridge.
- On LSW1 interface Eth 0/0/2 must be root for Instance 0 and Instance 2.
- On LSW2 interface Eth 0/0/3 and GE 0/0/4 must be blocked for Instance 1.
- On LSW3 interface Gi 0/0/4 must be root for Instances 2.
- Configure Rapid STP on LSW4. Ensure that LSW4 does not become the CIST root bridge.
- Make sure that if superior BPDU message is received from LSW4 to the MST region will not cause root bridge change.

- Ensure that all switching port connected to routers transition immediately to L2 forwarding state.
- Protect the interfaces in the MST region from loops in case of lost BPDUs on the interface.

8.3. L3 interface configuration

1.3.1. L3 address assignment.

- Configure the IP addresses from Table 3.

Device	Interface	IP address
AR1	Serial 3/0/0	10.0.10.1/25
	Vlan11	10.0.30.2/24
	Loopback0	10.0.110.1/32
AR2	Serial 3/0/0	10.0.10.2/25
	Serial 3/0/1	10.0.11.1/30
	Vlan32	10.10.6.2/24
	Vlan42	10.10.7.2/24
	Loopback0	10.0.120.1/32
AR3	Vlan33	10.10.8.2/24
	Vlan43	10.10.9.2/24
	Serial 3/0/0	10.10.10.1/30
	Gi 0/0/0	172.20.1.1/24
	Loopback0	10.0.130.1/32
AR4	Serial 3/0/0	10.0.10.4/25
	Serial 3/0/1	10.0.11.2/30
	Loopback0	10.0.140.1/24
AR5	Vlan45	10.10.11.2/24
	Serial 3/0/0	10.10.10.2/30
	Gi 0/0/0	172.20.2.1/24
	Loopback0	10.0.150.1/24
AR6	Gi 0/0/0	172.20.1.2/24
	Serial 3/0/0.1	172.20.3.1/24
AR7	Gi0/0/0	172.20.2.2/24
	Serial 3/0/0.1	172.20.4.1/24
	Serial 3/0/1	172.20.5.1/24
AR8	Serial 3/0/0.1	172.20.3.2/24
	Serial 3/0/0.2	172.20.4.2/24
	Serial 3/0/1	172.20.5.2/24
	Loopback0	172.20.180.1/24
LSW1	Vlan11	10.0.30.1/24
	Vlan12	10.10.1.1/24
	Vlan13	10.10.2.1/24
	Loopback0	10.0.210.1/24
LSW2	Vlan12	10.10.1.2/24
	Vlan23	10.10.3.1/24
	Vlan24	10.10.5.1/24
	Loopback0	10.0.220.1/24
LSW3	Vlan13	10.10.2.2/24
	Vlan23	10.10.3.2/24
	Vlan34	10.10.4.1/24
	Vlan32	10.10.6.1/24
	Vlan33	10.10.8.1/24
	Loopback0	10.0.230.1/24

LSW4	Vlan34	10.10.4.2/24
	Vlan24	10.10.5.2/24
	Vlan42	10.10.7.1/24
	Vlan43	10.10.9.1/24
	Vlan45	10.10.11.1/24
	Vlan47	172.20.2.1/24
	Loopback0	10.0.240.1/24

8.4. Frame Relay

1.4.1. Frame Relay between AR1, AR2 and AR4.

- Using the physical interfaces configure a full meshed Frame Relay network between AR1, AR2 and AR4.
- Do not use static mapping over these Frame Relay connections.

1.4.2. Frame Relay between AR6, AR7 and AR8.

- Configure Point-to-Point connections between AR6 and AR8, and between AR7 and AR8.
- You are not allowed to use InARP for Layer 3 to Layer 2 mapping.

8.5. PPP and HDLC configuration

1.5.1. PPP connection between AR2 and AR4.

- Configure PPP connection between AR2 and AR4.
- For increased security configure AR4 to issue three-way handshake unidirectional authentication for authenticating AR2 using username *Huawei* and password *workbook*.

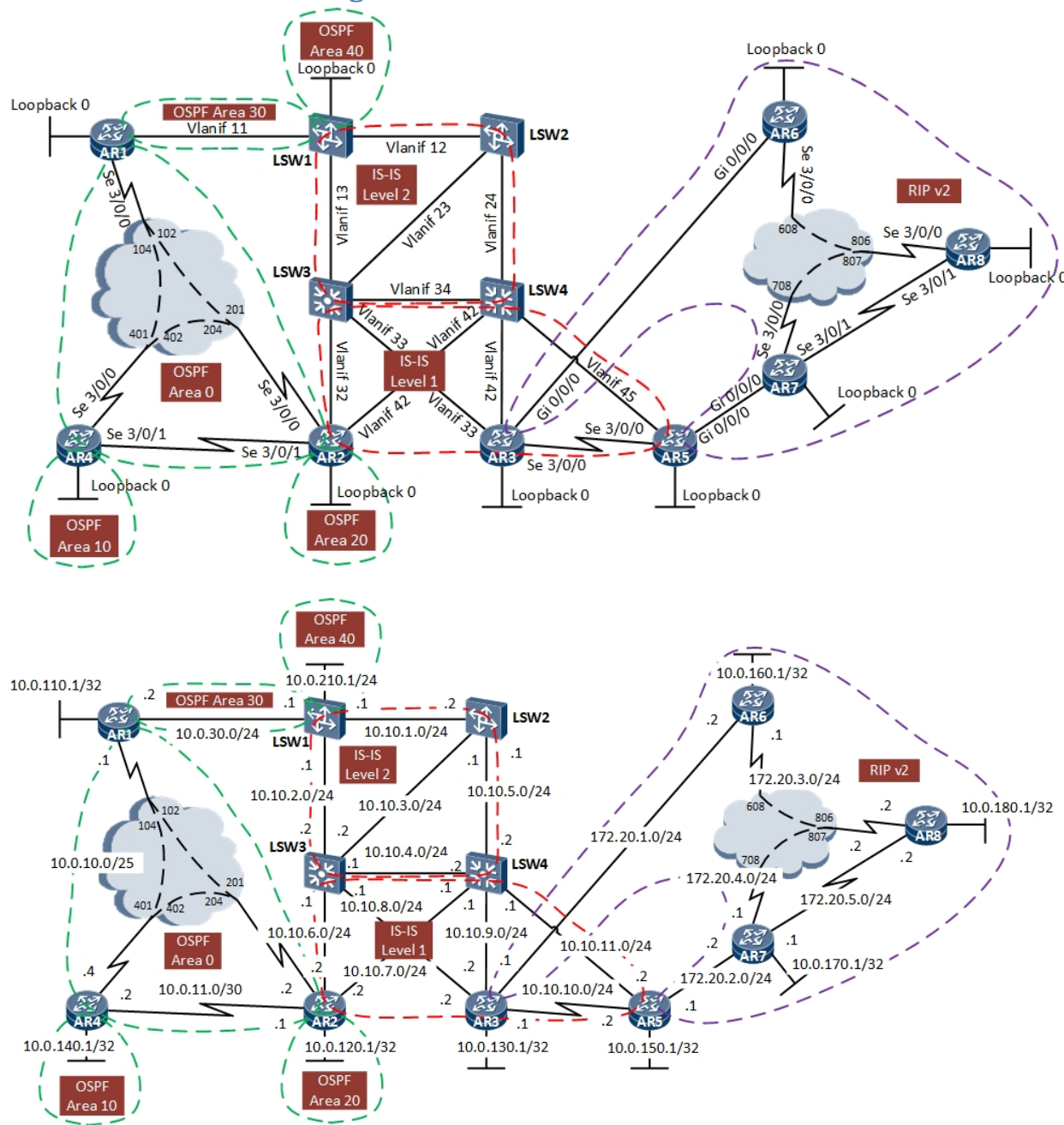
1.5.2. HDLC connection between AR3 and AR5.

- Configure HDLC connection between AR3 and AR5.

1.5.3. PPP connection between AR7 and AR8.

- Configure PPP connection between AR7 and AR8.
- Configure bidirectional PAP authentication using router's usernames and password *security*.

Part 2: IGP Network Configuration and features



2.1. OSPF Area 0

- Configure Area 0 on the Frame Relay connection between AR1, AR2 and AR4.
- No DR and BDR election should be performed.
- You are not allowed to use **peer** command.
- Configure area authentication using md5 encryption with password *workbook*.
- Make sure that Frame-relay subnet is seen on all routers with its correct mask.

2.2. OSPF Area 30 and Area 40

- Configure Area 30 between AR1 and LSW1. Make sure that no LSA4 and LSA5 are present in the OSPF database for Area 30.
- Configure Area 40 on interface Loopback 0 on LSW1. Make sure that Area 40 has reachability with other OSPF areas.
- Advertise Loopback 0 interface of AR1 in such a way that if any AR1 physical interface is down, the Loopback 0 is seen as NSSA route.
- Use IP address of the Loopback interface for an OSPF router-id where applicable.

2.3. OSPF Area 10 and Area 20

- Configure Area 10 and Area 20 for Loopback 0 interfaces on AR4 and AR2 respectively. Those prefixes must enter as Inter Area routes in the OSPF database.
- For security reasons configure OSPF to not send Hello messages on those interfaces.

2.4. IS-IS Level 2

- Configure IS-IS Level 2 adjacencies using Area ID 49.0002 on LSW1, LSW2, LSW3 and LSW4.
- LSW1 and LSW2 must have only Level 2 IS-IS adjacencies.
- Loopback0 subnets of LSW2, LSW3 and LSW4 should be as internal IS-IS routes in the routing table.
- Cost on the interface must be based on the interface bandwidth.
- Configure IS-IS interface MD5 authentication using password *workbook*.

2.5. IS-IS Level 1

- Configure IS-IS Level 1 adjacencies using Area ID 49.0001 on LSW3, LSW4, AR2, AR3 and AR5.
- AR2, AR3 and AR5 must have only Level 1 IS-IS adjacencies.
- Cost on the interface must be based on the interface bandwidth.
- Advertise as external routes the Loopback 0 interfaces of AR3 and AR5. Make sure that the /24 subnet is only advertised.

2.6. RIPv2 domain.

- Configure RIPv2 protocol on AR3, AR5, AR6, AR7 and AR8.
- Make sure that AR3 and AR5 send RIPv2 updates only on Gi0/0/0 interfaces. You must just single 'silent-interface' command to accomplish that.
- PPP interface between AR7 and AR8 should function as backup link in case of Frame Relay failure.

2.7. Redistribution between OSPF and IS-IS

- Make sure that OSPF domain has full reachability with rest of the network. Configure mutual redistribution between OSPF and IS-IS routing protocols. Make sure that all routes are redistributed.
- Use route tags to resolve any route loops.

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- A failure of AR2 should not limit the reachability to OSPF domain.
- Ensure that IS-IS Level 1 domain devices can make optimal decision for the routes from OSPF domain. No default routes must be learned from IS-IS Level-1-2 routers.

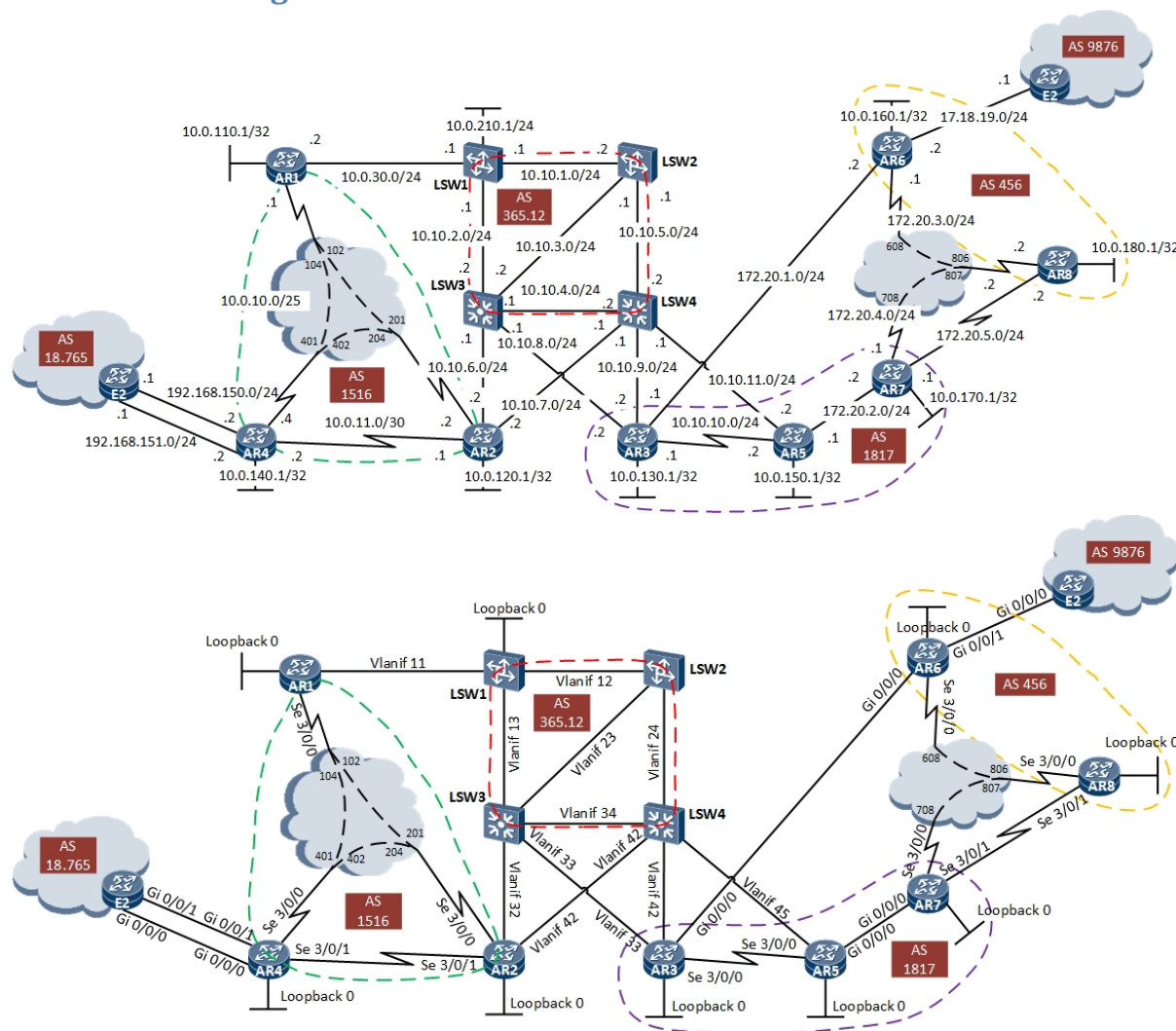
2.8. Redistribution between IS-IS and RIPv2

- Redistribute only single default route from IS-IS domain to RIPv2. You may configure a single static route to accomplish that task.
- IS-IS routers should have every single RIPv2 in the routing table.
- Be sure that no routing loops are present in IS-IS domain. You are not allowed to use route tags. Any changes should affect only 172.20/16 subnets.

2.9. General requirements

- You are not allowed to use static routes if explicitly stated.
- Full reachability and loop free connectivity should be achieved.

Part 3: BGP configuration and features



3.1. Configure the following AS numbers on the devices in following table.

Device	AS number
AR1	1516
AR2	1516
AR3	1817
AR4	1516
AR5	1817
AR6	456
AR7	1817
AR8	456
LSW1	365.12
LSW2	365.12
LSW3	365.12
LSW4	365.12

3.2. Configure the BGP peering sessions as shown in the following table.

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Peer 1	Peer 2	Peering interface
AR1	LSW1	Loopback0
AR1	AR4	Loopback0
AR1	AR2	Loopback0
AR2	AR4	Loopback0
AR2	LSW3	Loopback0
AR2	LSW4	Loopback0
AR2	AR3	Loopback0
AR3	LSW3	Direct
AR3	LSW4	Direct
AR3	AR5	Loopback0
AR3	AR7	Loopback0
AR3	AR6	Direct
AR4	E1	Loopback0
AR5	AR7	Loopback0
AR6	AR7	Loopback0
AR6	AR8	Loopback0
AR6	E2	Direct
LSW1	LSW2	Loopback0
LSW1	LSW3	Loopback0
LSW1	LSW4	Loopback0

- Configure LSW1 as Route Reflector for LSW2, LSW3 and LSW4 BGP routers. Make sure that the BGP sessions are authenticated with md5 password *workbook*.
- All iBGP routes in any AS should have local address for next-hop attribute.
- Configure additional interfaces on AR4 and AR6 for the peering sessions with E1 (AS18.765) and E2(9876). Following table contents the additional interface information.

Device	Interface	IP address
AR4	Gi 0/0/0	192.168.150.2/24
	Gi 0/0/1	192.168.151.2/24
AR6	Gi 0/0/1	17.18.19.2/24
E1	Gi 0/0/0	192.168.150.2/24
	Gi 0/0/1	192.168.151.2/24
	Loopback 0	15.15.15.15/32

- You are allowed to use a static route for the peering session between E1 and AR4.

3.3. BGP route manipulation

- Configure AR4 and AR6 to set different communities on the routes received from E1 (1516:1) and E2(456:1).
- Advertise a summary route 10.0.0.0/16 from AR2 and AR5. Make sure that summary route is advertised to E2 by AR6 even if the link to AR3 is down.
- Ensure that LSW1 is not receiving that summary route from AR1. This configuration should be done only on AR2.
- Advertise to E1 only routes marked with community 456:1. Make sure that the summary route 10.0.0.0/16 match that requirement and is sent to E1.
- Route 75.75.0.0/24 must be excluded from the routes sent to E1. This configuration should not be done on AR4.
- Make sure that AR2 is the preferred exit point from AS1615. Traffic coming to E1 through the AS1615 should prefer AR2. This configuration should be done on AR4.
- Ensure that the peering session between AR2 and AR3 is not established when the interfaces of AR2 to AS365.12 are down. In such cases E2 routes should not be advertised to E1.
- AS365.12 should send traffic to AR2 over the link from LSW4. Use the BGP attribute with the highest priority. This configuration should be done on AR2.
- Make sure that AS365.12 prefer to send traffic to AR3 from LSW4. Ensure that change affects only traffic through AS365.12 and is performed on AR3.

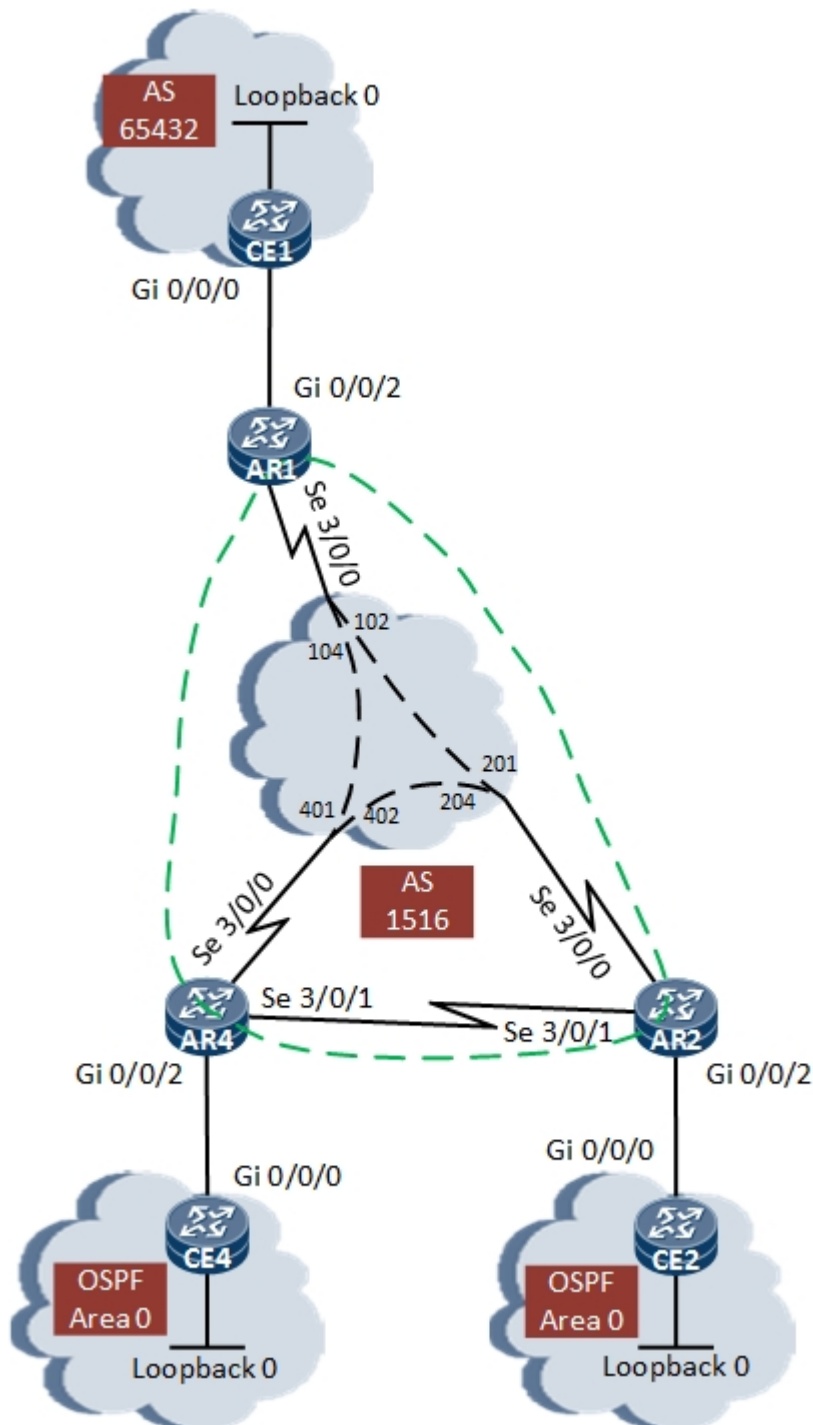
3.4. General requirements

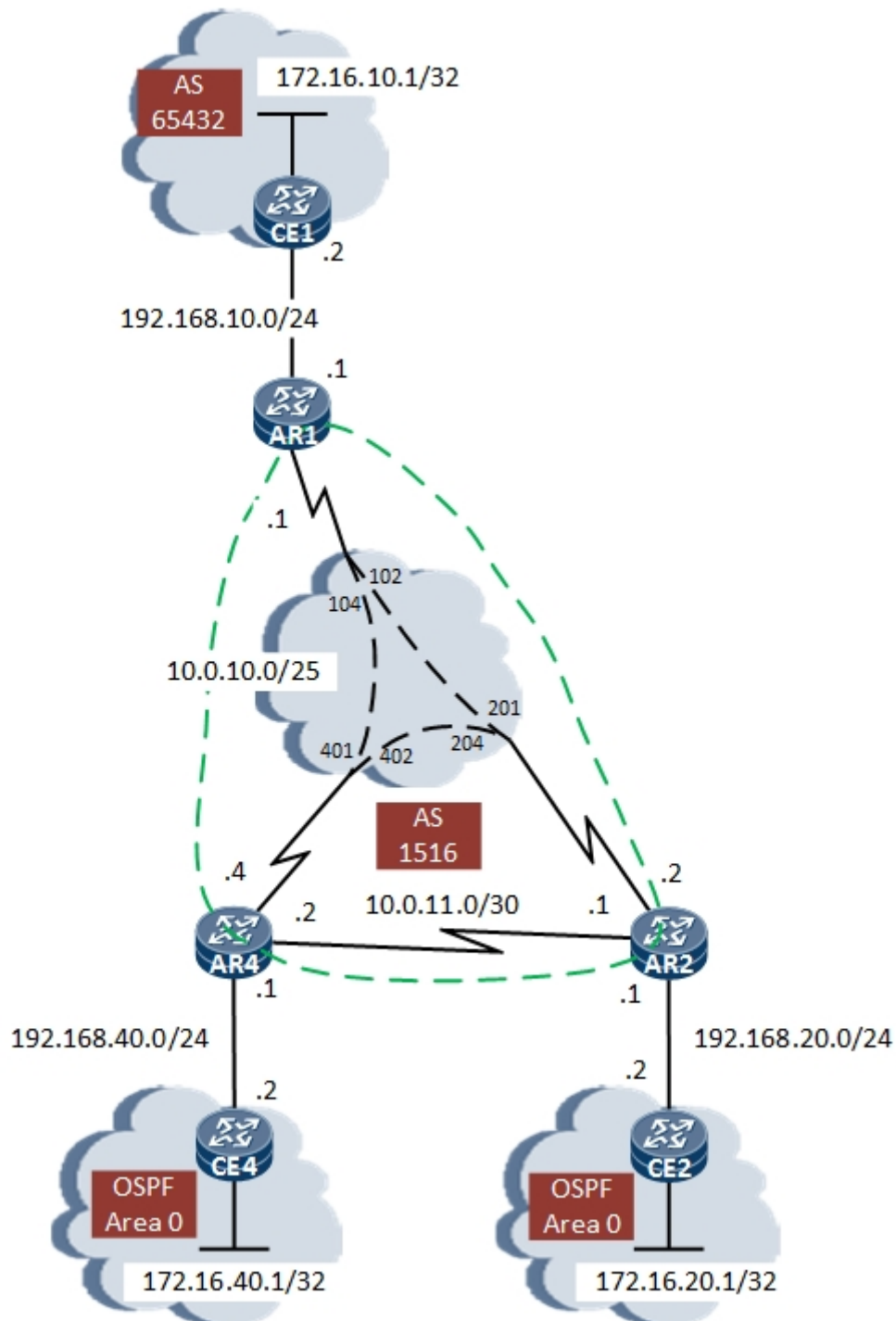
- You should provide two way IP reachability between E1 and E2 Loopback100 interfaces. You are allowed to use only user-view commands on those two devices.
- You are not allowed to use static routes if it is not explicitly allowed.

Part 4: MPLS and IPv6 services

4.1. MPLS service configuration

- Configure MPLS L3VPN service as show on the diagram below:





- Configure the additional interfaces as described in the table below.

Device	Interface	IP address	Peer IP address
AR1	Gi 0/0/2	192.168.10.1/24	192.168.10.2
AR2	Gi 0/0/2	192.168.20.1/24	192.168.20.2
AR4	Gi 0/0/2	192.168.40.1/24	192.168.40.2

- Configure LDP as the label distribution protocol. Ensure that all PE routers accept only labels for /32 routes.
- Configure L3VPN service with name *Customer-1*. Ensure full reachability between all three CE routers.
- Use eBGP as PE-CE routing protocol on AR1.
- Assume that CE2 and CE4 do not supporting BGP, therefor OSPF should be used as the PE-CE routing protocol from AR2 and AR4 to CE2 and CE4.
- Make sure that CE2 and CE4 have only External OSPF routes in the routing table.

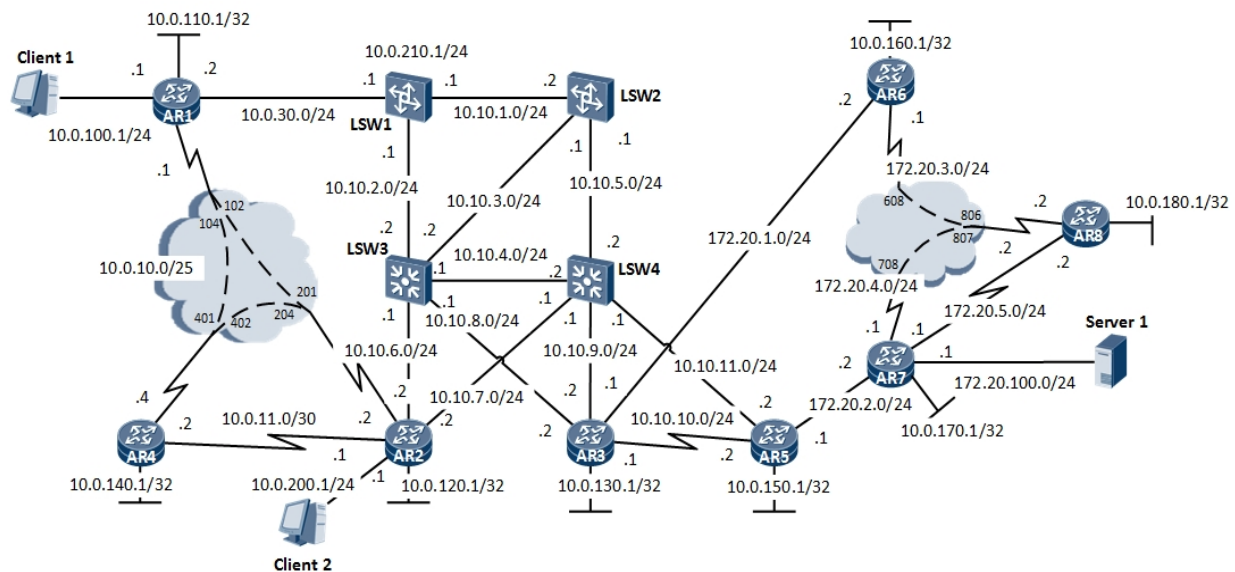
4.2. IPv6 service configuration

- Configure Automatic IPv6 tunnel to provide connectivity between the IPv6 networks through the IPv4 backbone.
- Make sure that tunnel stays connected if any of direct interfaces on AR3 or AR8 goes down.
- You must configure BGP to verify the connectivity between IPv6 islands.

4.3. General requirements

- You should provide two way IP reachability between all CE routers. You are allowed to use only user-view commands on those two devices.
- You are not allowed to use static routes if it is not explicitly allowed.

Part 5: Multicast



4.4. PIM configuration

- Configure IP multicast routing on AR1, AR2, AR4, AR5 and AR7.
- Configure two PIM domains – PD1 and PD2. Enable PIM sparse mode as described in the table below:

Domain	Device	Interface
PD1	AR1	Serial 3/0/0
	AR2	Serial 3/0/0
	AR2	Tunnel 0/0/0
	AR4	Serial 3/0/0
PD2	AR5	Gi 0/0/0
	AR5	Tunnel 0/0/0
	AR7	Gi 0/0/0

- Configure a GRE tunnel between AR2 and AR5 for interconnecting both PIM domains. Make sure that the boundary between the PIM domains is that tunnel. Use subnet 3.3.3.0/24 for IP addresses on the tunnel interfaces.

- Configure additional interfaces for the multicast Server1 and both multicast Clients. Use the data from the table below:

Device	Interface	IP address
AR1	Gi 0/0/0	10.0.100.1/24
AR4	Gi 0/0/0	10.0.200.1/24
AR5	Gi 0/0/1	172.20.100.1/24

- Following multicast hosts are preconfigured and connected to the network. Make sure that direct attached routers are configured appropriately to provide multicast service to respected hosts.

Host	IP address	Multicast Grop
SERVER1	172.20.100.100	(172.20.100.100 , 239.49.39.1)
CLIENT1	10.0.100.100	(172.20.100.100 , 239.49.39.1)
CLIENT2	10.0.200.100	(* , 239.49.39.1)

- Configure additional Loopback interfaces on AR2 and AR5 dedicated for multicast RP.

Device	Interface	IP address
AR2	Loopback 100	1.1.1.1/32
AR5	Loopback 100	2.2.2.2/32

- You may use static routes to provide routing between both PIM domains through the GRE interface. Use the respected routing protocol inside the domains.
- For PD1 use BSR election for configuring RP. Configure IP address 1.1.1.1 on AR2 as candidate RP, and AR4 for candidate BSR.
- For PD2 configure IP address 2.2.2.2 for RP on AR5 and AR7.
- Configure additional protocols if needed to provide multicast connectivity between the source on SERVER1 and both receivers.

4.5. General Multicast configuration

- Make sure that AR7 accepts multicast packets from source SERVER1 only and the multicast source lifetime is set to 10min.
- Configure AR1 and AR2 to stay on the tree through the RP until the traffic rate from the source is less than 3072kbit/s. This configuration should affect only traffic to group 239.49.39.1

4.6. General requirements

- You are not allowed to use static routes if it is not explicitly allowed.

Part 6: Quality of Service (QoS)

6.1. Frame Relay QoS

- Frame Relay PVCs purchased from the provider for connectivity between AR1, AR2 and AR4 can transmit up to 384Kbit/s of traffic. Make sure that AR1, AR2 and AR4 are not allowed to transmit more than the purchased bandwidth.
- Configure the CIR between AR1, AR2 and AR4 to 256Kbit/s.
- Make sure that if the output queue reaches length of 20 packets the transmission rate of the PVC is reduced to limit the packet loss.

6.2. Layer 2 QoS configuration

- Configure LSW1 and LSW2 to classify and remark the traffic based on the table below.

Device	VLANs	802.1p
LSW1	500	5
	600	6
	710	7
LSW2	500	5
	600	6
	710	7

- Make sure that the traffic marked with 802.1p of 5 is transmitted with priority on all interfaces to LSW3 and LSW4. Configure those interfaces for Weighted Round Robin scheduling using the information from the table below.

VLANs	Weight
500	PQ
600	40
710	20

- Traffic coming down from LSW1 and LSW2 is causing a congestion on LSW3 and LSW4. Classify, policy and remark the traffic coming to LSW3 and LSW4 according the table below. Ensure that you based your classification on both VLAN and 801.2p.

VLAN	802.1p marking	CIR (kbit/s)	PIR (kbit/s)	DSCP remarking
500	5	7000	20000	10
600	6	4000	10000	30
710	7	5000	10000	38

6.3. Layer 3 QoS configuration

- Limit the rate of traffic from each IP address sourced from 75.75.75.0/24 to 128kbit/s to E1. Make sure that single IP could not exceed that limit.
- Configure all other subnets advertised to E1 to not exceed 200mbit/s of traffic. Ensure that up to twice of this rate could be reached in case of high traffic demand.
- To limit the congestion on interfaces connecting CE1, CE2 and CE4, configure the bandwidth restrictions following the table below:

DSCP Value	Queue Number	Scheduling Method	Drop Method
10	7	PQ	Tail Drop
30	6	WFQ	WRED: 90% Upper drop 50% Lower drop 15% Drop Probability
38	5	WFQ	WRED: 70% Upper drop 30% Lower drop 20% Drop Probability
28	5	WFQ	WRED: 60% Upper drop 20% Lower drop 30% Drop Probability

Part 7: Security and Management features

7.1. Layer 2 security features

- Hosts connected to interfaces from Ethernet 0/0/15 to 0/0/20 on LSW1 and LSW2 should be authenticated before they get access to the network. Assign those interfaces to VLAN 900.
- Assume that RADIUS server is available with IP address 192.168.90.9 with pre-shared key *workbook*. Make sure that the authentication is done against that RADIUS server. To successful authenticate the host must use username ending with @lab1.
- Ensure that devices, which need access to the network but cannot provide credentials (link printers) are not restricted.

7.2. Device user and management access.

- Configure on all devices users and privileges shown in the table below.

User	Password	Privileges
super	admin123	System maintenance commands
operator	oper123	Configuration and debugging commands

- Make sure that those user can access the devices via SSH.

7.3. L3 security and NAT configuration.

- Configure the additional interface described in the Table below.

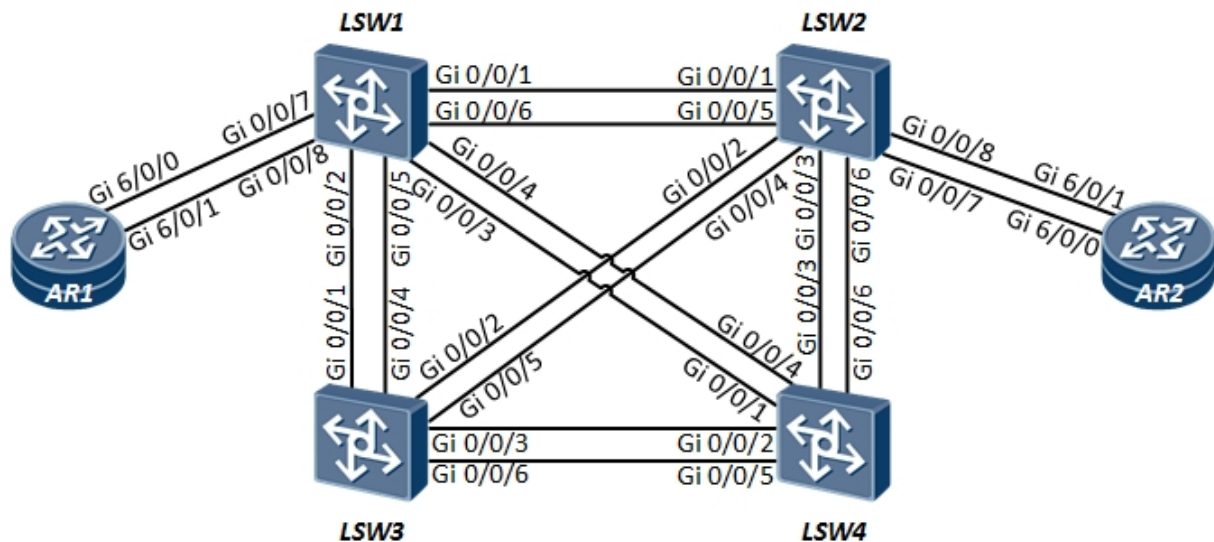
Device	Interface	IP Address
AR3	GE0/0/1	192.168.1.1/24
AR5	GE0/0/1	192.168.1.129/24

- Configure VRRP in load balancing mode across AR3 and AR5 using virtual IP addresses 192.168.1.100 and 19.68.1.200 respectively. Make sure that when mater is returned to service a delay of 30 sec. is configured.
- Configure AR3 and AR5 to provide statefull address assignment through DHCP protocol on interface GE0/0/1.
- Configure the DHCP server in a way to support the load balancing configuration.
- Ensure that configuration prevents conflict of IP addresses. You are not allowed to use **exclude-ip-address** option.
- Make sure that the traffic send from subnet 192.168.1.0 to prefix 143.25.64.0/21 is translated to the interface IP address.

APPENDIX - Chapter Solutions

Chapter 1: L2 connectivity and features - solutions

Note: Load topology with name – *L2Switching_STP*



Link Aggregation

Manual mode

Configure Manual mode Link Aggregation between AR1 and LSW1. Bond interface GE6/0/0 and GE6/0/1 on AR1 with interface GE0/0/7 and GE0/0/8 on LSW1:

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]interface Eth-Trunk 1

[AR1-Eth-Trunk1]trunkport GigabitEthernet 6/0/0 to 6/0/1
```

LSW1:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]interface Eth-Trunk 1

[LSW1-Eth-Trunk1]trunkport GigabitEthernet 0/0/7 to 0/0/8
```

Verify the configuration:

AR1:

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```
<AR1>display interface Eth-Trunk1
Eth-Trunk1 current state : UP
Line protocol current state : UP
Description:HUAWEI, AR Series, Eth-Trunk1 Interface
Switch Port, PVID : 1, TPID : 8100(Hex), Hash arithmetic : According to SA-XOR
-DA,Maximal BW: 2G, Current BW: 2G, The Maximum Frame Length is 1628
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 00e0-fc79-2b0c
Current system time: 2015-11-20 07:52:03-08:00
Input: 146 packets, 17958 bytes
  Unicast:      0, Multicast:      146
  Broadcast:    0, Discard:        0
  Total Error:  0

Output: 344 packets, 40936 bytes
  Unicast:      0, Multicast:      344
  Broadcast:    0, Discard:        0
  Total Error:  0

  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%

-----
PortName           Status    Weight
-----
GigabitEthernet6/0/0    UP        1
GigabitEthernet6/0/1    UP        1
-----

The Number of Ports in Trunk : 2
The Number of UP Ports in Trunk : 2
```

LSW1:

```
<LSW1>display interface Eth-Trunk1
Eth-Trunk1 current state : UP
Line protocol current state : UP
Description:
Switch Port, PVID : 1, Hash arithmetic : According to SIP-XOR-DIP,Maximal BW:
4294967.29G, Current BW: 4294967.29G, The Maximum Frame Length is 9216
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 4c1f-ccaf-a9a9
Current system time: 2015-11-20 01:53:17-08:00
  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%

-----
PortName           Status    Weight
-----
GigabitEthernet0/0/7    UP        1
GigabitEthernet0/0/8    UP        1
-----

The Number of Ports in Trunk : 2
The Number of UP Ports in Trunk : 2
```

Link Aggregation in LACP mode

Configure LACP mode Link Aggregation between AR2 and LSW3. Bond interface GE6/0/0 and GE6/0/1 on AR2 with interface GE0/0/7 and GE0/0/8 on LSW3:

AR2:

```

<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]interface Eth-Trunk 1

[AR2-Eth-Trunk1]mode lacp-static

[AR2-Eth-Trunk1]quit

[AR2]interface GigabitEthernet 6/0/0

[AR2-GigabitEthernet6/0/0]eth-trunk 1
Info: This operation may take a few seconds. Please wait for a moment...
Error: Failed to add the port into the trunk because the port has been a member o
f the trunk.done.

[AR2-GigabitEthernet6/0/0]quit

[AR2]interface GigabitEthernet 6/0/0

[AR2-GigabitEthernet6/0/1]eth-trunk 1
Info: This operation may take a few seconds. Please wait for a moment...
Error: Failed to add the port into the trunk because the port has been a member o
f the trunk.done.

```

LSW3:

```

<LSW3>system-view
Enter system view, return user view with Ctrl+Z.

[LSW3]interface Eth-Trunk 1

[LSW3-Eth-Trunk1]mode lacp-static

[LSW3-Eth-Trunk1]quit

[LSW3]interface GigabitEthernet 0/0/7

[LSW3-GigabitEthernet0/0/7]eth-trunk 1
Info: This operation may take a few seconds. Please wait for a moment...
Error: Failed to add the port into the trunk because the port has been a member o
f the trunk.

[LSW3-GigabitEthernet0/0/7]quit

[LSW3]interface GigabitEthernet 0/0/8

[LSW3-GigabitEthernet0/0/8]eth-trunk 1
Info: This operation may take a few seconds. Please wait for a moment...
Error: Failed to add the port into the trunk because the port has been a member o
f the trunk.

```

Verify the configuration:

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AR2:

```

<AR2>display interface Eth-Trunk1
Eth-Trunk1 current state : UP
Line protocol current state : UP
Description:HUAWEI, AR Series, Eth-Trunk1 Interface
Switch Port, PVID : 1, TPID : 8100(Hex), Hash arithmetic : According to SA-XOR
-DA,Maximal BW: 2G, Current BW: 2G, The Maximum Frame Length is 1628
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 00e0-fcc2-64f3
Current system time: 2015-11-20 22:58:38-08:00
Input: 52081 packets, 6423423 bytes
  Unicast:      0, Multicast:      52081
  Broadcast:    0, Discard:        0
  Total Error:  0

Output: 32011 packets, 3838619 bytes
  Unicast:      0, Multicast:      32011
  Broadcast:    0, Discard:        0
  Total Error:  0

  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%
-----
PortName          Status    Weight
-----
GigabitEthernet6/0/0    UP        1
GigabitEthernet6/0/1    UP        1
-----
The Number of Ports in Trunk : 2
The Number of UP Ports in Trunk : 2

<AR2>display lacp statistics eth-trunk
Eth-Trunk1's PDU statistic is:
-----
Port          LacpRevPdu  LacpSentPdu  MarkerRevPdu  MarkerSentPdu
GigabitEthernet6/0/0  1746      2930        0             0
GigabitEthernet6/0/1  1746      2930        0             0

```

LSW3:

```

<LSW3>display interface Eth-Trunk1
Eth-Trunk1 current state : UP
Line protocol current state : UP
Description:
Switch Port, PVID : 1, Hash arithmetic : According to SIP-XOR-DIP,Maximal BW:
4294967.29G, Current BW: 4294967.29G, The Maximum Frame Length is 9216
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 4c1f-cc73-2fd9
Current system time: 2015-11-20 17:01:02-08:00
  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%
-----
PortName          Status    Weight
-----
GigabitEthernet0/0/7    UP        1
GigabitEthernet0/0/8    UP        1
-----

```

The Number of Ports in Trunk : 2
 The Number of UP Ports in Trunk : 2

<LSW3>**display lacp statistics eth-trunk 1**

Eth-Trunk1's PDU statistic is:

```
-----
Port          LacpRevPdu  LacpSentPdu  MarkerRevPdu  MarkerSentPdu
GigabitEthernet0/0/7  3435973836  3435973836  3435973836  3435973836
GigabitEthernet0/0/8  3435973836  3435973836  3435973836  3435973836
```

STP features and settings.

RSTP timers.

Configure all LSW devices for RTSP and verify which device has the role of root bridge. Disable the STP on AR routers.

LSW1:

[LSW1]**stp mode rstp**

Info: This operation may take a few seconds. Please wait for a moment...done.

[LSW1]**interface Eth-Trunk 1**

[LSW1-Eth-Trunk1]**stp disable**

LSW2:

[LSW2]**stp mode rstp**

Info: This operation may take a few seconds. Please wait for a moment...done.

[LSW2]

LSW3:

```
[LSW3]stp mode rstp
Info: This operation may take a few seconds. Please wait for a moment...done.

[LSW3]interface Eth-Trunk 1

[LSW3-Eth-Trunk1]stp disable
```

LSW4:

```
[LSW4]stp mode rstp
Info: This operation may take a few seconds. Please wait for a moment...done.
[LSW4]
```

Verify the configuration:

LSW1:

```
<LSW1>display stp
-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :32768.4c1f-ccaf-a9a9
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :32768.4c1f-cc21-760d / 1
CIST RegRoot/IRPC :32768.4c1f-ccaf-a9a9 / 0
CIST RootPortId  :128.2
BPDU-Protection  :Disabled
TC or TCN received :265
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:7m:14s
Number of TC      :97
Last TC occurred  :GigabitEthernet0/0/6
```

LSW2:

```
<LSW2>display stp
-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :32768.4c1f-cc21-760d
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :32768.4c1f-cc21-760d / 0
CIST RegRoot/IRPC :32768.4c1f-cc21-760d / 0
CIST RootPortId  :0.0
BPDU-Protection  :Disabled
TC or TCN received :205
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:7m:37s
Number of TC      :96
Last TC occurred  :GigabitEthernet0/0/2
```

<LSW2>**display stp brief**

MSTID	Port	Role	STP State	Protection
0	GigabitEthernet0/0/1	DESI	FORWARDING	NONE
0	GigabitEthernet0/0/2	DESI	FORWARDING	NONE
0	GigabitEthernet0/0/3	DESI	FORWARDING	NONE
0	GigabitEthernet0/0/4	DESI	FORWARDING	NONE
0	GigabitEthernet0/0/5	DESI	FORWARDING	NONE
0	GigabitEthernet0/0/6	DESI	FORWARDING	NONE

LSW3:

<LSW3>**display stp**

```

-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :32768.4c1f-cc73-2fd9
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :32768.4c1f-cc21-760d / 1
CIST RegRoot/IRPC :32768.4c1f-cc73-2fd9 / 0
CIST RootPortId  :128.2
BPDU-Protection  :Disabled
TC or TCN received :765
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:7m:19s
Number of TC      :102
Last TC occurred  :GigabitEthernet0/0/5

```

LSW4:

<LSW4>**display stp**

```

-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :32768.4c1f-cc3a-edf3
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :32768.4c1f-cc21-760d / 1
CIST RegRoot/IRPC :32768.4c1f-cc3a-edf3 / 0
CIST RootPortId  :128.2
BPDU-Protection  :Disabled
TC or TCN received :503
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:7m:31s
Number of TC      :101
Last TC occurred  :GigabitEthernet0/0/1 1

```

Root bridge configuration

Configure LSW1 as a primary root bridge and LSW3 as a secondary.

LSW1:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]stp root primary
```

LSW3:

```
<LSW3>system-view
Enter system view, return user view with Ctrl+Z.

[LSW3]stp root secondary
Verify the configuration:
```

LSW1:

```
<LSW1>display stp
-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :0 4c1f-ccaf-a9a9
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :0 4c1f-ccaf-a9a9 / 0
CIST RegRoot/IRPC :0 4c1f-ccaf-a9a9 / 0
CIST RootPortId  :0.0
BPDU-Protection  :Disabled
CIST Root Type    :Primary root
TC or TCN received :267
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:5m:4s
Number of TC      :103
Last TC occurred  :GigabitEthernet0/0/1
```

LSW3:

```
<LSW3>display stp
-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :4096.4c1f-cc73-2fd9
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :0.4c1f-ccaf-a9a9 / 1
CIST RegRoot/IRPC :4096.4c1f-cc73-2fd9 / 0
CIST RootPortId  :128.1
BPDU-Protection  :Disabled
CIST Root Type   :Secondary root
TC or TCN received :792
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:10m:20s
Number of TC     :108
Last TC occurred  :GigabitEthernet0/0/6
```

STP timers and parameters.

Limit the RSTP diameter to 4.

All LSW devices

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]stp bridge-diameter 4
```

Configure the time whether the received BPDU expires to 10s.

Configure the forwarding-delay timer to 4s.

All LSW devices:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]stp timer max-age 1000

[LSW1]stp timer forward-delay 400
```


Verify the configuration:

LSW1:

```
<LSW1>display stp
-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :0 .4c1f-ccaf-a9a9
Config Times     :Hello 2s MaxAge 10s FwDly 4s MaxHop 20
Active Times     :Hello 2s MaxAge 10s FwDly 4s MaxHop 20
CIST Root/ERPC   :0 .4c1f-ccaf-a9a9 / 0
CIST RegRoot/IRPC :0 .4c1f-ccaf-a9a9 / 0
CIST RootPortId  :0.0
BPDU-Protection  :Disabled
CIST Root Type   :Primary root
TC or TCN received :271
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:35m:33s
Number of TC     :107
Last TC occurred  :GigabitEthernet0/0/3
```

Configure the LSW devices to shut down the edge port if the edge port receives a BPDU. The ports should recover automatically from shutdown state after 5 min.

All LSW devices

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]error-down auto-recovery cause bpdu-protection interval 300
.
[LSW1]stp bpdu-protection
```

Configure LSW1 and LSW3 for Root protection on the interfaces towards LSW2 and LSW4.

LSW1:

```

<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]interface GigabitEthernet 0/0/2

[LSW1-GigabitEthernet0/0/2]stp root-protection

[LSW1-GigabitEthernet0/0/2]quit

[LSW1]interface GigabitEthernet 0/0/3

[LSW1-GigabitEthernet0/0/3]stp root-protection

[LSW1-GigabitEthernet0/0/3]quit

[LSW1]interface GigabitEthernet 0/0/4

[LSW1-GigabitEthernet0/0/4]stp root-protection

[LSW1-GigabitEthernet0/0/4]quit

[LSW1]interface GigabitEthernet 0/0/5

[LSW1-GigabitEthernet0/0/5]stp root-protection

[LSW1-GigabitEthernet0/0/5]quit

```

LSW3:

```

<LSW3>system-view
Enter system view, return user view with Ctrl+Z.

[LSW3]interface GigabitEthernet 0/0/2

[LSW3-GigabitEthernet0/0/2]stp root-protection

[LSW3-GigabitEthernet0/0/2]quit

[LSW3]interface GigabitEthernet 0/0/3

[LSW3-GigabitEthernet0/0/3]stp root-protection

[LSW3-GigabitEthernet0/0/3]quit

[LSW3]interface GigabitEthernet 0/0/4

[LSW3-GigabitEthernet0/0/4]stp root-protection

[LSW3-GigabitEthernet0/0/4]quit

[LSW3]interface GigabitEthernet 0/0/6

[LSW3-GigabitEthernet0/0/6]stp root-protection

[LSW3-GigabitEthernet0/0/6]quit

```

Verify the configuration:

LSW1:

```
<LSW1>display stp interface GigabitEthernet 0/0/2
----[Port2(GigabitEthernet0/0/2)][FORWARDING]----
Port Protocol      :Enabled
Port Role          :Designated Port
Port Priority       :128
Port Cost(Dot1T)   :Config=auto / Active=1
Designated Bridge/Port :0.4c1f-ccaf-a9a9 / 128.2
Port Edged         :Config=default / Active=disabled
Point-to-point     :Config=auto / Active=true
Transit Limit      :147 packets/hello-time
Protection Type     :Root
Port STP Mode       :RSTP
Port Protocol Type  :Config=auto / Active=dot1s
BPDU Encapsulation :Config=stp / Active=stp
PortTimes          :Hello 2s MaxAge 10s FwDly 4s RemHop 20
TC or TCN send     :21
TC or TCN received :17
BPDU Sent          :29111
                   TCN: 0, Config: 0, RST: 29111, MST: 0
BPDU Received      :3412
                   TCN: 0, Config: 0, RST: 3412, MST: 0
```

Configure all Alternate port for loop protection.

LSW3:

```
<LSW3>display stp brief
MSTID Port          Role STP State Protection
0  GigabitEthernet0/0/1  ROOT FORWARDING NONE
0  GigabitEthernet0/0/2  DESI FORWARDING ROOT
0  GigabitEthernet0/0/3  DESI FORWARDING ROOT
0  GigabitEthernet0/0/4  DESI FORWARDING ROOT
0  GigabitEthernet0/0/5  ALTE DISCARDING NONE
0  GigabitEthernet0/0/6  DESI FORWARDING ROOT

<LSW3>system-view
Enter system view, return user view with Ctrl+Z.

[LSW3]interface GigabitEthernet 0/0/5

[LSW3-GigabitEthernet0/0/5]stp loop-protection

[LSW3-GigabitEthernet0/0/5]quit
```

LSW2:

```
<LSW2>display stp brief
MSTID Port          Role STP State  Protection
0  GigabitEthernet0/0/1  ROOT FORWARDING  NONE
0  GigabitEthernet0/0/2  ALTE DISCARDING  NONE
0  GigabitEthernet0/0/3  DESI FORWARDING  NONE
0  GigabitEthernet0/0/4  ALTE DISCARDING  NONE
0  GigabitEthernet0/0/5  ALTE DISCARDING  NONE
0  GigabitEthernet0/0/6  DESI FORWARDING  NONE
```

<LSW2>system-view

Enter system view, return user view with Ctrl+Z.

[LSW2]interface GigabitEthernet 0/0/2

[LSW2-GigabitEthernet0/0/2]stp loop-protection

[LSW2-GigabitEthernet0/0/2]quit

[LSW2]interface GigabitEthernet 0/0/4

[LSW2-GigabitEthernet0/0/4]stp loop-protection

[LSW2-GigabitEthernet0/0/4]interface GigabitEthernet 0/0/4

[LSW2-GigabitEthernet0/0/4]quit

[LSW2]interface GigabitEthernet 0/0/5

[LSW2-GigabitEthernet0/0/5]stp loop-protection

[LSW2-GigabitEthernet0/0/5]quit

LSW4:

```
<LSW4>display stp brief
MSTID Port          Role STP State  Protection
0  GigabitEthernet0/0/1  ROOT FORWARDING  NONE
0  GigabitEthernet0/0/2  ALTE DISCARDING  NONE
0  GigabitEthernet0/0/3  ALTE DISCARDING  NONE
0  GigabitEthernet0/0/4  ALTE DISCARDING  NONE
0  GigabitEthernet0/0/5  ALTE DISCARDING  NONE
0  GigabitEthernet0/0/6  ALTE DISCARDING  NONE
```

<LSW4>system-view

Enter system view, return user view with Ctrl+Z.

[LSW4]interface GigabitEthernet 0/0/2

[LSW4-GigabitEthernet0/0/2]stp loop-protection

[LSW4-GigabitEthernet0/0/2]quit

[LSW4]interface GigabitEthernet 0/0/3

```

[LSW4-GigabitEthernet0/0/3]quit
\
[LSW4-GigabitEthernet0/0/3]stp loop-protection

[LSW4-GigabitEthernet0/0/3]quit

[LSW4]interface GigabitEthernet 0/0/4

[LSW4-GigabitEthernet0/0/4]stp loop-protection

[LSW4-GigabitEthernet0/0/4]quit

[LSW4]interface GigabitEthernet 0/0/5

[LSW4-GigabitEthernet0/0/5]stp loop-protection

[LSW4-GigabitEthernet0/0/5]quit

[LSW4]interface GigabitEthernet 0/0/6

[LSW4-GigabitEthernet0/0/6] stp loop-protection

[LSW4-GigabitEthernet0/0/6]quit

```

Verify the configuration:

LSW3:

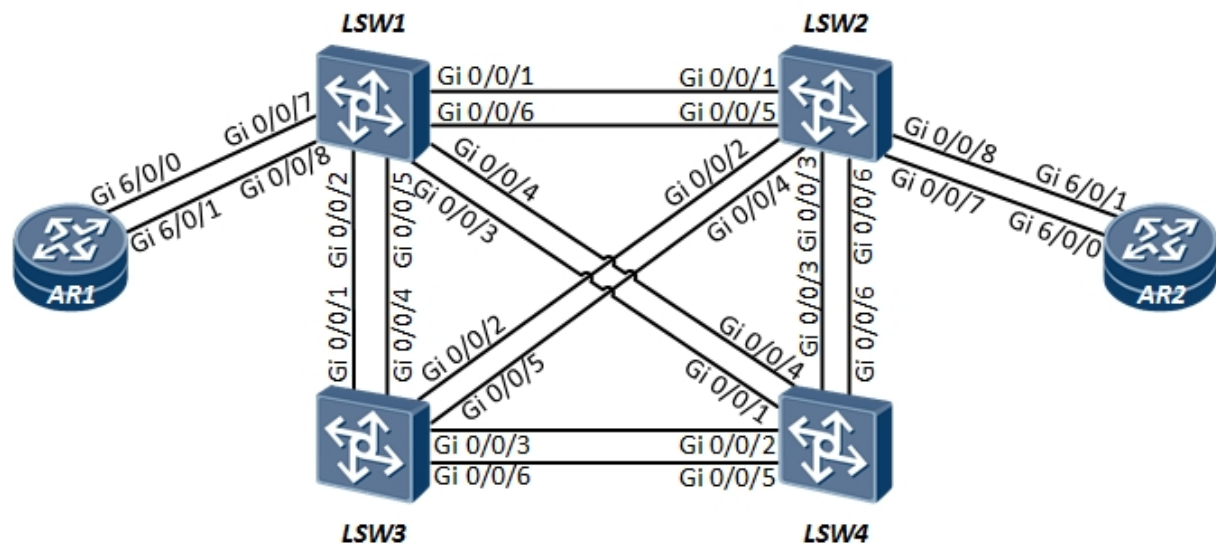
```

<LSW3>display stp interface GigabitEthernet 0/0/5
---[Port5(GigabitEthernet0/0/5)][DISCARDING]---
Port Protocol      :Enabled
Port Role          :Alternate Port
Port Priority       :128
Port Cost(Dot1T )  :Config=auto / Active=1
Designated Bridge/Port :0.4c1f-ccaf-a9a9 / 128.6
Port Edged         :Config=default / Active=disabled
Point-to-point     :Config=auto / Active=true
Transit Limit      :147 packets/hello-time
Protection Type     :Loop
Port STP Mode       :RSTP
Port Protocol Type  :Config=auto / Active=dot1s
BPDU Encapsulation :Config=stp / Active=stp
PortTimes           :Hello 2s MaxAge 10s FwDly 4s RemHop 0
TC or TCN send      :12
TC or TCN received  :62
BPDU Sent           :3402
                    TCN: 0, Config: 0, RST: 3402, MST: 0
BPDU Received       :45966
                    TCN: 0, Config: 0, RST: 45966, MST: 0

```

MSTP Configuration.

NOTE:



MSTP configuration.

Configure VLANs 10, 30, 50 in instance 1

Configure VLANs 20, 40, 60 in instance 2

AR1:

```
<AR1>system-view
[AR1]interface gi 6/0/0
[AR1-GigabitEthernet6/0/0]port link-type trunk
[AR1-GigabitEthernet6/0/0]port trunk allow-pass vlan all
[AR1-GigabitEthernet6/0/0]inter gi 6/0/1
[AR1-GigabitEthernet6/0/1]port link-type trunk
[AR1-GigabitEthernet6/0/1]port trunk allow-pass vlan all
[AR1]vlan batch 10 20 30 40 50 60
[AR1]stp mode mstp
[AR1]stp region-configuration
Info: Please activate the stp region-configuration after it is modified.
[AR1-mst-region]revision-level 1
```

```
[AR1-mst-region]region-name RG1
[AR1-mst-region]instance 1 vlan 10 30 50
[AR1-mst-region]instance 2 vlan 20 40 60
[AR1-mst-region]active region-configuration
[AR1-mst-region]quit
```

AR2:

```
<AR2>system-view
[AR2]interface gi 6/0/0
[AR2-GigabitEthernet6/0/0]port link-type trunk
[AR2-GigabitEthernet6/0/0]port trunk allow-pass vlan all
[AR2-GigabitEthernet6/0/0]inter gi 6/0/1
[AR2-GigabitEthernet6/0/1]port link-type trunk
[AR2-GigabitEthernet6/0/1]port trunk allow-pass vlan all
[AR2]vlan batch 10 20 30 40 50 60
[AR2]stp mode mstp
[AR2]stp region-configuration
Info: Please activate the stp region-configuration after it is modified.
[AR2-mst-region] region-name RG1
[AR2-mst-region] revision-level 1
[AR2-mst-region] instance 1 vlan 10 30 50
[AR2-mst-region] instance 2 vlan 20 40 60
[AR2-mst-region] active region-configuration
```

All LSW devices:

```
<LSW1>system-view
[LSW1]interface gi 0/0/1
[LSW1-GigabitEthernet0/0/1]port link-type trunk
[LSW1-GigabitEthernet0/0/1]port trunk allow-pass vlan all
```

```
[LSW1-GigabitEthernet0/0/1]inter gi 0/0/2
[LSW1-GigabitEthernet0/0/2]port link-type trunk
[LSW1-GigabitEthernet0/0/2]port trunk allow-pass vlan all
[LSW1-GigabitEthernet0/0/2]inter gi 0/0/3
[LSW1-GigabitEthernet0/0/3]port link-type trunk
[LSW1-GigabitEthernet0/0/3]port trunk allow-pass vlan all
[LSW1-GigabitEthernet0/0/3]inter gi 0/0/4
[LSW1-GigabitEthernet0/0/4]port link-type trunk
[LSW1-GigabitEthernet0/0/4]port trunk allow-pass vlan all
[LSW1-GigabitEthernet0/0/4]inter gi 0/0/5
[LSW1-GigabitEthernet0/0/5]port link-type trunk
[LSW1-GigabitEthernet0/0/5]port trunk allow-pass vlan all
[LSW1-GigabitEthernet0/0/5]inter gi 0/0/6
[LSW1-GigabitEthernet0/0/6]port link-type trunk
[LSW1-GigabitEthernet0/0/6]port trunk allow-pass vlan all
[LSW1-GigabitEthernet0/0/6]inter gi 0/0/7
[LSW1-GigabitEthernet0/0/7]port link-type trunk
[LSW1-GigabitEthernet0/0/7]port trunk allow-pass vlan all
[LSW1-GigabitEthernet0/0/7]inter gi 0/0/8
[LSW1-GigabitEthernet0/0/8]port link-type trunk
[LSW1-GigabitEthernet0/0/8]port trunk allow-pass vlan all
[LSW1]vlan batch 10 20 30 40 50 60
[LSW1]stp mode mstp
[LSW1]stp region-configuration
Info: Please activate the stp region-configuration after it is modified.
[LSW1-mst-region] region-name RG1
[LSW1-mst-region] revision-level 1
[LSW1-mst-region] instance 1 vlan 10 30 50
[LSW1-mst-region] instance 2 vlan 20 40 60
[LSW1-mst-region] active region-configuration
```


Verify the configuration:

AR1:

```
<AR1>display stp region-configuration
Oper configuration
Format selector :0
Region name :RG1
Revision level :1

Instance VLANs Mapped
0 1 to 9, 11 to 19, 21 to 29, 31 to 39, 41 to 49, 51 to 59, 61 to
4094
1 10, 30, 50
2 20, 40, 60

<AR1>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge :32768.00e0-fc79-2b0c
Config Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC :32768.00e0-fc79-2b0c / 0 (This bridge is the root)
CIST RegRoot/IRPC :32768.00e0-fc79-2b0c / 0 (This bridge is the root)
CIST RootPortId :0.0
BPDU-Protection :Disabled
TC or TCN received :49
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:15m:29s
Number of TC :16
Last TC occurred :GigabitEthernet6/0/0

<AR1>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID :32768.00e0-fc79-2b0c
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 0 (This bridge is the root)
MSTI RootPortId :0.0
Master Bridge :32768.00e0-fc79-2b0c
Cost to Master :0
TC received :5
TC count per hello :0
Time since last TC :0 days 0h:6m:9s
Number of TC :5
Last TC occurred :GigabitEthernet6/0/1

<AR1>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID :32768.00e0-fc79-2b0c
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 0 (This bridge is the root)
MSTI RootPortId :0.0
Master Bridge :32768.00e0-fc79-2b0c
Cost to Master :0
TC received :5
TC count per hello :0
Time since last TC :0 days 0h:6m:14s
Number of TC :5
Last TC occurred :GigabitEthernet6/0/1
```

AR2:

```

<AR2>display stp region-configuration
Oper configuration
Format selector   :0
Region name      :RG1
Revision level   :1

Instance  VLANs Mapped
  0      1 to 9, 11 to 19, 21 to 29, 31 to 39, 41 to 49, 51 to 59, 61 to
        4094
  1      10, 30, 50
  2      20, 40, 60

<AR2>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge      :32768.00e0-fcc2-64f3
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 17
CIST Root/ERPC   :32768.00e0-fc79-2b0c / 0
CIST RegRoot/IRPC :32768.00e0-fc79-2b0c / 20002
CIST RootPortId  :128.1 (GigabitEthernet6/0/0)
BPDU-Protection  :Disabled
TC or TCN received :77
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:19m:1s
Number of TC      :20
Last TC occurred  :GigabitEthernet6/0/0

<AR2>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID   :32768.00e0-fcc2-64f3
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 20002
MSTI RootPortId  :128.1 (GigabitEthernet6/0/0)
Master Bridge     :32768.00e0-fc79-2b0c
Cost to Master    :20002
TC received       :39
TC count per hello :0
Time since last TC :0 days 0h:9m:51s
Number of TC      :18
Last TC occurred  :GigabitEthernet6/0/0

<AR2>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID   :32768.00e0-fcc2-64f3
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 20002
MSTI RootPortId  :128.1 (GigabitEthernet6/0/0)
Master Bridge     :32768.00e0-fc79-2b0c
Cost to Master    :20002
TC received       :43
TC count per hello :0
Time since last TC :0 days 0h:9m:54s

```

```
Number of TC      :17
Last TC occurred  :GigabitEthernet6/0/0
```

LSW1:

```
<LSW1>display stp region-configuration
Oper configuration
Format selector   :0
Region name       :RG1
Revision level    :1

Instance VLANs Mapped
 0   1 to 9, 11 to 19, 21 to 29, 31 to 39, 41 to 49, 51 to 59, 61 to
     4094
 1   10, 30, 50
 2   20, 40, 60
```

```
<LSW1>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge       :32768.4c1f-ccb0-8d4c
Config Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 19
CIST Root/ERPC    :32768.00e0-fc79-2b0c / 0
CIST RegRoot/IRPC :32768.00e0-fc79-2b0c / 1
CIST RootPortId   :128.7
BPDU-Protection   :Disabled
TC or TCN received :109
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:22m:12s
Number of TC       :43
Last TC occurred   :GigabitEthernet0/0/2
```

```
<LSW1>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID    :32768.4c1f-ccb0-8d4c
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 1
MSTI RootPortId   :128.7
Master Bridge      :32768.00e0-fc79-2b0c
Cost to Master     :1
TC received        :72
TC count per hello :0
Time since last TC :0 days 0h:12m:53s
Number of TC       :32
Last TC occurred   :GigabitEthernet0/0/7
```

```
<LSW1>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.4c1f-ccb0-8d4c
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 1
MSTI RootPortId   :128.7
Master Bridge      :32768.00e0-fc79-2b0c
Cost to Master     :1
TC received        :70
TC count per hello :0
Time since last TC :0 days 0h:13m:8s
Number of TC       :30
```

```
Last TC occurred :GigabitEthernet0/0/7
```

LSW2:

```
<LSW2>display stp region-configuration
```

```
Oper configuration
```

```
Format selector :0
```

```
Region name :RG1
```

```
Revision level :1
```

```
Instance VLANs Mapped
```

```
0 1 to 9, 11 to 19, 21 to 29, 31 to 39, 41 to 49, 51 to 59, 61 to 4094
```

```
1 10, 30, 50
```

```
2 20, 40, 60
```

```
<LSW2>display stp
```

```
-----[CIST Global Info][Mode MSTP]-----
```

```
CIST Bridge :32768.4c1f-cc64-9e5a
```

```
Config Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
```

```
Active Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 18
```

```
CIST Root/ERPC :32768.00e0-fc79-2b0c / 0
```

```
CIST RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
```

```
CIST RootPortId :128.1
```

```
BPDU-Protection :Disabled
```

```
TC or TCN received :162
```

```
TC count per hello :0
```

```
STP Converge Mode :Normal
```

```
Time since last TC :0 days 0h:24m:36s
```

```
Number of TC :35
```

```
Last TC occurred :GigabitEthernet0/0/5
```

```
<LSW2>display stp instance 1
```

```
-----[MSTI 1 Global Info]-----
```

```
MSTI Bridge ID :32768.4c1f-cc64-9e5a
```

```
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
```

```
MSTI RootPortId :128.1
```

```
Master Bridge :32768.00e0-fc79-2b0c
```

```
Cost to Master :2
```

```
TC received :77
```

```
TC count per hello :0
```

```
Time since last TC :0 days 0h:15m:20s
```

```
Number of TC :10
```

```
Last TC occurred :GigabitEthernet0/0/1
```

```
<LSW2>display stp instance 2
```

```
-----[MSTI 2 Global Info]-----
```

```
MSTI Bridge ID :32768.4c1f-cc64-9e5a
```

```
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
```

```
MSTI RootPortId :128.1
```

```
Master Bridge :32768.00e0-fc79-2b0c
```

```
Cost to Master :2
```

```
TC received :74
```

```
TC count per hello :0
```

```
Time since last TC :0 days 0h:15m:24s
```

```
Number of TC :10
```

```
Last TC occurred :GigabitEthernet0/0/1
```

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<https://t.me/learningnets>

LSW3:

```
<LSW3>display stp region-configuration
Oper configuration
Format selector   :0
Region name       :RG1
Revision level    :1

Instance  VLANs Mapped
  0      1 to 9, 11 to 19, 21 to 29, 31 to 39, 41 to 49, 51 to 59, 61 to
        4094
  1      10, 30, 50
  2      20, 40, 60

<LSW3>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge       :32768.4c1f-cc85-294f
Config Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 18
CIST Root/ERPC    :32768.00e0-fc79-2b0c / 0
CIST RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
CIST RootPortId   :128.1
BPDU-Protection   :Disabled
TC or TCN received :192
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:26m:51s
Number of TC       :44
Last TC occurred   :GigabitEthernet0/0/1

<LSW3>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc85-294f
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
MSTI RootPortId   :128.1
Master Bridge     :32768.00e0-fc79-2b0c
Cost to Master     :2
TC received       :92
TC count per hello :0
Time since last TC :0 days 0h:17m:30s
Number of TC       :21
Last TC occurred   :GigabitEthernet0/0/1

<LSW3>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc85-294f
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
MSTI RootPortId   :128.1
Master Bridge     :32768.00e0-fc79-2b0c
Cost to Master     :2
TC received       :80
TC count per hello :0
Time since last TC :0 days 0h:17m:34s
```

```
Number of TC      :21
Last TC occurred  :GigabitEthernet0/0/1
```

LSW4:

```
<LSW4>display stp region-configuration
Oper configuration
Format selector   :0
Region name       :RG1
Revision level    :1

Instance VLANs Mapped
 0    1 to 9, 11 to 19, 21 to 29, 31 to 39, 41 to 49, 51 to 59, 61 to
      4094
 1    10, 30, 50
 2    20, 40, 60
```

```
<LSW4>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge       :32768.4c1f-cc00-d672
Config Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 18
CIST Root/ERPC    :32768.00e0-fc79-2b0c / 0
CIST RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
CIST RootPortId   :128.1
BPDU-Protection   :Disabled
TC or TCN received :89
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:30m:19s
Number of TC       :35
Last TC occurred   :GigabitEthernet0/0/1
```

```
<LSW4>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc00-d672
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
MSTI RootPortId   :128.1
Master Bridge     :32768.00e0-fc79-2b0c
Cost to Master     :2
TC received        :41
TC count per hello :0
Time since last TC :0 days 0h:21m:2s
Number of TC       :17
Last TC occurred   :GigabitEthernet0/0/6
```

```
<LSW4>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc00-d672
MSTI RegRoot/IRPC :32768.00e0-fc79-2b0c / 2
MSTI RootPortId   :128.1
Master Bridge     :32768.00e0-fc79-2b0c
Cost to Master     :2
TC received        :39
TC count per hello :0
Time since last TC :0 days 0h:21m:5s
Number of TC       :14
```

```
Last TC occurred :GigabitEthernet0/0/6
```

Configure LSW1 as root bridge for CIST and MSTI 1, whereas LSW3 backup root bridge for CIST and instance 1.

Configure LSW3 as root bridge for MSTI 2 and LSW1 as a backup root.

LSW1:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]stp instance 0 priority 0

[LSW1]stp instance 1 priority 0

[LSW1]stp instance 2 priority 4096
```

LSW3:

```
<LSW3>system-view
Enter system view, return user view with Ctrl+Z.

[LSW3]stp instance 0 priority 4096

[LSW3]stp instance 1 priority 4096

[LSW3]stp instance 2 priority 0
```

Verify the configuration:

LSW1:

```
<LSW1>display stp instance 0
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge      :0 .4c1f-ccb0-8d4c
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :0 .4c1f-ccb0-8d4c / 0
CIST RegRoot/IRPC :0 .4c1f-ccb0-8d4c / 0
CIST RootPortId  :0.0
BPDU-Protection  :Disabled
TC or TCN received :111
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:10m:35s
Number of TC      :45
Last TC occurred  :GigabitEthernet0/0/1
```

```
<LSW1>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID   :0.4c1f-ccb0-8d4c
MSTI RegRoot/IRPC :0.4c1f-ccb0-8d4c / 0
MSTI RootPortId  :0.0
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :0
TC received       :74
TC count per hello :0
Time since last TC :0 days 0h:10m:32s
Number of TC      :34
Last TC occurred  :GigabitEthernet0/0/1
```

```
<LSW1>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID   :4096.4c1f-ccb0-8d4c
MSTI RegRoot/IRPC :0.4c1f-cc85-294f / 1
MSTI RootPortId  :128.1
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :0
TC received       :73
TC count per hello :0
Time since last TC :0 days 0h:10m:33s
Number of TC      :33
Last TC occurred  :GigabitEthernet0/0/1
```


LSW3:

```
<LSW3>display stp instance 0
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge      :4096.4c1f-cc85-294f
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 19
CIST Root/ERPC   :0 .4c1f-ccb0-8d4c / 0
CIST RegRoot/IRPC :0 .4c1f-ccb0-8d4c / 1
CIST RootPortId  :128.1
BPDU-Protection  :Disabled
TC or TCN received :207
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:25m:40s
Number of TC      :49
Last TC occurred  :GigabitEthernet0/0/6
```

```
<LSW3>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID   :4096.4c1f-cc85-294f
MSTI RegRoot/IRPC :0.4c1f-ccb0-8d4c / 1
MSTI RootPortId  :128.1
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :1
TC received       :118
TC count per hello :0
Time since last TC :0 days 0h:25m:31s
Number of TC      :26
Last TC occurred  :GigabitEthernet0/0/6
```

```
<LSW3>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID   :0.4c1f-cc85-294f
MSTI RegRoot/IRPC :0.4c1f-cc85-294f / 0
MSTI RootPortId  :0.0
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :1
TC received       :95
TC count per hello :0
Time since last TC :0 days 0h:25m:26s
Number of TC      :27
Last TC occurred  :GigabitEthernet0/0/6
```

Configure interfaces GE6/0/0 on AR1 and AR2 to be Alternate ports for all MSTIs. Using only port priority setting.

LSW1:

```
<LSW1>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[LSW1]interface GigabitEthernet 0/0/8  
  
[LSW1-GigabitEthernet0/0/8]stp instance 0 port priority 16  
.  
[LSW1-GigabitEthernet0/0/8]stp instance 1 port priority 16  
.  
[LSW1-GigabitEthernet0/0/8]stp instance 2 port priority 16
```

AR1:

```
<AR1>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR1]interface GigabitEthernet 6/0/1  
  
[AR1-GigabitEthernet6/0/1]stp instance 0 port priority 16  
.  
[AR1-GigabitEthernet6/0/1]stp instance 1 port priority 16  
.  
[AR1-GigabitEthernet6/0/1]stp instance 2 port priority 16
```

LSW3:

```
<LSW3>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[LSW3]interface GigabitEthernet 0/0/8  
  
[LSW3-GigabitEthernet0/0/8]stp instance 0 port priority 16  
.  
[LSW3-GigabitEthernet0/0/8]stp instance 1 port priority 16  
.  
[LSW3-GigabitEthernet0/0/8]stp instance 2 port priority 16
```

AR2:

```
<AR2>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR2]interface GigabitEthernet 6/0/1  
  
[AR2-GigabitEthernet6/0/1]stp instance 0 port priority 16  
.  
[AR2-GigabitEthernet6/0/1]stp instance 1 port priority 16  
[AR2-GigabitEthernet6/0/1]stp instance 2 port priority 16
```

Verify the configuration:

AR1:

```
<AR1>display stp brief
MSTID  Port                Role STP State  Protection
0  GigabitEthernet6/0/0    ALTE DISCARDING  NONE
0  GigabitEthernet6/0/1    ROOT FORWARDING  NONE
1  GigabitEthernet6/0/0    ALTE DISCARDING  NONE
1  GigabitEthernet6/0/1    ROOT FORWARDING  NONE
2  GigabitEthernet6/0/0    ALTE DISCARDING  NONE
2  GigabitEthernet6/0/1    ROOT FORWARDING  NONE

<AR1>display stp interface GigabitEthernet6/0/1
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge      :32768.00e0-fc79-2b0c
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 19
CIST Root/ERPC   :0 .4c1f-ccb0-8d4c / 0
CIST RegRoot/IRPC :0 .4c1f-ccb0-8d4c / 20000
CIST RootPortId  :16.2 (GigabitEthernet6/0/1)
BPDU-Protection  :Disabled
TC or TCN received :85
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:47m:43s
Number of TC      :24
Last TC occurred  :GigabitEthernet6/0/1
----[Port2(GigabitEthernet6/0/1)][FORWARDING]----
Port Protocol     :Enabled
Port Role         :Root Port
Port Priority      :16
Port Cost(Dot1T ) :Config=auto / Active=20000
Designated Bridge/Port :0.4c1f-ccb0-8d4c / 16.8
Port Edged        :Config=default / Active=disabled
Point-to-point    :Config=auto / Active=true
Transit Limit     :6 packets/s
Protection Type    :None
Port STP Mode      :MSTP
Port Protocol Type :Config=auto / Active=dot1s
PortTimes         :Hello 2s MaxAge 20s FwDly 15s RemHop 20
TC or TCN send    :3
TC or TCN received :6
BPDU Sent         :8
TCN: 0, Config: 0, RST: 0, MST: 8
BPDU Received     :2878
TCN: 0, Config: 0, RST: 0, MST: 2878
Last forwarding time: 2015/11/23 01:57:49 UTC-08:00

-----[MSTI 1 Global Info]-----
MSTI Bridge ID    :32768.00e0-fc79-2b0c
MSTI RegRoot/IRPC :0.4c1f-ccb0-8d4c / 20000
MSTI RootPortId   :16.2 (GigabitEthernet6/0/1)
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master     :20000
TC received       :41
TC count per hello :0
Time since last TC :0 days 0h:47m:34s
Number of TC      :13
```

```

Last TC occurred   :GigabitEthernet6/0/1
----[Port2(GigabitEthernet6/0/1)][FORWARDING]----
Port Role         :Root Port
Port Priority      :16
Port Cost(Dot1T)  :Config=auto / Active=20000
Designated Bridge/Port :0.4c1f-ccb0-8d4c / 16.8
Port Times        :RemHops 20
TC or TCN send    :2
TC or TCN received :6
Last forwarding time: 2015/11/23 01:57:59 UTC-08:00

-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.00e0-fc79-2b0c
MSTI RegRoot/IRPC :0.4c1f-cc85-294f / 20001
MSTI RootPortId   :16.2 (GigabitEthernet6/0/1)
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :20000
TC received       :37
TC count per hello :0
Time since last TC :0 days 0h:47m:30s
Number of TC      :14
Last TC occurred   :GigabitEthernet6/0/1
----[Port2(GigabitEthernet6/0/1)][FORWARDING]----
Port Role         :Root Port
Port Priority      :16
Port Cost(Dot1T)  :Config=auto / Active=20000
Designated Bridge/Port :4096.4c1f-ccb0-8d4c / 16.8
Port Times        :RemHops 19
TC or TCN send    :2
TC or TCN received :6
Last forwarding time: 2015/11/23 01:58:04 UTC-08:00

```

<AR2>display stp brief

MSTID	Port	Role	STP State	Protection
0	GigabitEthernet6/0/0	ALTE	DISCARDING	NONE
0	GigabitEthernet6/0/1	ROOT	FORWARDING	NONE
1	GigabitEthernet6/0/0	ALTE	DISCARDING	NONE
1	GigabitEthernet6/0/1	ROOT	FORWARDING	NONE
2	GigabitEthernet6/0/0	ALTE	DISCARDING	NONE
2	GigabitEthernet6/0/1	ROOT	FORWARDING	NONE

<AR2>display stp interface GigabitEthernet 6/0/1

-----[CIST Global Info][Mode MSTP]-----

CIST Bridge :32768.00e0-fcc2-64f3
 Config Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
 Active Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 18
 CIST Root/ERPC :0 .4c1f-ccb0-8d4c / 0
 CIST RegRoot/IRPC :0 .4c1f-ccb0-8d4c / 20001
 CIST RootPortId :16.2 (GigabitEthernet6/0/1)
 BPDU-Protection :Disabled
 TC or TCN received :117
 TC count per hello :0
 STP Converge Mode :Normal
 Time since last TC :0 days 0h:51m:0s
 Number of TC :28
 Last TC occurred :GigabitEthernet6/0/1

----[Port2(GigabitEthernet6/0/1)][FORWARDING]----

Port Protocol :Enabled
 Port Role :Root Port
 Port Priority :16
 Port Cost(Dot1T) :Config=auto / Active=20000
 Designated Bridge/Port :4096.4c1f-cc85-294f / 16.8
 Port Edged :Config=default / Active=disabled
 Point-to-point :Config=auto / Active=true
 Transit Limit :6 packets/s
 Protection Type :None
 Port STP Mode :MSTP
 Port Protocol Type :Config=auto / Active=dot1s
 PortTimes :Hello 2s MaxAge 20s FwDly 15s RemHop 19
 TC or TCN send :5
 TC or TCN received :37
 BPDU Sent :307
 TCN: 0, Config: 0, RST: 0, MST: 307
 BPDU Received :10868
 TCN: 0, Config: 0, RST: 0, MST: 10868
 Last forwarding time: 2015/11/23 01:50:21 UTC-08:00

-----[MSTI 1 Global Info]-----

MSTI Bridge ID :32768.00e0-fcc2-64f3
 MSTI RegRoot/IRPC :0.4c1f-ccb0-8d4c / 20001
 MSTI RootPortId :16.2 (GigabitEthernet6/0/1)
 Master Bridge :0.4c1f-ccb0-8d4c
 Cost to Master :20001
 TC received :80
 TC count per hello :0
 Time since last TC :0 days 0h:50m:51s
 Number of TC :26

```

Last TC occurred   :GigabitEthernet6/0/1
----[Port2(GigabitEthernet6/0/1)][FORWARDING]----
Port Role         :Root Port
Port Priority      :16
Port Cost(Dot1T)  :Config=auto / Active=20000
Designated Bridge/Port :4096.4c1f-cc85-294f / 16.8
Port Times        :RemHops 19
TC or TCN send    :16
TC or TCN received :25
Last forwarding time: 2015/11/23 01:50:27 UTC-08:00

-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.00e0-fcc2-64f3
MSTI RegRoot/IRPC :0.4c1f-cc85-294f / 20000
MSTI RootPortId   :16.2 (GigabitEthernet6/0/1)
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :20001
TC received       :84
TC count per hello :0
Time since last TC :0 days 0h:50m:47s
Number of TC      :26
Last TC occurred   :GigabitEthernet6/0/1
----[Port2(GigabitEthernet6/0/1)][FORWARDING]----
Port Role         :Root Port
Port Priority      :16
Port Cost(Dot1T)  :Config=auto / Active=20000
Designated Bridge/Port :0.4c1f-cc85-294f / 16.8
Port Times        :RemHops 20
TC or TCN send    :15
TC or TCN received :24
Last forwarding time: 2015/11/23 01:50:35 UTC-08:00

```

Make sure that the direct interfaces between the LSW2 and LW4 are least preferred for path to the root bridge in all MSTIs. Use port cost to accomplish that.

LSW2:

```
<LSW2>system-view
Enter system view, return user view with Ctrl+Z.

[LSW2]interface GigabitEthernet 0/0/3

[LSW2-GigabitEthernet0/0/3]stp instance 0 cost 10000
[LSW2-GigabitEthernet0/0/3]stp instance 1 cost 10000
[LSW2-GigabitEthernet0/0/3]stp instance 2 cost 10000

[LSW2-GigabitEthernet0/0/3]interface GigabitEthernet 0/0/6

[LSW2-GigabitEthernet0/0/6]stp instance 0 cost 10000
[LSW2-GigabitEthernet0/0/6]stp instance 1 cost 10000
[LSW2-GigabitEthernet0/0/6]stp instance 2 cost 10000
```

LSW4:

```
<LSW4>system-view
Enter system view, return user view with Ctrl+Z.

[LSW4]interface GigabitEthernet 0/0/2

[LSW4-GigabitEthernet0/0/2]stp instance 0 cost 10000
[LSW4-GigabitEthernet0/0/2]stp instance 1 cost 10000
[LSW4-GigabitEthernet0/0/2]stp instance 2 cost 10000

[LSW4-GigabitEthernet0/0/2]interface GigabitEthernet 0/0/5

[LSW4-GigabitEthernet0/0/5]stp instance 0 cost 10000
[LSW4-GigabitEthernet0/0/5]stp instance 1 cost 10000
[LSW4-GigabitEthernet0/0/5]stp instance 2 cost 10000
```

Verify the configuration:

LSW2:


```
<LSW2>display stp interface GigabitEthernet 0/0/3 brief
MSTID Port                Role STP State  Protection
0  GigabitEthernet0/0/3    ALTE DISCARDING  NONE
1  GigabitEthernet0/0/3    ALTE DISCARDING  NONE
2  GigabitEthernet0/0/3    ALTE DISCARDING  NONE
```

```
<LSW2>display stp interface GigabitEthernet 0/0/6 brief
MSTID Port                Role STP State  Protection
0  GigabitEthernet0/0/6    ALTE DISCARDING  NONE
1  GigabitEthernet0/0/6    ALTE DISCARDING  NONE
2  GigabitEthernet0/0/6    ALTE DISCARDING  NONE
```

```
<LSW2>display stp interface GigabitEthernet 0/0/3
---[Port3(GigabitEthernet0/0/3)][DISCARDING]---
Port Protocol      :Enabled
Port Role          :Alternate Port
Port Priority       :128
Port Cost(Dot1T )  :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Edged         :Config=default / Active=disabled
Point-to-point     :Config=auto / Active=true
Transit Limit      :147 packets/hello-time
Protection Type     :None
Port STP Mode       :MSTP
Port Protocol Type  :Config=auto / Active=dot1s
BPDU Encapsulation :Config=stp / Active=stp
PortTimes          :Hello 2s MaxAge 20s FwDly 15s RemHop 19
TC or TCN send     :1
TC or TCN received :32
BPDU Sent          :6
TCN: 0, Config: 0, RST: 0, MST: 6
BPDU Received      :17290
TCN: 0, Config: 0, RST: 0, MST: 17290
```

```
-----[MSTI 1 Global Info]-----
MSTI Bridge ID     :32768.4c1f-cc64-9e5a
MSTI RegRoot/IRPC  :0.4c1f-ccb0-8d4c / 1
MSTI RootPortId    :128.1
Master Bridge      :0.4c1f-ccb0-8d4c
Cost to Master     :1
TC received        :209
TC count per hello :0
Time since last TC :0 days 1h:58m:41s
Number of TC       :19
Last TC occurred   :GigabitEthernet0/0/1
---[Port3(GigabitEthernet0/0/3)][DISCARDING]---
Port Role          :Alternate Port
Port Priority       :128
Port Cost(Dot1T )  :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Times         :RemHops 19
TC or TCN send     :1
TC or TCN received :54
```

```
-----[MSTI 2 Global Info]-----
MSTI Bridge ID     :32768.4c1f-cc64-9e5a
MSTI RegRoot/IRPC  :0.4c1f-cc85-294f / 1
MSTI RootPortId    :128.2
Master Bridge      :0.4c1f-ccb0-8d4c
Cost to Master     :1
```

```

TC received      :202
TC count per hello :0
Time since last TC :0 days 1h:59m:15s
Number of TC     :21
Last TC occurred  :GigabitEthernet0/0/2
----[Port3(GigabitEthernet0/0/3)][DISCARDING]----
Port Role        :Alternate Port
Port Priority     :128
Port Cost(Dot1T) :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Times       :RemHops 19
TC or TCN send   :1
TC or TCN received :52

```

```

<LSW2>display stp interface GigabitEthernet 0/0/6
----[Port6(GigabitEthernet0/0/6)][DISCARDING]----
Port Protocol     :Enabled
Port Role         :Alternate Port
Port Priority      :128
Port Cost(Dot1T)  :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.5
Port Edged        :Config=default / Active=disabled
Point-to-point    :Config=auto / Active=true
Transit Limit     :147 packets/hello-time
Protection Type   :None
Port STP Mode     :MSTP
Port Protocol Type :Config=auto / Active=dot1s
BPDU Encapsulation :Config=stp / Active=stp
PortTimes         :Hello 2s MaxAge 20s FwdDly 15s RemHop 19
TC or TCN send    :0
TC or TCN received :29
BPDU Sent         :6
                  TCN: 0, Config: 0, RST: 0, MST: 6
BPDU Received     :17387
                  TCN: 0, Config: 0, RST: 0, MST: 17387

```

```

-----[MSTI 1 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc64-9e5a
MSTI RegRoot/IRPC :0.4c1f-ccb0-8d4c / 1
MSTI RootPortId   :128.1
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :1
TC received       :209
TC count per hello :0
Time since last TC :0 days 2h:2m:20s
Number of TC      :19
Last TC occurred   :GigabitEthernet0/0/1
----[Port6(GigabitEthernet0/0/6)][DISCARDING]----
Port Role         :Alternate Port
Port Priority      :128
Port Cost(Dot1T)  :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.5
Port Times       :RemHops 19
TC or TCN send    :0
TC or TCN received :47

```

```

-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc64-9e5a
MSTI RegRoot/IRPC :0.4c1f-cc85-294f / 1
MSTI RootPortId   :128.2

```

```

Master Bridge      :0.4c1f-ccb0-8d4c
Cost to Master     :1
TC received        :202
TC count per hello :0
Time since last TC :0 days 2h:2m:54s
Number of TC       :21
Last TC occurred   :GigabitEthernet0/0/2
----[Port6(GigabitEthernet0/0/6)][DISCARDING]----
Port Role          :Alternate Port
Port Priority       :128
Port Cost(Dot1T )  :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.5
Port Times         :RemHops 19
TC or TCN send     :0
TC or TCN received :46

```

LSW4:

```

<LSW4>display stp interface GigabitEthernet 0/0/2 brief
MSTID Port          Role STP State  Protection
0  GigabitEthernet0/0/2  DESI FORWARDING  NONE
1  GigabitEthernet0/0/2  DESI FORWARDING  NONE
2  GigabitEthernet0/0/2  DESI FORWARDING  NONE
<LSW4>display stp interface GigabitEthernet 0/0/5 brief
MSTID Port          Role STP State  Protection
0  GigabitEthernet0/0/5  DESI FORWARDING  NONE
1  GigabitEthernet0/0/5  DESI FORWARDING  NONE
2  GigabitEthernet0/0/5  DESI FORWARDING  NONE

<LSW4>display stp interface GigabitEthernet 0/0/2
----[Port2(GigabitEthernet0/0/2)][FORWARDING]----
Port Protocol       :Enabled
Port Role           :Designated Port
Port Priority        :128
Port Cost(Dot1T )   :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Edged          :Config=default / Active=disabled
Point-to-point      :Config=auto / Active=true
Transit Limit       :147 packets/hello-time
Protection Type     :None
Port STP Mode       :MSTP
Port Protocol Type   :Config=auto / Active=dot1s
BPDU Encapsulation  :Config=stp / Active=stp
PortTimes           :Hello 2s MaxAge 20s FwDly 15s RemHop 19
TC or TCN send      :33
TC or TCN received  :3
BPDU Sent           :17393
                    TCN: 0, Config: 0, RST: 0, MST: 17393
BPDU Received       :8
                    TCN: 0, Config: 0, RST: 0, MST: 8

-----[MSTI 1 Global Info]-----
MSTI Bridge ID      :32768.4c1f-cc00-d672
MSTI RegRoot/IRPC   :0.4c1f-ccb0-8d4c / 1
MSTI RootPortId     :128.1
Master Bridge       :0.4c1f-ccb0-8d4c
Cost to Master       :1

```

```

TC received      :118
TC count per hello :0
Time since last TC :0 days 2h:2m:2s
Number of TC      :26
Last TC occurred   :GigabitEthernet0/0/1
----[Port2(GigabitEthernet0/0/2)][FORWARDING]----
Port Role         :Designated Port
Port Priority      :128
Port Cost(Dot1T ) :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Times        :RemHops 19
TC or TCN send    :57
TC or TCN received :1

-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc00-d672
MSTI RegRoot/IRPC :0.4c1f-cc85-294f / 1
MSTI RootPortId   :128.3
Master Bridge     :0.4c1f-ccb0-8d4c
Cost to Master    :1
TC received       :111
TC count per hello :0
Time since last TC :0 days 2h:2m:35s
Number of TC      :25
Last TC occurred   :GigabitEthernet0/0/3
----[Port2(GigabitEthernet0/0/2)][FORWARDING]----
Port Role         :Designated Port
Port Priority      :128
Port Cost(Dot1T ) :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Times        :RemHops 19
TC or TCN send    :55
TC or TCN received :1

<LSW4>display stp interface GigabitEthernet 0/0/2
----[Port2(GigabitEthernet0/0/2)][FORWARDING]----
Port Protocol     :Enabled
Port Role         :Designated Port
Port Priority      :128
Port Cost(Dot1T ) :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Edged        :Config=default / Active=disabled
Point-to-point    :Config=auto / Active=true
Transit Limit     :147 packets/hello-time
Protection Type   :None
Port STP Mode     :MSTP
Port Protocol Type :Config=auto / Active=dot1s
BPDU Encapsulation :Config=stp / Active=stp
PortTimes         :Hello 2s MaxAge 20s FwDly 15s RemHop 19
TC or TCN send    :33
TC or TCN received :3
BPDU Sent         :17393
                  TCN: 0, Config: 0, RST: 0, MST: 17393
BPDU Received     :8
                  TCN: 0, Config: 0, RST: 0, MST: 8

-----[MSTI 1 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc00-d672
MSTI RegRoot/IRPC :0.4c1f-ccb0-8d4c / 1
MSTI RootPortId   :128.1

```

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<https://t.me/learningnets>

```

Master Bridge      :0.4c1f-ccb0-8d4c
Cost to Master     :1
TC received        :118
TC count per hello :0
Time since last TC :0 days 2h:2m:2s
Number of TC       :26
Last TC occurred   :GigabitEthernet0/0/1
----[Port2(GigabitEthernet0/0/2)][FORWARDING]----
Port Role          :Designated Port
Port Priority       :128
Port Cost(Dot1T )  :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Times         :RemHops 19
TC or TCN send     :57
TC or TCN received :1

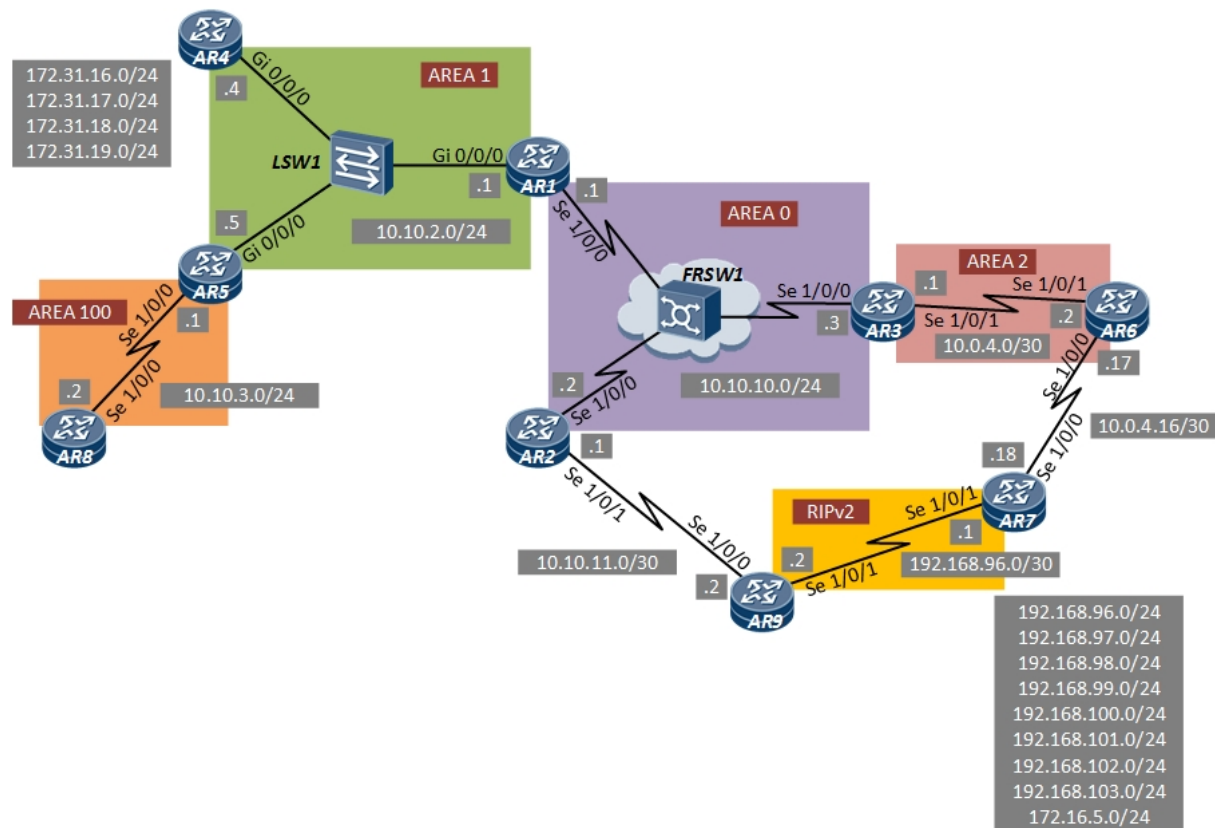
-----[MSTI 2 Global Info]-----
MSTI Bridge ID     :32768.4c1f-cc00-d672
MSTI RegRoot/IRPC  :0.4c1f-cc85-294f / 1
MSTI RootPortId    :128.3
Master Bridge      :0.4c1f-ccb0-8d4c
Cost to Master     :1
TC received        :111
TC count per hello :0
Time since last TC :0 days 2h:2m:35s
Number of TC       :25
Last TC occurred   :GigabitEthernet0/0/3
----[Port2(GigabitEthernet0/0/2)][FORWARDING]----
Port Role          :Designated Port
Port Priority       :128
Port Cost(Dot1T )  :Config=10000 / Active=10000
Designated Bridge/Port :32768.4c1f-cc00-d672 / 128.2
Port Times         :RemHops 19
TC or TCN send     :55
TC or TCN received :1

```

Chapter 2: IGP configuration and features - solutions

2.1. OSPF configuration and features.

NOTE: Load topology with name – *IGP_OSPF*



- Configure Frame-Relay encapsulation on AR1, AR2 and AR3 Serial1/0/0 interfaces. Disable inverse ARP on AR3 interface.
- Configure static mapping where needed. Do not allow transmitting of broadcast.
- Configure the IP addresses as shown on the diagram.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]interface Serial 1/0/0

[AR1-Serial1/0/0]link-protocol fr

[AR1-Serial1/0/0]ip address 10.10.10.1 24

[AR1-Serial1/0/0]fr map ip 10.10.10.3 103
```

AR2:**<AR2>system-view**

Enter system view, return user view with Ctrl+Z.

[AR2]interface Serial 1/0/0**[AR2-Serial1/0/0]link-protocol fr****[AR2-Serial1/0/0]ip address 10.10.10.2 24****[AR2-Serial1/0/0]fr map ip 10.10.10.3 203****AR3:****<AR3>system-view**

Enter system view, return user view with Ctrl+Z.

[AR3]interface Serial 1/0/0**[AR3-Serial1/0/0]link-protocol fr****[AR3-Serial1/0/0]ip address 10.10.10.3 24****[AR3-Serial1/0/0]fr map ip 10.10.10.1 301****[AR3-Serial1/0/0]fr map ip 10.10.10.2 302**

Verify the configuration:

AR1:**<AR1>display interface serial 1/0/0**

Serial1/0/0 current state : UP

Line protocol current state : UP

Last line protocol up time : 2015-11-24 05:47:20 UTC-08:00

Description:HUAWEI, AR Series, Serial1/0/0 Interface

Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)

Internet Address is 10.10.10.1/24

Link layer protocol is FR IETF

LMI DLCI is 0, LMI type is ANSI, frame relay DTE

LMI status enquiry sent 274, LMI status received 272

LMI status timeout 0, LMI message discarded 0

Last physical up time : 2015-11-24 05:47:20 UTC-08:00

Last physical down time : 2015-11-24 05:47:20 UTC-08:00

Current system time: 2015-11-24 06:32:38-08:00

Physical layer is synchronous, Virtualbaudrate is 64000 bps

Interface is DTE, Cable type is V11, Clock mode is TC

Last 300 seconds input rate 5 bytes/sec 40 bits/sec 0 packets/sec

Last 300 seconds output rate 2 bytes/sec 16 bits/sec 0 packets/sec

Input: 356 packets, 14794 bytes

Broadcast: 0, Multicast: 0

Errors: 0, Runt: 0

Giants: 0, CRC: 0

Alignments: 0, Overruns: 0

Dribbles: 0, Aborts: 0

No Buffers: 0, Frame Error: 0

Output: 2338 packets, 42880 bytes

```
Total Error:      0, Overruns:      0
Collisions:      0, Deferred:      0
Input bandwidth utilization : 0%
Output bandwidth utilization : 0%
```

<AR1>display fr map-info

Map Statistics for interface Serial1/0/0 (DTE)

```
DLCI = 102, IP INARP 10.10.10.2, Serial1/0/0
create time = 2015/11/24 05:54:05, status = ACTIVE
encapsulation = ietf, vlink = 1, broadcast
DLCI = 103, IP 10.10.10.3, Serial1/0/0
create time = 2015/11/24 06:01:24, status = ACTIVE
encapsulation = ietf, vlink = 2
```

<AR1>display fr map-info

Map Statistics for interface Serial1/0/0 (DTE)

```
DLCI = 102, IP INARP 10.10.10.2, Serial1/0/0
create time = 2015/11/24 05:54:05, status = ACTIVE
encapsulation = ietf, vlink = 1, broadcast
DLCI = 103, IP 10.10.10.3, Serial1/0/0
create time = 2015/11/24 06:01:24, status = ACTIVE
encapsulation = ietf, vlink = 2
```

AR2:

<AR2>display interface Serial 1/0/0

```
Serial1/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-11-24 05:47:52 UTC-08:00
Description:HUAWEI, AR Series, Serial1/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.10.10.2/24
Link layer protocol is FR IETF
LMI DLCI is 0, LMI type is ANSI, frame relay DTE
LMI status enquiry sent 282, LMI status received 280
LMI status timeout 0, LMI message discarded 0
Last physical up time : 2015-11-24 05:47:52 UTC-08:00
Last physical down time : 2015-11-24 05:47:52 UTC-08:00
Current system time: 2015-11-24 06:34:30-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 7 bytes/sec 56 bits/sec 0 packets/sec
Last 300 seconds output rate 4 bytes/sec 32 bits/sec 0 packets/sec
```

Input: 380 packets, 16524 bytes

```
Broadcast:      0, Multicast:      0
Errors:         0, Runt:           0
Giants:         0, CRC:            0
```

```
Alignments:     0, Overruns:      0
Dribbles:       0, Aborts:        0
No Buffers:     0, Frame Error:   0
```

Output: 2367 packets, 43850 bytes

```
Total Error:      0, Overruns:      0
Collisions:      0, Deferred:      0
Input bandwidth utilization : 0%
Output bandwidth utilization : 0%
```


<AR2>display fr map-info

Map Statistics for interface Serial1/0/0 (DTE)

DLCI = 201, IP INARP 10.10.10.1, Serial1/0/0

create time = 2015/11/24 05:53:54, status = ACTIVE

encapsulation = ietf, vlink = 1, broadcast

DLCI = 203, IP 10.10.10.3, Serial1/0/0

create time = 2015/11/24 06:27:09, status = ACTIVE

encapsulation = ietf, vlink = 2

AR3:**<AR3>display interface Serial 1/0/0**

Serial1/0/0 current state : UP

Line protocol current state : UP

Last line protocol up time : 2015-11-24 05:48:52 UTC-08:00

Description:HUAWEI, AR Series, Serial1/0/0 Interface

Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)

Internet Address is 10.10.10.3/24

Link layer protocol is FR IETF

LMI DLCI is 0, LMI type is ANSI, frame relay DTE

LMI status enquiry sent 288, LMI status received 286

LMI status timeout 0, LMI message discarded 0

Last physical up time : 2015-11-24 05:48:52 UTC-08:00

Last physical down time : 2015-11-24 05:48:51 UTC-08:00

Current system time: 2015-11-24 06:36:24-08:00

Physical layer is synchronous, Virtualbaudrate is 64000 bps

Interface is DTE, Cable type is V11, Clock mode is TC

Last 300 seconds input rate 6 bytes/sec 48 bits/sec 0 packets/sec

Last 300 seconds output rate 2 bytes/sec 16 bits/sec 0 packets/sec

Input: 383 packets, 16192 bytes

Broadcast: 0, Multicast: 0

Errors: 0, Runts: 0

Giants: 0, CRC: 0

Alignments: 0, Overruns: 0

Dribbles: 0, Aborts: 0

No Buffers: 0, Frame Error: 0

Output: 2258 packets, 40610 bytes

Total Error: 0, Overruns: 0

Collisions: 0, Deferred: 0

Input bandwidth utilization : 0%

Output bandwidth utilization : 0%

<AR3>display fr map-info

Map Statistics for interface Serial1/0/0 (DTE)

DLCI = 301, IP 10.10.10.1, Serial1/0/0

create time = 2015/11/24 05:54:50, status = ACTIVE

encapsulation = ietf, vlink = 4

DLCI = 302, IP 10.10.10.2, Serial1/0/0

create time = 2015/11/24 05:54:59, status = ACTIVE

encapsulation = ietf, vlink = 3

<AR3>ping 10.10.10.1

PING 10.10.10.1: 56 data bytes, press CTRL_C to break

Reply from 10.10.10.1: bytes=56 Sequence=1 ttl=255 time=30 ms

Reply from 10.10.10.1: bytes=56 Sequence=2 ttl=255 time=10 ms

Reply from 10.10.10.1: bytes=56 Sequence=3 ttl=255 time=20 ms

```

Reply from 10.10.10.1: bytes=56 Sequence=4 ttl=255 time=10 ms

--- 10.10.10.1 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/17/30 ms

```

```

<AR3>ping 10.10.10.2
PING 10.10.10.2: 56 data bytes, press CTRL_C to break
Reply from 10.10.10.2: bytes=56 Sequence=1 ttl=255 time=20 ms
Reply from 10.10.10.2: bytes=56 Sequence=2 ttl=255 time=10 ms
Reply from 10.10.10.2: bytes=56 Sequence=3 ttl=255 time=20 ms
Reply from 10.10.10.2: bytes=56 Sequence=4 ttl=255 time=10 ms

--- 10.10.10.2 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/15/20 ms

```

- Configure GE 0/0/0 interfaces on AR1, AR4 and AR5.
- Use the IP addresses shown on the diagram.

AR1:

```

[AR1]interface GigabitEthernet 0/0/0

[AR1-GigabitEthernet0/0/0]ip address 10.10.2.1 24

[AR1-GigabitEthernet0/0/0]return

```

AR4:

```

[AR4]interface GigabitEthernet 0/0/0

[AR4-GigabitEthernet0/0/0]ip address 10.10.2.4 24

[AR4-GigabitEthernet0/0/0]return

```

AR5:

```

[AR5]interface GigabitEthernet 0/0/05

[AR5-GigabitEthernet0/0/0]ip address 10.10.2.4 24

[AR5-GigabitEthernet0/0/0]return

```

Verify the configuration:

AR1:

```

<AR1>ping 10.10.2.4
PING 10.10.2.4: 56 data bytes, press CTRL_C to break
Reply from 10.10.2.4: bytes=56 Sequence=1 ttl=255 time=100 ms
Reply from 10.10.2.4: bytes=56 Sequence=2 ttl=255 time=40 ms
Reply from 10.10.2.4: bytes=56 Sequence=3 ttl=255 time=20 ms

```

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```

Reply from 10.10.2.4: bytes=56 Sequence=4 ttl=255 time=40 ms

--- 10.10.2.4 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 20/50/100 ms

```

<AR1>ping 10.10.2.5

```

PING 10.10.2.5: 56 data bytes, press CTRL_C to break
Reply from 10.10.2.5: bytes=56 Sequence=1 ttl=255 time=40 ms
Reply from 10.10.2.5: bytes=56 Sequence=2 ttl=255 time=40 ms
Reply from 10.10.2.5: bytes=56 Sequence=3 ttl=255 time=40 ms
Reply from 10.10.2.5: bytes=56 Sequence=4 ttl=255 time=30 ms

```

```

--- 10.10.2.5 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 30/37/40 ms

```

- Configure HDLC encapsulation on the link between AR5 and AR8.
- Use the IP addresses shown on the diagram.

AR5:

```

[AR5]interface Serial 1/0/0

[AR5-Serial1/0/0]link-protocol hdlc

[AR5-Serial1/0/0]ip address 10.10.3.1 30

```

AR8:

```

<AR8>system-view
Enter system view, return user view with Ctrl+Z.

[AR8]interface Serial 1/0/0

[AR8-Serial1/0/0]link-protocol hdlc

[AR8-Serial1/0/0]ip address 10.10.3.2 30

```

Verify the configuration:

AR5:

```

<AR5>display interface Serial 1/0/0
Serial1/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-11-24 07:16:36 UTC-08:00
Description:HUAWEI, AR Series, Serial1/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.10.3.1/30
Link layer protocol is nonstandard HDLC
Last physical up time : 2015-11-24 07:15:32 UTC-08:00
Last physical down time : 2015-11-24 07:15:32 UTC-08:00

```

```
Current system time: 2015-11-24 07:23:54-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 4 bytes/sec 32 bits/sec 0 packets/sec
Last 300 seconds output rate 2 bytes/sec 16 bits/sec 0 packets/sec
```

```
Input: 4602 packets, 148052 bytes
```

```
Broadcast:      0, Multicast:      0
Errors:         0, Runt:           0
Giants:         0, CRC:            0
```

```
Alignments:     0, Overruns:       0
Dribbles:       0, Aborts:         0
No Buffers:     0, Frame Error:    0
```

```
Output: 4602 packets, 56036 bytes
```

```
Total Error:    0, Overruns:       0
Collisions:     0, Deferred:       0
Input bandwidth utilization : 0%
Output bandwidth utilization : 0%
```

<AR5>ping 10.10.3.2

```
PING 10.10.3.2: 56 data bytes, press CTRL_C to break
Reply from 10.10.3.2: bytes=56 Sequence=1 ttl=255 time=50 ms
Reply from 10.10.3.2: bytes=56 Sequence=2 ttl=255 time=10 ms
Reply from 10.10.3.2: bytes=56 Sequence=3 ttl=255 time=20 ms
Reply from 10.10.3.2: bytes=56 Sequence=4 ttl=255 time=20 ms
```

```
--- 10.10.3.2 ping statistics ---
```

```
4 packet(s) transmitted
4 packet(s) received
0.00% packet loss
round-trip min/avg/max = 10/25/50 ms
```

- Configure Serial link between AR3 and AR6 with PPP encapsulation. AR3 should authenticate AR6 using user *lab@huawei* and password *workbook*.
- Configure the IP address as shown on the diagram.

AR3:

<AR3>system-view

Enter system view, return user view with Ctrl+Z.

```
[AR3]aaa
```

```
[AR3-aaa]authentication-scheme huawei_ppp
```

Info: Create a new authentication scheme.

```
[AR3-aaa-authen-huawei_ppp]quit
```

```
[AR3-aaa]domain huawei
```

Info: Success to create a new domain.

```
[AR3-aaa-domain-huawei]authentication-scheme huawei_ppp
```

```
[AR3-aaa-domain-huawei]quit
```

```
[AR3-aaa]local-user lab@huawei password cipher workbook
```

Info: Add a new user.

```
[AR3-aaa]local-user lab@huawei service-type ppp
```

```
[AR3-aaa]quit
```

```
[AR3]interface Serial 1/0/1
```

```
[AR3-Serial1/0/1]link-protocol ppp
```

```
[AR3-Serial1/0/1]ppp authentication-mode chap domain huawei
```

```
[AR3-Serial1/0/1]ip address 10.0.4.1 30
```

```
[AR3-Serial1/0/1]quit
```

AR6:

```
<AR6>system-view
```

Enter system view, return user view with Ctrl+Z.

```
[AR6]interface Serial 1/0/1
```

```
[AR6-Serial1/0/1]link-protocol ppp
```

```
[AR6-Serial1/0/1]ppp chap user lab@huawei
```

```
[AR6-Serial1/0/1]ppp chap password cipher workbook
```

```
[AR6-Serial1/0/1]ip address 10.0.4.2 30
```

Verify the configuration:

AR3:

```
<AR3>display interface serial 1/0/1
```

Serial1/0/1 current state : UP

Line protocol current state : UP

Last line protocol up time : 2015-11-24 07:40:03 UTC-08:00

Description:HUAWEI, AR Series, Serial1/0/1 Interface

Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)

Internet Address is 10.0.4.1/30

Link layer protocol is PPP

LCP opened, IPCP opened

Last physical up time : 2015-11-24 00:56:19 UTC-08:00

Last physical down time : 2015-11-24 00:56:06 UTC-08:00

Current system time: 2015-11-24 07:40:30-08:00

Physical layer is synchronous, Virtualbaudrate is 64000 bps

Interface is DTE, Cable type is V11, Clock mode is TC

Last 300 seconds input rate 7 bytes/sec 56 bits/sec 0 packets/sec

Last 300 seconds output rate 2 bytes/sec 16 bits/sec 0 packets/sec

Input: 4856 packets, 155406 bytes

Broadcast: 0, Multicast: 0

Errors: 0, Runt: 0

Giants: 0, CRC: 0

Alignments: 0, Overruns: 0

Dribbles: 0, Aborts: 0

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```

No Buffers:      0, Frame Error:      0

Output: 4855 packets, 58284 bytes
Total Error:      0, Overruns:      0
Collisions:      0, Deferred:      0
  Input bandwidth utilization :  0%
  Output bandwidth utilization :  0%

<AR3>ping 10.0.4.2
PING 10.0.4.2: 56 data bytes, press CTRL_C to break
  Reply from 10.0.4.2: bytes=56 Sequence=1 ttl=255 time=50 ms
  Reply from 10.0.4.2: bytes=56 Sequence=2 ttl=255 time=1 ms
  Reply from 10.0.4.2: bytes=56 Sequence=3 ttl=255 time=10 ms
  Reply from 10.0.4.2: bytes=56 Sequence=4 ttl=255 time=20 ms
  Reply from 10.0.4.2: bytes=56 Sequence=5 ttl=255 time=10 ms

--- 10.0.4.2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 1/18/50 ms

```

AR6:

```

<AR6>display interface Serial 1/0/1
Serial1/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-11-24 07:39:52 UTC-08:00
Description:HUAWEI, AR Series, Serial1/0/1 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.0.4.2/30
Link layer protocol is PPP
LCP opened, IPCP opened
Last physical up time   : 2015-11-24 00:56:18 UTC-08:00
Last physical down time : 2015-11-24 00:56:15 UTC-08:00
Current system time: 2015-11-24 07:57:48-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 6 bytes/sec 48 bits/sec 0 packets/sec
Last 300 seconds output rate 2 bytes/sec 16 bits/sec 0 packets/sec

Input: 5070 packets, 162644 bytes
Broadcast:      0, Multicast:      0
Errors:         0, Runt:           0
Giants:         0, CRC:            0

Alignments:     0, Overruns:       0
Dribbles:       0, Aborts:         0
No Buffers:     0, Frame Error:    0

Output: 5071 packets, 61246 bytes
Total Error:     0, Overruns:      0
Collisions:     0, Deferred:       0
  Input bandwidth utilization :  0%
  Output bandwidth utilization :  0%

```

- Configure the link between AR6 and AR7, AR7 and AR9, AR9 and AR2 with IP addresses shown on the diagram using the default link encapsulation.

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AR6:

<AR6>system-view

Enter system view, return user view with Ctrl+Z.

[AR6-Serial1/0/0]ip address 10.0.4.17 30

AR7:

<AR7>system-view

Enter system view, return user view with Ctrl+Z.

[AR7]interface Serial 1/0/0

[AR7-Serial1/0/0]ip address 10.0.4.18 30

[AR7-Serial1/0/0]quit

[AR7]interface Serial 1/0/1

[AR7-Serial1/0/1]ip address 192.168.96.1 30

AR9:

<AR9>system-view

Enter system view, return user view with Ctrl+Z.

[AR9]interface Serial 1/0/1

[AR9-Serial1/0/1]ip address 192.168.96.2 30

[AR9-Serial1/0/1]quit

[AR9]interface Serial 1/0/0

[AR9-Serial1/0/0]ip address 10.10.11.2 30

[AR9-Serial1/0/0]quit

AR2:

<AR2>system-view

Enter system view, return user view with Ctrl+Z.

[AR2]interface Serial 1/0/1

[AR2-Serial1/0/1]ip address 10.10.11.1 30

[AR2-Serial1/0/1]quit

- Configure OSPF on AR1, AR2 and AR3 Serial 0/0/0 interfaces in Area 0.

AR1:

<AR1>system-view

Enter system view, return user view with Ctrl+Z.

[AR1]ospf 1

```
[AR1-ospf-1]area 0
[AR1-ospf-1-area-0.0.0.0]network 10.10.10.0 0.0.0.255
[AR1-ospf-1-area-0.0.0.0]quit
[AR1-ospf-1]peer 10.10.10.2
[AR1-ospf-1]peer 10.10.10.3
```

AR2:

```
<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]ospf 1
[AR2-ospf-1]area 0
[AR2-ospf-1-area-0.0.0.0]network 10.10.10.0 0.0.0.255
[AR2-ospf-1-area-0.0.0.0]quit
[AR2-ospf-1]peer 10.10.10.1
[AR2-ospf-1]peer 10.10.10.3
```

AR3:

```
<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]ospf 1
[AR3-ospf-1]area 0
[AR3-ospf-1-area-0.0.0.0]network 10.10.10.0 0.0.0.255
[AR3-ospf-1-area-0.0.0.0]quit
[AR3-ospf-1]peer 10.10.10.1
[AR3-ospf-1]peer 10.10.10.2
```


Verify the configuration:

AR1:

```
<AR1>display ospf peer

      OSPF Process 1 with Router ID 10.10.10.1
        Neighbors

Area 0.0.0.0 interface 10.10.10.1(Serial1/0/0)'s neighbors
Router ID: 10.10.10.2    Address: 10.10.10.2
State: Full Mode:Nbr is Master Priority: 1
DR: 10.10.10.2 BDR: 10.10.10.1 MTU: 0
Dead timer due in 106 sec
Retrans timer interval: 0
Neighbor is up for 10:29:26
Authentication Sequence: [ 0 ]

Router ID: 10.10.10.3    Address: 10.10.10.3
State: Full Mode:Nbr is Master Priority: 1
DR: 10.10.10.2 BDR: 10.10.10.1 MTU: 0
Dead timer due in 96 sec
Retrans timer interval: 0
Neighbor is up for 10:25:31
Authentication Sequence: [ 0 ]

<AR1>display ospf interface Serial 1/0/0

      OSPF Process 1 with Router ID 10.10.10.1
        Interfaces

Interface: 10.10.10.1 (Serial1/0/0)
Cost: 48    State: BDR    Type: NBMA    MTU: 1500
Priority: 1
Designated Router: 10.10.10.2
Backup Designated Router: 10.10.10.1
Timers: Hello 30 , Dead 120 , Poll 120 , Retransmit 5 , Transmit Delay 1
```

AR2:

```
<AR2>display ospf peer

      OSPF Process 1 with Router ID 10.10.10.2
        Neighbors

Area 0.0.0.0 interface 10.10.10.2(Serial1/0/0)'s neighbors
Router ID: 10.10.10.1    Address: 10.10.10.1
State: Full Mode:Nbr is Slave Priority: 1
DR: 10.10.10.2 BDR: 10.10.10.1 MTU: 0
Dead timer due in 119 sec
Retrans timer interval: 5
Neighbor is up for 10:32:57
Authentication Sequence: [ 0 ]

Router ID: 10.10.10.3    Address: 10.10.10.3
State: Full Mode:Nbr is Master Priority: 1
DR: 10.10.10.2 BDR: 10.10.10.1 MTU: 0
Dead timer due in 109 sec
```

Retrans timer interval: 5
 Neighbor is up for 10:29:02
 Authentication Sequence: [0]

<AR2>**display ospf interface Serial 1/0/0**

OSPF Process 1 with Router ID 10.10.10.2
 Interfaces

Interface: 10.10.10.2 (Serial1/0/0)
 Cost: 48 State: DR Type: NBMA MTU: 1500
 Priority: 1
 Designated Router: 10.10.10.2
 Backup Designated Router: 10.10.10.1
 Timers: Hello 30 , Dead 120 , Poll 120 , Retransmit 5 , Transmit Delay 1

AR3:

<AR2>**display ospf peer**

OSPF Process 1 with Router ID 10.10.10.2
 Neighbors

Area 0.0.0.0 interface 10.10.10.2(Serial1/0/0)'s neighbors
 Router ID: 10.10.10.1 Address: 10.10.10.1
 State: Full Mode:Nbr is Slave Priority: 1
 DR: 10.10.10.2 BDR: 10.10.10.1 MTU: 0
 Dead timer due in 119 sec
 Retrans timer interval: 5
 Neighbor is up for 10:32:57
 Authentication Sequence: [0]

Router ID: 10.10.10.3 Address: 10.10.10.3
 State: Full Mode:Nbr is Master Priority: 1
 DR: 10.10.10.2 BDR: 10.10.10.1 MTU: 0
 Dead timer due in 109 sec
 Retrans timer interval: 5
 Neighbor is up for 10:29:02
 Authentication Sequence: [0]

<AR2>**display ospf interface Serial 1/0/0**

OSPF Process 1 with Router ID 10.10.10.2
 Interfaces

Interface: 10.10.10.2 (Serial1/0/0)
 Cost: 48 State: DR Type: NBMA MTU: 1500
 Priority: 1
 Designated Router: 10.10.10.2
 Backup Designated Router: 10.10.10.1
 Timers: Hello 30 , Dead 120 , Poll 120 , Retransmit 5 , Transmit Delay 1

- Configure OSPF on AR1, AR4 and AR5 GE0/0/0 interfaces in Area 1. Make sure that AR1 is DR for the segment, where AR4 is BDR and AR5 should not participate in DR election.

AR1:

```
<AR1>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR1]interface GigabitEthernet 0/0/0  
  
[AR1-GigabitEthernet0/0/0]ospf dr-priority 100  
  
[AR1-GigabitEthernet0/0/0]quit  
  
[AR1]ospf 1  
  
[AR1-ospf-1]area 1  
  
[AR1-ospf-1-area-0.0.0.1]network 10.10.2.0 0.0.0.255  
  
[AR1-ospf-1-area-0.0.0.1]return
```

AR4:

```
<AR4>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR4]interface GigabitEthernet 0/0/0  
  
[AR4-GigabitEthernet0/0/0]ospf dr-priority 50  
  
[AR4-GigabitEthernet0/0/0]quit  
  
[AR4]ospf 1  
  
[AR4-ospf-1]area 1  
  
[AR4-ospf-1-area-0.0.0.1]network 10.10.2.0 0.0.0.255  
  
[AR4-ospf-1-area-0.0.0.1]return
```

AR5:

```
<AR5>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR5]interface GigabitEthernet 0/0/0  
  
[AR5-GigabitEthernet0/0/0]ospf dr-priority 0  
  
[AR5-GigabitEthernet0/0/0]quit  
  
[AR5]ospf 1  
  
[AR5-ospf-1]area 1  
  
[AR5-ospf-1-area-0.0.0.1]network 10.10.2.0 0.0.0.255  
  
[AR5-ospf-1-area-0.0.0.1]return
```

Verify the configuration:

AR1:

```
<AR1>display ospf peer

      OSPF Process 1 with Router ID 10.10.10.1
        Neighbors

Area 0.0.0.1 interface 10.10.2.1(GigabitEthernet0/0/0)'s neighbors
Router ID: 10.10.2.4    Address: 10.10.2.4
State: Full Mode:Nbr is Slave Priority: 50
DR: 10.10.2.1 BDR: 10.10.2.4 MTU: 0
Dead timer due in 35 sec
Retrans timer interval: 5
Neighbor is up for 00:02:25
Authentication Sequence: [ 0 ]

Router ID: 10.10.2.5    Address: 10.10.2.5
State: Full Mode:Nbr is Slave Priority: 0
DR: 10.10.2.1 BDR: 10.10.2.4 MTU: 0
Dead timer due in 34 sec
Retrans timer interval: 5
Neighbor is up for 00:00:18
Authentication Sequence: [ 0 ]

<AR1>display ospf interface GigabitEthernet 0/0/0

      OSPF Process 1 with Router ID 10.10.10.1
        Interfaces

Interface: 10.10.2.1 (GigabitEthernet0/0/0)
Cost: 1    State: DR    Type: Broadcast    MTU: 1500
Priority: 100
Designated Router: 10.10.2.1
Backup Designated Router: 10.10.2.4
Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1
```

AR4:

```
<AR4>display ospf peer

      OSPF Process 1 with Router ID 10.10.2.4
        Neighbors

Area 0.0.0.1 interface 10.10.2.4(GigabitEthernet0/0/0)'s neighbors
Router ID: 10.10.10.1    Address: 10.10.2.1
State: Full Mode:Nbr is Master Priority: 100
DR: 10.10.2.1 BDR: 10.10.2.4 MTU: 0
Dead timer due in 29 sec
Retrans timer interval: 5
Neighbor is up for 00:03:24
Authentication Sequence: [ 0 ]

Router ID: 10.10.2.5    Address: 10.10.2.5
State: Full Mode:Nbr is Master Priority: 0
DR: 10.10.2.1 BDR: 10.10.2.4 MTU: 0
Dead timer due in 36 sec
```

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Retrans timer interval: 5
 Neighbor is up for 00:01:11
 Authentication Sequence: [0]

<AR4>**display ospf interface GigabitEthernet 0/0/0**

OSPF Process 1 with Router ID 10.10.2.4
 Interfaces

Interface: 10.10.2.4 (GigabitEthernet0/0/0)
 Cost: 1 State: BDR Type: Broadcast MTU: 1500
Priority: 50
 Designated Router: 10.10.2.1
 Backup Designated Router: 10.10.2.4
 Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1

AR5:

<AR5>**display ospf peer**

OSPF Process 1 with Router ID 10.10.2.5
 Neighbors

Area 0.0.0.1 interface 10.10.2.5(GigabitEthernet0/0/0)'s neighbors

Router ID: 10.10.10.1 Address: 10.10.2.1
 State: Full Mode:Nbr is Master Priority: 100
DR: 10.10.2.1 BDR: 10.10.2.4 MTU: 0
 Dead timer due in 33 sec
 Retrans timer interval: 5
 Neighbor is up for 00:02:24
 Authentication Sequence: [0]

Router ID: 10.10.2.4 Address: 10.10.2.4
 State: Full Mode:Nbr is Slave Priority: 50
DR: 10.10.2.1 BDR: 10.10.2.4 MTU: 0
 Dead timer due in 34 sec
 Retrans timer interval: 5
 Neighbor is up for 00:02:18
 Authentication Sequence: [0]

<AR5>**display ospf interface GigabitEthernet 0/0/0**

OSPF Process 1 with Router ID 10.10.2.5
 Interfaces

Interface: 10.10.2.5 (GigabitEthernet0/0/0)
 Cost: 1 State: DROther Type: Broadcast MTU: 1500
Priority: 0
 Designated Router: 10.10.2.1
 Backup Designated Router: 10.10.2.4
 Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1

- Configure Serial link between AR3 and AR6. Make sure that no LSA 4 and LSA 5 are allowed.

AR3:

<AR3>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR3]**ospf 1**

[AR3-ospf-1]**area 2**

[AR3-ospf-1-area-0.0.0.2]**network 10.0.4.0 0.0.0.3**

[AR3-ospf-1-area-0.0.0.2]**nssa default-route-advertise**

[AR3-ospf-1-area-0.0.0.2]**return**

AR6:

<AR6>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR6]**ospf 1**

[AR6-ospf-1]**area 2**

[AR6-ospf-1-area-0.0.0.2]**nssa**

[AR6-ospf-1-area-0.0.0.2]**network 10.0.4.0 0.0.0.3**

[AR6-ospf-1-area-0.0.0.2]**return**

Verify the configuration:

AR3:

<AR3>**display ospf peer**

OSPF Process 1 with Router ID 10.10.10.3
Neighbors

Area 0.0.0.2 interface 10.0.4.1(Serial1/0/1)'s neighbors
Router ID: 10.0.4.2 Address: 10.0.4.2
State: Full Mode:Nbr is Slave Priority: 1
DR: None BDR: None MTU: 0
Dead timer due in 36 sec
Retrans timer interval: 5
Neighbor is up for 00:00:43
Authentication Sequence: [0]

<AR3>**display ospf interface Serial 1/0/1**

OSPF Process 1 with Router ID 10.10.10.3
Interfaces

Interface: 10.0.4.1 (Serial1/0/1) --> 10.0.4.2
Cost: 48 State: P-2-P Type: P2P MTU: 1500
Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1

AR6:

<AR6>display ospf peer

OSPF Process 1 with Router ID 10.0.4.2
Neighbors

Area 0.0.0.2 interface 10.0.4.2(Serial1/0/1)'s neighbors
Router ID: 10.10.10.3 Address: 10.0.4.1
State: Full Mode:Nbr is Master Priority: 1
DR: None BDR: None MTU: 0
Dead timer due in 36 sec
Retrans timer interval: 5
Neighbor is up for 00:00:11
Authentication Sequence: [0]

<AR6>display ospf interface Serial 1/0/1

OSPF Process 1 with Router ID 10.0.4.2
Interfaces

Interface: 10.0.4.2 (Serial1/0/1) --> 10.0.4.1
Cost: 48 State: P-2-P Type: P2P MTU: 1500
Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1

<AR6>display ospf lsdb

OSPF Process 1 with Router ID 10.0.4.2
Link State Database

Area: 0.0.0.2

Type	LinkState ID	AdvRouter	Age	Len	Sequence	Metric
Router	10.0.4.2	10.0.4.2	33	48	8000000B	48
Router	10.10.10.3	10.10.10.3	32	48	8000000C	48
Sum-Net	10.10.2.0	10.10.10.3	35	28	80000001	49
Sum-Net	10.10.10.0	10.10.10.3	35	28	80000001	48
NSSA	0.0.0.0	10.10.10.3	34	36	80000009	1

- Configure Serial link between AR5 and AR8 in Area 100.

AR5:

<AR5>system-view

Enter system view, return user view with Ctrl+Z.

[AR5]ospf 1

[AR5-ospf-1]area 100

[AR5-ospf-1-area-0.0.0.100]network 10.10.3.0 0.0.0.3

[AR5-ospf-1-area-0.0.0.100]return

AR8:

```
<AR8>system-view
Enter system view, return user view with Ctrl+Z.

[AR8]ospf 1

[AR8-ospf-1]area 100

[AR8-ospf-1-area-0.0.0.100]network 10.10.3.0 0.0.0.3

[AR8-ospf-1-area-0.0.0.100]return
```

Verify the configuration:

AR5:

```
<AR5>display ospf peer

        OSPF Process 1 with Router ID 10.10.2.5
          Neighbors

Area 0.0.0.100 interface 10.10.3.1(Serial1/0/0)'s neighbors
Router ID: 10.10.3.2    Address: 10.10.3.2
State: Full  Mode:Nbr is Master  Priority: 1
DR: None  BDR: None  MTU: 0
Dead timer due in 40 sec
Retrans timer interval: 5
Neighbor is up for 00:00:46
Authentication Sequence: [ 0 ]

<AR5>display ospf interface Serial 1/0/0

        OSPF Process 1 with Router ID 10.10.2.5
          Interfaces

Interface: 10.10.3.1 (Serial1/0/0) --> 10.10.3.2
Cost: 48  State: P-2-P  Type: P2P  MTU: 1500
Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1
```

- Configure RIPv2 on AR2, AR9, AR7 and AR6. Make sure that all subnets are advertised by AR7.
- AR2 and AR6 should send RIP updates only on the interfaces to AR9 and AR7 respectively.

AR2:

```
[AR2]rip 1

[AR2-rip-1]version 2

[AR2-rip-1]network 10.0.0.0

[AR2-rip-1]silent-interface Serial 1/0/0

[AR2-rip-1]return
```


AR6:

```
[AR6]rip 1
[AR6-rip-1]version 2
[AR6-rip-1]network 10.0.0.0
[AR6-rip-1]silent-interface Serial 1/0/1
[AR6-rip-1]return
```

AR7:

```
<AR7>system-view
Enter system view, return user view with Ctrl+Z.

[AR7]rip 1
[AR7-rip-1]network 10.0.0.0
[AR7-rip-1]network 192.168.96.0
[AR7-rip-1]version 2
[AR7-rip-1]import-route static
[AR7-rip-1]quit
[AR7]ip route-static 192.168.96.0 24 NULL 0
[AR7]ip route-static 192.168.97.0 24 NULL 0
[AR7]ip route-static 192.168.98.0 24 NULL 0
[AR7]ip route-static 192.168.99.0 24 NULL 0
[AR7]ip route-static 192.168.100.0 24 NULL 0
[AR7]ip route-static 192.168.101.0 24 NULL 0
[AR7]ip route-static 192.168.102.0 24 NULL 0
[AR7]ip route-static 192.168.103.0 24 NULL 0
[AR7]ip route-static 172.16.5.0 24 NULL 0
```

AR9:

```
[AR9]rip 1
[AR9-rip-1]version 2
[AR9-rip-1]network 192.168.96.0
[AR9-rip-1]network 10.0.0.0
[AR9-rip-1]return
```

Verify the configuration:

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<https://t.me/learningnets>

AR2:

<AR2>display rip 1 neighbor

```

-----
IP Address    Interface          Type  Last-Heard-Time
-----
10.10.11.2    Serial1/0/1        RIP   0:0:21
Number of RIP routes : 9

```

<AR2>display rip 1 route

Route Flags : R - RIP

A - Aging, G - Garbage-collect

Peer 10.10.11.2 on Serial1/0/1

```

-----
Destination/Mask  Nexthop  Cost  Tag  Flags  Sec
192.168.96.0/24   10.10.11.2  1  0    RA     4
192.168.97.0/24   10.10.11.2  2  0    RA     4
192.168.98.0/24   10.10.11.2  2  0    RA     4
192.168.99.0/24   10.10.11.2  2  0    RA     4
192.168.100.0/24  10.10.11.2  2  0    RA     4
192.168.101.0/24  10.10.11.2  2  0    RA     4
192.168.102.0/24  10.10.11.2  2  0    RA     4
192.168.103.0/24  10.10.11.2  2  0    RA     4
172.16.5.0/24     10.10.11.2  2  0    RA     4

```

AR6:

<AR6>display rip 1 neighbor

```

-----
IP Address    Interface          Type  Last-Heard-Time
-----
10.0.4.18     Serial1/0/0        RIP   0:0:14
Number of RIP routes : 10

```

<AR6>display rip 1 route

Route Flags : R - RIP

A - Aging, G - Garbage-collect

Peer 10.0.4.18 on Serial1/0/0

```

-----
Destination/Mask  Nexthop  Cost  Tag  Flags  Sec
192.168.96.0/24   10.0.4.18  1  0    RA    17
10.10.11.0/30     10.0.4.18  1  0    RA    17
192.168.103.0/24  10.0.4.18  1  0    RA    17
192.168.102.0/24  10.0.4.18  1  0    RA    17
192.168.101.0/24  10.0.4.18  1  0    RA    17
192.168.100.0/24  10.0.4.18  1  0    RA    17
192.168.99.0/24   10.0.4.18  1  0    RA    17
192.168.98.0/24   10.0.4.18  1  0    RA    17
192.168.97.0/24   10.0.4.18  1  0    RA    17
172.16.5.0/24     10.0.4.18  1  0    RA    17

```

AR7:

<AR7>display rip 1 neighbor

IP Address	Interface	Type	Last-Heard-Time
10.0.4.17	Serial1/0/0	RIP	0:0:9
Number of RIP routes : 1			
192.168.96.2	Serial1/0/1	RIP	0:0:19
Number of RIP routes : 1			

AR9:

<AR9>display rip 1 neighbor

IP Address	Interface	Type	Last-Heard-Time
10.10.11.1	Serial1/0/0	RIP	0:0:32
Number of RIP routes : 1			
192.168.96.1	Serial1/0/1	RIP	0:0:15
Number of RIP routes : 10			

- Redistribute all shown routes as External from AR4 to the OSPF domain.

AR4:

<AR4>system-view

Enter system view, return user view with Ctrl+Z.

[AR4]ip route-static 172.31.16.0 24 NULL 0

[AR4]ip route-static 172.31.17.0 24 NULL 0

[AR4]ip route-static 172.31.18.0 24 NULL 0

[AR4]ip route-static 172.31.19.0 24 NULL 0

[AR4]ospf 1

[AR4-ospf-1]import-route static

[AR4-ospf-1]return

Verify the configuration:

AR4:

<AR4>display ospf lsdb ase

OSPF Process 1 with Router ID 10.10.2.4
Link State Database

Type : External

Ls id : 172.31.18.0

Adv rtr : 10.10.2.4

Ls age : 65

Len : 36

Options : E

seq# : 80000001

checksum : 0x2dab

Net mask : 255.255.255.0

TOS 0 Metric: 1

E type : 2

Forwarding Address : 0.0.0.0

Tag : 1

Priority : Low

Type : External

Ls id : 172.31.19.0

```

Adv rtr : 10.10.2.4
Ls age : 65
Len : 36
Options : E
seq# : 80000001
chksum : 0x22b5
Net mask : 255.255.255.0
TOS 0 Metric: 1
E type : 2
Forwarding Address : 0.0.0.0
Tag : 1
Priority : Low

```

```

Type : External
Ls id : 172.31.16.0
Adv rtr : 10.10.2.4
Ls age : 68
Len : 36
Options : E
seq# : 80000001
chksum : 0x4397
Net mask : 255.255.255.0
TOS 0 Metric: 1
E type : 2
Forwarding Address : 0.0.0.0
Tag : 1
Priority : Low

```

```

Type : External
Ls id : 172.31.17.0
Adv rtr : 10.10.2.4
Ls age : 68
Len : 36
Options : E
seq# : 80000001
chksum : 0x38a1
Net mask : 255.255.255.0
TOS 0 Metric: 1
E type : 2
Forwarding Address : 0.0.0.0
Tag : 1
Priority : Low

```

AR3:

<AR3>display ospf routing

OSPF Process 1 with Router ID 10.10.10.3
Routing Tables

Routing for Network

Destination	Cost	Type	NextHop	AdvRouter	Area
10.0.4.0/30	48	Stub	10.0.4.1	10.10.10.3	0.0.0.2
10.10.10.0/24	48	Transit	10.10.10.3	10.10.10.3	0.0.0.0
10.10.2.0/24	49	Inter-area	10.10.10.1	10.10.10.1	0.0.0.0

Routing for ASEs

Destination	Cost	Type	Tag	NextHop	AdvRouter
172.31.16.0/24	1	Type2	1	10.10.10.1	10.10.2.4

```

172.31.17.0/24 1 Type2 1 10.10.10.1 10.10.2.4
172.31.18.0/24 1 Type2 1 10.10.10.1 10.10.2.4
172.31.19.0/24 1 Type2 1 10.10.10.1 10.10.2.4

```

Total Nets: 7

Intra Area: 2 Inter Area: 1 ASE: 4 NSSA: 0

<AR3>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 18 Routes : 18

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.4.0/30	Direct	0	0	D	10.0.4.1	Serial1/0/1
10.0.4.1/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.0.4.2/32	Direct	0	0	D	10.0.4.2	Serial1/0/1
10.0.4.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.10.2.0/24	OSPF	10	49	D	10.10.10.1	Serial1/0/0
10.10.10.0/24	Direct	0	0	D	10.10.10.3	Serial1/0/0
10.10.10.1/32	Direct	0	0	D	10.10.10.1	Serial1/0/0
10.10.10.2/32	Direct	0	0	D	10.10.10.2	Serial1/0/0
10.10.10.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.10.255/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.31.16.0/24	O_ASE	150	1	D	10.10.10.1	Serial1/0/0
172.31.17.0/24	O_ASE	150	1	D	10.10.10.1	Serial1/0/0
172.31.18.0/24	O_ASE	150	1	D	10.10.10.1	Serial1/0/0
172.31.19.0/24	O_ASE	150	1	D	10.10.10.1	Serial1/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

- Summarise the External routes advertised by AR4 entering Area 0. Make sure that AR5 also have only the summary route.

AR4:

```
[AR4]ospf 1
```

```
[AR4-ospf-1]asbr-summary 172.31.16.0 255.255.252.0
```

Verify the configuration:

AR4:

```
<AR4>display ospf lsdb ase
```

```

OSPF Process 1 with Router ID 10.10.2.4
Link State Database

```

```

Type      : External
Ls id     : 172.31.16.0
Adv rtr   : 10.10.2.4
Ls age    : 217
Len       : 36
Options   : E

```

```
seq#      : 80000003
chksum    : 0x3aa0
Net mask  : 255.255.252.0
TOS 0 Metric: 2
E type    : 2
Forwarding Address : 0.0.0.0
Tag       : 1
Priority   : Low
```

AR5:

```
<AR5>display ip routing-table protocol ospf
```

```
Route Flags: R - relay, D - download to fib
```

```
-----
Public routing table : OSPF
```

```
Destinations : 3      Routes : 3
```

```
OSPF routing table status : <Active>
```

```
Destinations : 3      Routes : 3
```

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.4.0/30	OSPF	10	97	D	10.10.2.1	GigabitEthernet0
10.10.10.0/24	OSPF	10	49	D	10.10.2.1	GigabitEthernet0
172.31.16.0/22	O ASE	150	2	D	10.10.2.4	GigabitEthernet0

```
OSPF routing table status : <Inactive>
```

```
Destinations : 0      Routes : 0
```

- Advertise all OSPF routes to RIPv2 from AR2 except any routes which start with 172.
- Advertise default route from AR2 instead.
- Advertise all OSPF routes to RIPv2 domain from AR6.

AR2:

```
[AR2]ip ip-prefix 172_routes index 5 permit 172.0.0.0 8 less-equal 32
```

```
[AR2]route-policy 172_limit deny node 5
```

```
Info: New Sequence of this List.
```

```
[AR2-route-policy]if-match ip-prefix 172_routes
```

```
[AR2-route-policy]route-policy 172_limit permi node 10
```

```
Info: New Sequence of this List.
```

```
[AR2]rip 1
```

```
[AR2-rip-1]default-route originate
```

AR6:

<AR6>system-view

Enter system view, return user view with Ctrl+Z.

[AR6]rip 1

[AR6-rip-1]import-route ospf

Verify the configuration:

AR2:

<AR2>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 27 Routes : 27

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.4.0/30	OSPF	10	96	D	10.10.10.3	Serial1/0/0
10.0.4.16/30	RIP	100	2	D	10.10.11.2	Serial1/0/1
10.10.2.0/24	OSPF	10	49	D	10.10.10.1	Serial1/0/0
10.10.10.0/24	Direct	0	0	D	10.10.10.2	Serial1/0/0
10.10.10.1/32	Direct	0	0	D	10.10.10.1	Serial1/0/0
10.10.10.2/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.10.3/32	Direct	0	0	D	10.10.10.3	Serial1/0/0
10.10.10.255/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.11.0/30	Direct	0	0	D	10.10.11.1	Serial1/0/1
10.10.11.1/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.10.11.2/32	Direct	0	0	D	10.10.11.2	Serial1/0/1
10.10.11.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.5.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
172.31.16.0/22	O_ASE	150	2	D	10.10.10.1	Serial1/0/0
192.168.96.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
192.168.96.0/30	RIP	100	1	D	10.10.11.2	Serial1/0/1
192.168.97.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
192.168.98.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
192.168.99.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
192.168.100.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
192.168.101.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
192.168.102.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
192.168.103.0/24	RIP	100	2	D	10.10.11.2	Serial1/0/1
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

AR6:

[AR6]display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 26 Routes : 26

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
0.0.0.0/0	RIP	100	3	D	10.0.4.18	Serial1/0/0
10.0.4.0/30	Direct	0	0	D	10.0.4.2	Serial1/0/1
10.0.4.1/32	Direct	0	0	D	10.0.4.1	Serial1/0/1
10.0.4.2/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.0.4.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.0.4.16/30	Direct	0	0	D	10.0.4.17	Serial1/0/0
10.0.4.17/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.0.4.18/32	Direct	0	0	D	10.0.4.18	Serial1/0/0
10.0.4.19/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.2.0/24	OSPF	10	97	D	10.0.4.1	Serial1/0/1
10.10.10.0/24	OSPF	10	96	D	10.0.4.1	Serial1/0/1
10.10.11.0/30	RIP	100	2	D	10.0.4.18	Serial1/0/0
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.5.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.96.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.96.0/30	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.97.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.98.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.99.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.100.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.101.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0
192.168.102.0/24	RIP	100	1	D	10.0.4.18	Serial1/0/0

- Redistribute all RIPv2 routes to OSPF domain on AR2 and AR6.
- Make sure that the direct interface routes on AR2 and AR6 to RIPv2 domain are advertised as internal for the OSPF domain only.

AR2:

<AR2>system-view

Enter system view, return user view with Ctrl+Z.

[AR2]ospf 1**[AR2-ospf-1]area 0****[AR2-ospf-1-area-0.0.0.0]network 10.10.11.0 0.0.0.3****[AR2-ospf-1-area-0.0.0.0]quit****[AR2-ospf-1]silent-interface Serial 1/0/1****[AR2-ospf-1]quit****[AR2]ip ip-prefix limit_direct_routes index 5 permit 10.10.11.0 30 less-equal 32****[AR2]ip ip-prefix limit_direct_routes index 10 permit 10.0.4.16 30 less-equal 32**

```
[AR2]route-policy limit_direct deny node 5
Info: New Sequence of this List.

[AR2-route-policy]if-match ip-prefix limit_direct_routes

[AR2-route-policy]quit

[AR2]route-policy limit_direct permit node 10
Info: New Sequence of this List.

[AR2-route-policy]quit

[AR2]ospf 1

[AR2-ospf-1]import-route rip route-policy limit_direct_routes

[AR2-ospf-1]quit
```

AR6:

```
[AR6]ip ip-prefix limit_direct_routes index 5 permit 10.10.11.0 30 less-equal 32

[AR6]ip ip-prefix limit_direct_routes index 10 permit 10.0.4.16 30 less-equal 32

[AR6]route-policy limit_direct deny node 5
Info: New Sequence of this List.

[AR6-route-policy]if-match ip-prefix limit_direct_routes

[AR6-route-policy]quit

[AR6]route-policy limit_direct permit node 10
Info: New Sequence of this List.

[AR6-route-policy]quit

[AR6]ospf 1

[AR6-ospf-1]import-route rip route-policy limit_direct_routes

[AR6-ospf-1]area 2

[AR6-ospf-1-area-0.0.0.2]network 10.0.4.16 0.0.0.3

[AR6-ospf-1-area-0.0.0.2]quit

[AR6-ospf-1]silent-interface serial 1/0/0

[AR6-ospf-1]return
```

Verify the configuration:

AR3:

```
<AR3>display ip routing-table protocol ospf
Route Flags: R - relay, D - download to fib
-----
Public routing table : OSPF
    Destinations : 14    Routes : 24

OSPF routing table status : <Active>
    Destinations : 14    Routes : 24

Destination/Mask  Proto  Pre  Cost   Flags NextHop   Interface
-----
10.0.4.16/30     OSPF   10   96     D  10.0.4.2   Serial1/0/1
10.10.2.0/24     OSPF   10   49     D  10.10.10.1 Serial1/0/0
10.10.11.0/30    OSPF   10   96     D  10.10.10.2 Serial1/0/0
172.16.5.0/24    O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
172.31.16.0/22   O_ASE  150  2      D  10.10.10.1 Serial1/0/0
192.168.96.0/24  O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.96.0/30  O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.97.0/24  O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.98.0/24  O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.99.0/24  O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.100.0/24 O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.101.0/24 O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.102.0/24 O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1
192.168.103.0/24 O_ASE  150  1      D  10.10.10.2 Serial1/0/0
                  O_NSSA 150  1      D  10.0.4.2   Serial1/0/1

OSPF routing table status : <Inactive>
    Destinations : 0    Routes : 0
```

- Configure AR3 to advertise only a summary route of RIP routes to Area 0.
- To avoid load balancing the traffic to the RIP destinations ensure that each router calculates the shortest path based on the cost to the RIP domain.
- Increase the cost of interface Serial 1/0/0 on AR1, AR2 and AR3 with 100.

*AR3:***<AR3>system-view**

Enter system view, return user view with Ctrl+Z.

[AR3]ospf 1**[AR3-ospf-1]asbr-summary 192.168.96.0 255.255.248.0****[AR3]interface Serial 1/0/0****[AR3-Serial1/0/0]ospf cost 148****[AR3-Serial1/0/0]quit***AR2:***[AR2]ospf 1****[AR2-ospf-1]import-route rip route-policy limit_direct_routes type 1****[AR2-ospf-1]quit****[AR2]interface Serial 1/0/0****[AR2-Serial1/0/0]ospf cost 148***AR6:***<AR6>system-view**

Enter system view, return user view with Ctrl+Z.

[AR6]ospf 1**[AR6-ospf-1]import-route rip route-policy limit_direct_routes type 1***AR1:***[AR1]interface Serial 1/0/0****[AR1-Serial1/0/0]ospf cost 148**

Verify the configuration:

AR3:

```
<AR3>display ospf lsdb ase self-originate
```

```
OSPF Process 1 with Router ID 10.10.10.3
Link State Database
```

```
Type      : External
Ls id     : 192.168.96.0
Adv rtr   : 10.10.10.3
Ls age    : 1749
Len       : 36
Options   : E
seq#      : 80000002
chksum    : 0x7dee
Net mask  : 255.255.248.0
TOS 0 Metric: 1
E type    : 1
Forwarding Address : 0.0.0.0
Tag       : 1
Priority   : Low
```

```
Type      : External
Ls id     : 172.16.5.0
Adv rtr   : 10.10.10.3
Ls age    : 1749
Len       : 36
Options   : E
seq#      : 80000001
chksum    : 0x7ae3
Net mask  : 255.255.255.0
TOS 0 Metric: 1
E type    : 1
Forwarding Address : 10.0.4.2
Tag       : 1
Priority   : Low
```

```
<AR3>display ip routing-table
```

```
Route Flags: R - relay, D - download to fib
```

```
-----
Routing Tables: Public
```

```
Destinations : 28    Routes : 28
```

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.4.0/30	Direct	0	0	D	10.0.4.1	Serial1/0/1
10.0.4.1/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.0.4.2/32	Direct	0	0	D	10.0.4.2	Serial1/0/1
10.0.4.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.0.4.16/30	OSPF	10	96	D	10.0.4.2	Serial1/0/1
10.10.2.0/24	OSPF	10	149	D	10.10.10.1	Serial1/0/0
10.10.10.0/24	Direct	0	0	D	10.10.10.3	Serial1/0/0
10.10.10.1/32	Direct	0	0	D	10.10.10.1	Serial1/0/0
10.10.10.2/32	Direct	0	0	D	10.10.10.2	Serial1/0/0
10.10.10.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.10.255/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.11.0/30	OSPF	10	196	D	10.10.10.2	Serial1/0/0

```

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0
127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0
127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0
172.16.5.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
172.31.16.0/22 O ASE 150 2 D 10.10.10.1 Serial1/0/0
192.168.96.0/21 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.96.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.96.0/30 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.97.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.98.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.99.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.100.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.101.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.102.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
192.168.103.0/24 O NSSA 150 49 D 10.0.4.2 Serial1/0/1
255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

```

- Ensure that AR6 prefers the path through AR3 to reach the rest of the network.
- Eliminate any potential routing loops in the network.
- You are allowed to use a single command line to accomplish this.

AR6:

```
<AR6>system-view
```

Enter system view, return user view with Ctrl+Z.

```
[AR6]rip 1
```

```
[AR6-rip-1]preference 180
```

Verify the configuration:

AR6:

```
<AR6>display ip routing-table
```

Route Flags: R - relay, D - download to fib

```
-----
Routing Tables: Public
```

Destinations : 27 Routes : 27

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
0.0.0.0/0	O NSSA	150	1	D	10.0.4.1	Serial1/0/1
10.0.4.0/30	Direct	0	0	D	10.0.4.2	Serial1/0/1
10.0.4.1/32	Direct	0	0	D	10.0.4.1	Serial1/0/1
10.0.4.2/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.0.4.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.0.4.16/30	Direct	0	0	D	10.0.4.17	Serial1/0/0
10.0.4.17/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.0.4.18/32	Direct	0	0	D	10.0.4.18	Serial1/0/0
10.0.4.19/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.2.0/24	OSPF	10	197	D	10.0.4.1	Serial1/0/1
10.10.10.0/24	OSPF	10	196	D	10.0.4.1	Serial1/0/1
10.10.11.0/30	OSPF	10	244	D	10.0.4.1	Serial1/0/1
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.5.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.96.0/21	RIP	180	3	D	10.0.4.18	Serial1/0/0
192.168.96.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0

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<https://t.me/learningnets>

192.168.96.0/30	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.97.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.98.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.99.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.100.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.101.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.102.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
192.168.103.0/24	RIP	180	1	D	10.0.4.18	Serial1/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

- Configure interface Loopback 100 on AR8 and set IP address 10.10.100.1/24.
- Assign interface Loopback 100 to Area 100. Ensure that interface route is advertised with correct subnet mask.
- Make sure that all routers can ping the Loopback 100 IP address.

AR8:

```
[AR8]interface LoopBack 100
[AR8-LoopBack100]ip address 10.10.100.1 255.255.255.0
[AR8-LoopBack100]ospf network-type broadcast
[AR8-LoopBack100]quit
[AR8]ospf 1
[AR8-ospf-1]area 1
[AR8-ospf-1-area-0.0.0.1]network 10.10.100.0 0.0.0.255
[AR8-ospf-1-area-0.0.0.1]quit
[AR8-ospf-1]return
```

AR5:

```
<AR5>system-view
Enter system view, return user view with Ctrl+Z.
[AR5]ospf 1
[AR5-ospf-1]area 1
[AR5-ospf-1-area-0.0.0.1]vlink-peer 10.10.10.1
[AR5-ospf-1-area-0.0.0.1]return
```

AR1:

```

<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]ospf 1

[AR1-ospf-1]area 1

[AR1-ospf-1-area-0.0.0.1]vlink-peer 10.10.2.5

[AR1-ospf-1-area-0.0.0.1]return

```

Checking configuration:

AR8:

```

<AR8>display ip routing-table 10.10.100.0
Route Flags: R - relay, D - download to fib
-----
Routing Table : Public
Summary Count : 1
Destination/Mask  Proto  Pre  Cost   Flags NextHop   Interface
-----
10.10.100.0/24   Direct  0    0       D  10.10.100.1   LoopBack100

```

AR5:

```

<AR5>display ip routing-table 10.10.100.0
Route Flags: R - relay, D - download to fib
-----
Routing Table : Public
Summary Count : 1
Destination/Mask  Proto  Pre  Cost   Flags NextHop   Interface
-----
10.10.100.0/24   OSPF    10   48       D  10.10.3.2     Serial1/0/0

```

```

<AR5>display ospf vlink

```

```

    OSPF Process 1 with Router ID 10.10.2.5
    Virtual Links

```

```

Virtual-link Neighbor-id -> 10.10.10.1, Neighbor-State: Full

```

```

Interface: 10.10.2.5 (GigabitEthernet0/0/0)
Cost: 1 State: P-2-P Type: Virtual
Transit Area: 0.0.0.1
Timers: Hello 10 , Dead 40 , Retransmit 5 , Transmit Delay 1
GR State: Normal

```


AR1:

<AR1>display ip routing-table 10.10.100.0

Route Flags: R - relay, D - download to fib

Routing Table : Public

Summary Count : 1

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.100.0/24	OSPF	10	49	D	10.10.2.5	GigabitEthernet0/0/0

<AR1>display ospf vlink

OSPF Process 1 with Router ID 10.10.10.1
Virtual Links

Virtual-link Neighbor-id -> 10.10.2.5, Neighbor-State: Full

Interface: 10.10.2.1 (GigabitEthernet0/0/0)

Cost: 1 State: P-2-P Type: Virtual

Transit Area: 0.0.0.1

Timers: Hello 10 , Dead 40 , Retransmit 5 , Transmit Delay 1

GR State: Normal

AR6:

<AR6>ping 10.10.100.1

PING 10.10.100.1: 56 data bytes, press CTRL_C to break

Reply from 10.10.100.1: bytes=56 Sequence=1 ttl=252 time=50 ms

Reply from 10.10.100.1: bytes=56 Sequence=2 ttl=252 time=60 ms

Reply from 10.10.100.1: bytes=56 Sequence=3 ttl=252 time=50 ms

Reply from 10.10.100.1: bytes=56 Sequence=4 ttl=252 time=80 ms

Reply from 10.10.100.1: bytes=56 Sequence=5 ttl=252 time=50 ms

--- 10.10.100.1 ping statistics ---

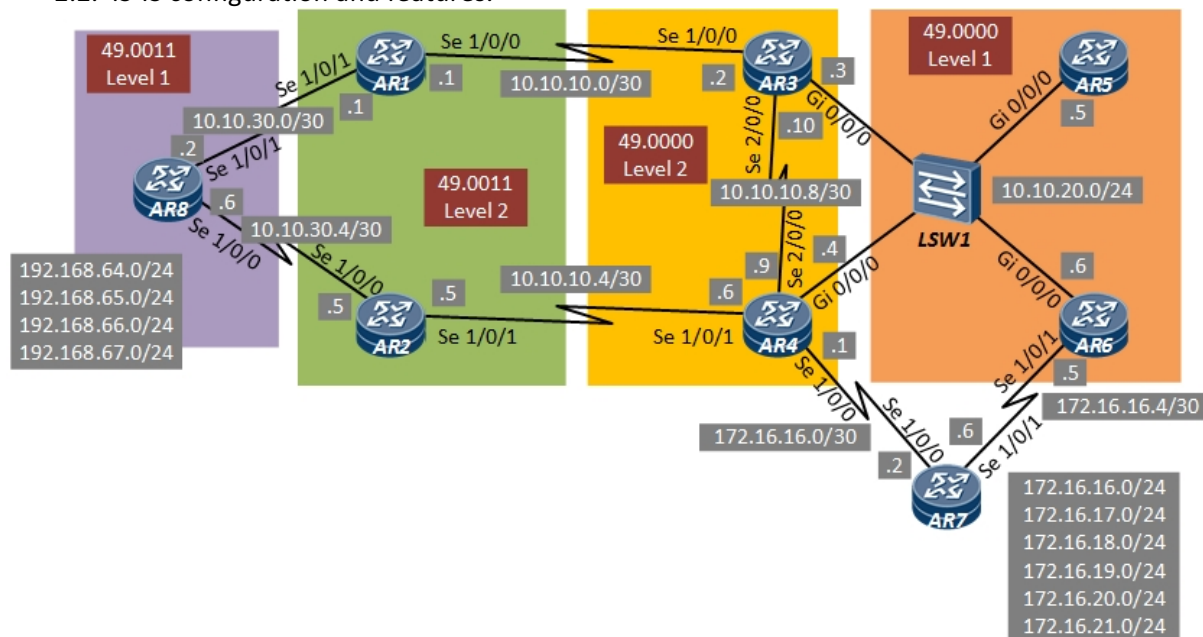
5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 50/58/80 ms

2.2. IS-IS configuration and features.



NOTE: Load topology with name – *IGP_ISIS*

- Configure the interfaces with the IP addresses shown on the diagram.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]interface Serial 1/0/0

[AR1-Serial1/0/0]ip address 10.10.10.1 30

[AR1-Serial1/0/0]quit

[AR1]interface Serial 1/0/1

[AR1-Serial1/0/1]ip address 10.10.30.1 30

[AR1-Serial1/0/1]quit
```

AR2:

```
[AR2]interface Serial 1/0/0

[AR2-Serial1/0/0]ip address 10.10.30.5 30

[AR2-Serial1/0/0]quit

[AR2]interface Serial 1/0/1

[AR2-Serial1/0/1]ip address 10.10.10.5 30

[AR2-Serial1/0/1]quit
```

AR3:

```
[AR3]interface Serial 1/0/0
[AR3-Serial1/0/0]ip address 10.10.10.2 30
[AR3-Serial1/0/0]quit
[AR3]interface Serial 2/0/0
[AR3-Serial2/0/0]ip address 10.10.10.10 30
[AR3-Serial2/0/0]quit
[AR3]interface GigabitEthernet 0/0/0
[AR3-GigabitEthernet0/0/0]ip address 10.10.20.3 24
[AR3-GigabitEthernet0/0/0]quit
```

AR4:

```
[AR4]interface Serial 1/0/1
[AR4-Serial1/0/1]ip address 10.10.10.6 30
[AR4-Serial1/0/1]quit
[AR4]interface Serial 2/0/0
[AR4-Serial2/0/0]ip address 10.10.10.9 30
[AR4-Serial2/0/0]quit
[AR4]interface Serial 1/0/0
[AR4-Serial1/0/0]ip address 172.16.16.1 30
[AR4-Serial1/0/0]quit
[AR4]interface GigabitEthernet 0/0/0
[AR4-GigabitEthernet0/0/0]ip address 10.10.20.4 24
[AR4-GigabitEthernet0/0/0]quit
```

AR5:

```
[AR5]interface GigabitEthernet 0/0/0
[AR5-GigabitEthernet0/0/0]ip address 10.10.20.5 24
[AR5-GigabitEthernet0/0/0]quit
```

AR6:

```
[AR6]interface GigabitEthernet 0/0/0
[AR6-GigabitEthernet0/0/0]ip address 10.10.20.6 24
[AR6-GigabitEthernet0/0/0]quit
[AR6]interface Serial 1/0/1
[AR6-Serial1/0/1]ip address 172.16.16.5 30
[AR6-Serial1/0/1]quit
```

AR7:

```
[AR7]interface Serial 1/0/0
[AR7-Serial1/0/0]ip address 172.16.16.2 30
[AR7-Serial1/0/0]quit
[AR7]interface Serial 1/0/1
[AR7-Serial1/0/1]ip address 172.16.16.6 30
[AR7-Serial1/0/1]quit
```

AR8:

```
[AR8]interface Serial 1/0/0
[AR8-Serial1/0/0]ip address 10.10.30.6 30
[AR8-Serial1/0/0]quit
[AR8]interface Serial 1/0/1
[AR8-Serial1/0/1]ip address 10.10.30.2 30
[AR8-Serial1/0/1]quit
```

- Configure IS-IS adjacency as shown on the diagram. You can use the device number for building the NET.
- Make sure that for Level 2 only the Hello messages are authenticated. Use MD5 password *workbook*.
- Configure BFD session detection on the broadcast domain shared by AR3, AR4, AR5 and AR6.

AR1:

```
[AR1]isis 1

[AR1-isis-1]network-entity 49.0011.0000.0000.0001.00
Nov 26 2015 07:32:33-08:00 AR1 %%01ISIS/4/START_ENABLE_ISIS(1)[2]:ISIS 256 enable
d all ISIS modules.

[AR1-isis-1]quit

[AR1]interface Serial 1/0/0

[AR1-Serial1/0/0]isis enable 1

[AR1-Serial1/0/0]isis authentication-mode md5 workbook

[AR1-Serial1/0/0]quit

[AR1]inter Serial 1/0/1

[AR1-Serial1/0/1]isis enable 1

[AR1-Serial1/0/1]quit
```

AR2:

```
[AR2]isis 1

[AR2-isis-1]network-entity 49.0011.0000.0000.0002.00
Nov 26 2015 07:32:33-08:00 AR2 %%01ISIS/4/START_ENABLE_ISIS(1)[2]:ISIS 256 enable
d all ISIS modules.

[AR2-isis-1]quit

[AR2]interface Serial 1/0/1

[AR2-Serial1/0/1]isis enable 1

[AR2-Serial1/0/1]isis authentication-mode md5 workbook

[AR2-Serial1/0/1]quit

[AR2]inter Serial 1/0/0

[AR2-Serial1/0/0]isis enable 1

[AR2-Serial1/0/0]quit
```

AR3:

```
[AR3]isis 1

[AR3-isis-1]network-entity 49.0000.0000.0000.0003.00
Nov 26 2015 07:32:33-08:00 AR3 %%01ISIS/4/START_ENABLE_ISIS(1)[2]:ISIS 256 enable
d all ISIS modules.

[AR3]bfd

[AR3]interface Serial 1/0/0

[AR3-Serial1/0/0]isis enable 1

[AR3-Serial1/0/0]isis authentication-mode md5 workbook

[AR3-Serial1/0/0]quit

[AR3]interface Serial 2/0/0

[AR3-Serial2/0/0]isis enable 1

[AR3-Serial2/0/0]isis authentication-mode md5 workbook

[AR3-Serial2/0/0]quit

[AR3]interface GigabitEthernet0/0/0

[AR3-GigabitEthernet0/0/0]isis enable 1

[AR3-GigabitEthernet0/0/0]isis bfd enable

[AR3-GigabitEthernet0/0/0]quit
```

AR4:

```
[AR4]isis 1

[AR4-isis-1]network-entity 49.0000.0000.0000.0004.00
Nov 26 2015 07:32:33-08:00 AR4 %%01ISIS/4/START_ENABLE_ISIS(1)[2]:ISIS 256 enable
d all ISIS modules.

[AR4]bfd

[AR4]interface Serial 1/0/

[AR4-Serial1/0/1]isis enable 1

[AR4-Serial1/0/1]isis authentication-mode md5 workbook

[AR4-Serial1/0/1]quit

[AR4]interface Serial 2/0/0

[AR4-Serial2/0/0]isis enable 1

[AR4-Serial2/0/0]isis authentication-mode md5 workbook

[AR4-Serial2/0/0]quit

[AR4]interface GigabitEthernet0/0/0
```

```
[AR4-GigabitEthernet0/0/0]isis enable 1
[AR4-GigabitEthernet0/0/0]isis bfd enable
[AR4-GigabitEthernet0/0/0]quit
```

AR5:

```
[AR5]isis 1
[AR5-isis-1]is-level level-1
[AR5-isis-1]network-entity 49.0000.0000.0000.0005.00
Nov 26 2015 07:32:33-08:00 AR5 %%%01ISIS/4/START_ENABLE_ISIS(l)[2]:ISIS 256 enable
d all ISIS modules.
[AR5-isis-1]quit
[AR5]bfd
[AR5]interface GigabitEthernet0/0/0
[AR5-GigabitEthernet0/0/0]isis enable 1
[AR5-GigabitEthernet0/0/0]isis bfd enable
[AR5-GigabitEthernet0/0/0]quit
```

AR6:

```
[AR6]isis 1
[AR6-isis-1]is-level level-1
[AR6-isis-1]network-entity 49.0000.0000.0000.0005.00
Nov 26 2015 07:32:33-08:00 AR6 %%%01ISIS/4/START_ENABLE_ISIS(l)[2]:ISIS 256 enable
d all ISIS modules.
[AR6-isis-1]quit
[AR6]bfd
[AR6]interface GigabitEthernet0/0/0
[AR6-GigabitEthernet0/0/0]isis enable 1
[AR6-GigabitEthernet0/0/0]isis bfd enable
[AR6-GigabitEthernet0/0/0]quit
```

AR8:

```

[AR8]isis 1

[AR8-isis-1]is-level level-1

[AR8-isis-1]network-entity 49.0011.0000.0000.0008.00
Nov 26 2015 07:32:33-08:00 AR8 %%%01ISIS/4/START_ENABLE_ISIS(1)[2]:ISIS 256 enable
d all ISIS modules.

[AR8-isis-1]quit

[AR8]interface Serial 1/0/1

[AR8-Serial1/0/1]isis enable 1

[AR8-Serial1/0/1]quit

[AR8]inter Serial 1/0/0

[AR8-Serial1/0/0]isis enable 1

[AR8-Serial1/0/0]quit

```

Verify the configuration:

AR1:

```
<AR1>display isis peer
```

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
0000.0000.0003	S1/0/0	0000000001	Up	24s	L1L2	--
0000.0000.0008	S1/0/1	0000000001	Up	27s	L1	--

AR2:

```
<AR2>display isis peer
```

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
0000.0000.0004	S1/0/1	0000000001	Up	29s	L1L2	--
0000.0000.0008	S1/0/0	0000000002	Up	27s	L1	--

AR3:

<AR3>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
0000.0000.0001	S1/0/0	0000000001	Up	23s	L1L2	--
0000.0000.0004	S2/0/0	0000000002	Up	28s	L1L2	--
0000.0000.0006	GE0/0/0	0000.0000.0003.01	Up	21s	L1	64
0000.0000.0004	GE0/0/0	0000.0000.0003.01	Up	20s	L1(L1L2)	64
0000.0000.0005	GE0/0/0	0000.0000.0003.01	Up	23s	L1	64
0000.0000.0004	GE0/0/0	0000.0000.0003.01	Up	24s	L2(L1L2)	64

Total Peer(s): 6

<AR3>display isis interface GigabitEthernet 0/0/0

Interface information for ISIS(1)

Interface	Id	IPV4.State	IPV6.State	MTU	Type	DIS
GE0/0/0	001	Up	Down	1497	L1/L2	<u>Yes/Yes</u>

<AR3>display bfd session all

Local	Remote	PeerIpAddr	State	Type	InterfaceName
8192	8194	10.10.20.6	Up	D_IP_IF	GigabitEthernet0/0/0
8193	8195	10.10.20.4	Up	D_IP_IF	GigabitEthernet0/0/0
8194	8194	10.10.20.5	Up	D_IP_IF	GigabitEthernet0/0/0

Total UP/DOWN Session Number : 3/0

AR4:

<AR4>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
0000.0000.0002	S1/0/1	0000000001	Up	28s	L1L2	--
0000.0000.0003	S2/0/0	0000000002	Up	25s	L1L2	--
0000.0000.0005	GE0/0/0	0000.0000.0003.01	Up	27s	L1	64
0000.0000.0006	GE0/0/0	0000.0000.0003.01	Up	24s	L1	64
0000.0000.0003	GE0/0/0	0000.0000.0003.01	Up	9s	L1(L1L2)	64
0000.0000.0003	GE0/0/0	0000.0000.0003.01	Up	8s	L2(L1L2)	64

Total Peer(s): 6

<AR4>display isis interface GigabitEthernet 0/0/0

Interface information for ISIS(1)

Interface	Id	IPV4.State	IPV6.State	MTU	Type	DIS
GE0/0/0	001	Up	Down	1497	L1/L2	No/No

<AR4>display bfd session all

Local Remote	PeerIpAddr	State	Type	InterfaceName
8195 8193	10.10.20.3	Up	D_IP_IF	GigabitEthernet0/0/0
Total UP/DOWN Session Number : 1/0				

AR5:

<AR5>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
0000.0000.0004	GE0/0/0	0000.0000.0003.01	Up	30s	L1	64
0000.0000.0006	GE0/0/0	0000.0000.0003.01	Up	26s	L1	64
0000.0000.0003	GE0/0/0	0000.0000.0003.01	Up	7s	L1	64

Total Peer(s): 3

<AR5>display bfd session all

Local Remote	PeerIpAddr	State	Type	InterfaceName
8194 8194	10.10.20.3	Up	D_IP_IF	GigabitEthernet0/0/0
Total UP/DOWN Session Number : 1/0				

AR6:

<AR6>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
0000.0000.0004	GE0/0/0	0000.0000.0003.01	Up	24s	L1	64
0000.0000.0005	GE0/0/0	0000.0000.0003.01	Up	26s	L1	64
0000.0000.0003	GE0/0/0	0000.0000.0003.01	Up	7s	L1	64

Total Peer(s): 3

<AR6>display bfd session all

Local Remote	PeerIpAddr	State	Type	InterfaceName
8194 8192	10.10.20.3	Up	D_IP_IF	GigabitEthernet0/0/0
Total UP/DOWN Session Number : 1/0				

AR8:

<AR8>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
0000.0000.0001	S1/0/1	0000000002	Up	25s	L1	--
0000.0000.0002	S1/0/0	0000000002	Up	27s	L1	--

- Configure RIPv2 sessions between AR4 and AR6 to AR7.

AR4:

```
<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4-rip-1]version 2

[AR4-rip-1]network 172.16.0.0

[AR4-rip-1]return
```

AR6:

```
<AR6>system-view
Enter system view, return user view with Ctrl+Z.

[AR6-rip-1]version 2

[AR6-rip-1]network 172.16.0.0

[AR6-rip-1]return
```

AR7:

```
<AR7>system-view
Enter system view, return user view with Ctrl+Z.

[AR7-rip-1]version 2

[AR7-rip-1]network 172.16.0.0

[AR7-rip-1]return
```

Verify the configuration:

AR4:

```
<AR4>display rip 1 neighbor

-----
IP Address    Interface      Type  Last-Heard-Time
-----
172.16.16.2   Serial1/0/0    RIP   0:0:15
Number of RIP routes : 1
```

AR6:

```
<AR6>display rip 1 neighbor

-----
IP Address    Interface      Type  Last-Heard-Time
-----
172.16.16.6   Serial1/0/1    RIP   0:0:12
Number of RIP routes : 1
```

- Advertise the routes shown on the diagram besides AR7 into RIPv2.

AR7:

```

<AR7>system-view
Enter system view, return user view with Ctrl+Z.

[AR7]ip route-static 172.16.16.0 24 NULL 0

[AR7]ip route-static 172.16.17.0 24 NULL 0

[AR7]ip route-static 172.16.18.0 24 NULL 0

[AR7]ip route-static 172.16.19.0 24 NULL 0

[AR7]ip route-static 172.16.20.0 24 NULL 0

[AR7]ip route-static 172.16.21.0 24 NULL 0

[AR7]rip 1

[AR7-rip-1]import-route static

[AR7-rip-1]quit

```

Verify the configuration:

AR4:

```

<AR4>display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
-----
Public routing table : RIP
    Destinations : 7    Routes : 7

RIP routing table status : <Active>
    Destinations : 7    Routes : 7

Destination/Mask    Proto  Pre  Cost   Flags NextHop         Interface
-----
172.16.16.0/24     RIP    100  1      D  172.16.16.2   Serial1/0/0
172.16.16.4/30     RIP    100  1      D  172.16.16.2   Serial1/0/0
172.16.17.0/24     RIP    100  1      D  172.16.16.2   Serial1/0/0
172.16.18.0/24     RIP    100  1      D  172.16.16.2   Serial1/0/0
172.16.19.0/24     RIP    100  1      D  172.16.16.2   Serial1/0/0
172.16.20.0/24     RIP    100  1      D  172.16.16.2   Serial1/0/0
172.16.21.0/24     RIP    100  1      D  172.16.16.2   Serial1/0/0

RIP routing table status : <Inactive>
    Destinations : 0    Routes : 0

```

AR6:

```

<AR6>display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
-----
Public routing table : RIP
    Destinations : 7    Routes : 7

RIP routing table status : <Active>
    Destinations : 7    Routes : 7

Destination/Mask    Proto  Pre  Cost   Flags NextHop         Interface
-----

```

172.16.16.0/24	RIP	100	1	D	172.16.16.6	Serial1/0/1
172.16.16.0/30	RIP	100	1	D	172.16.16.6	Serial1/0/1
172.16.17.0/24	RIP	100	1	D	172.16.16.6	Serial1/0/1
172.16.18.0/24	RIP	100	1	D	172.16.16.6	Serial1/0/1
172.16.19.0/24	RIP	100	1	D	172.16.16.6	Serial1/0/1
172.16.20.0/24	RIP	100	1	D	172.16.16.6	Serial1/0/1
172.16.21.0/24	RIP	100	1	D	172.16.16.6	Serial1/0/1

RIP routing table status : <Inactive>
Destinations : 0 Routes : 0

- Configure mutual redistribution between IS-IS and RIPv2 domains on AR4 and AR6.
- Make sure that the RIPv2 routes are imported as internal in IS-IS.

AR4:

<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]isis 1

[AR4-isis-1]import-route rip level-1-2

[AR4-isis-1] quit

[AR4]rip 1

[AR4-rip-1]import-route isis

[AR4-rip-1]quit

AR6:

<AR6>system-view
Enter system view, return user view with Ctrl+Z.

[AR6]isis 1

[AR6-isis-1]import-route rip level-1

[AR6-isis-1]quit

[AR6]rip 1

[AR6-rip-1]import-route isis

[AR6-rip-1]quit

All device:

<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]isis 1

[AR1-isis-1]cost-style wide

[AR1-isis-1]quit

Verify the configuration:

AR4:

<AR4>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 29 Routes : 30

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.10.0/30	ISIS-L1	15	20	D	10.10.10.10	Serial2/0/0
10.10.10.4/30	Direct	0	0	D	10.10.10.6	Serial1/0/1
10.10.10.5/32	Direct	0	0	D	10.10.10.5	Serial1/0/1
10.10.10.6/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.10.10.7/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.10.10.8/30	Direct	0	0	D	10.10.10.9	Serial2/0/0
10.10.10.9/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
10.10.10.10/32	Direct	0	0	D	10.10.10.10	Serial2/0/0
10.10.10.11/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
10.10.20.0/24	Direct	0	0	D	10.10.20.4	GigabitEthernet0/0/0
10.10.20.4/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
10.10.20.255/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
10.10.30.0/30	ISIS-L1	15	10	D	10.10.20.6	GigabitEthernet0/0/0
10.10.30.4/30	ISIS-L1	15	10	D	10.10.20.6	GigabitEthernet0/0/0
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.16.0/24	RIP	100	1	D	172.16.16.2	Serial1/0/0
172.16.16.0/30	Direct	0	0	D	172.16.16.1	Serial1/0/0
172.16.16.1/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
172.16.16.2/32	Direct	0	0	D	172.16.16.2	Serial1/0/0
172.16.16.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
172.16.16.4/30	RIP	100	1	D	172.16.16.2	Serial1/0/0
172.16.17.0/24	RIP	100	1	D	172.16.16.2	Serial1/0/0
172.16.18.0/24	RIP	100	1	D	172.16.16.2	Serial1/0/0
172.16.19.0/24	RIP	100	1	D	172.16.16.2	Serial1/0/0
172.16.20.0/24	RIP	100	1	D	172.16.16.2	Serial1/0/0
172.16.21.0/24	RIP	100	1	D	172.16.16.2	Serial1/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

AR6:

<AR6>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 24 Routes : 26

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
0.0.0.0/0	ISIS-L1	15	10	D	10.10.20.3	GigabitEthernet0/0/0
10.10.10.0/30	ISIS-L1	15	20	D	10.10.20.3	GigabitEthernet0/0/0
10.10.10.4/30	ISIS-L1	15	20	D	10.10.20.4	GigabitEthernet0/0/0
10.10.10.8/30	ISIS-L1	15	20	D	10.10.20.3	GigabitEthernet0/0/0
10.10.20.0/24	Direct	0	0	D	10.10.20.6	GigabitEthernet0/0/0
10.10.20.6/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0

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<https://t.me/learningnets>

```

10.10.20.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
10.10.30.0/30 RIP 100 2 D 172.16.16.6 Serial1/0/1
10.10.30.4/30 RIP 100 2 D 172.16.16.6 Serial1/0/1
127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0
127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0
127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0
172.16.16.0/24 ISIS-L1 15 10 D 10.10.20.4 GigabitEthernet0/0/0
172.16.16.0/30 ISIS-L1 15 10 D 10.10.20.4 GigabitEthernet0/0/0
172.16.16.4/30 Direct 0 0 D 172.16.16.5 Serial1/0/1
172.16.16.5/32 Direct 0 0 D 127.0.0.1 Serial1/0/1
172.16.16.6/32 Direct 0 0 D 172.16.16.6 Serial1/0/1
172.16.16.7/32 Direct 0 0 D 127.0.0.1 Serial1/0/1
172.16.17.0/24 ISIS-L1 15 10 D 10.10.20.4 GigabitEthernet0/0/0
172.16.18.0/24 ISIS-L1 15 10 D 10.10.20.4 GigabitEthernet0/0/0
172.16.19.0/24 ISIS-L1 15 10 D 10.10.20.4 GigabitEthernet0/0/0
172.16.20.0/24 ISIS-L1 15 10 D 10.10.20.4 GigabitEthernet0/0/0
172.16.21.0/24 ISIS-L1 15 10 D 10.10.20.4 GigabitEthernet0/0/0
255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

```

AR3:

<AR3>display isis lsdb 0000.0000.0004.00-01 verbose

Database information for ISIS(1)

Level-1 Link State Database

LSPID	Seq Num	Checksum	Holdtime	Length	ATT/P/OL
0000.0000.0004.00-01	0x00000014	0xa330	975	95	0/0/0
SOURCE 0000.0000.0004.00					
+IP-Extended 172.16.16.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.16.0 255.255.255.252 COST: 0					
+IP-Extended 172.16.16.4 255.255.255.252 COST: 0					
+IP-Extended 172.16.17.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.18.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.19.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.20.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.21.0 255.255.255.0 COST: 0					

Total LSP(s): 1

*(In TLV)-Leaking Route, *(By LSPID)-Self LSP, +-Self LSP(Extended),
ATT-Attached, P-Partition, OL-Overload

Level-2 Link State Database

LSPID	Seq Num	Checksum	Holdtime	Length	ATT/P/OL
0000.0000.0004.00-01	0x00000013	0xa52f	975	95	0/0/0
SOURCE 0000.0000.0004.00					
+IP-Extended 172.16.16.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.16.0 255.255.255.252 COST: 0					
+IP-Extended 172.16.16.4 255.255.255.252 COST: 0					
+IP-Extended 172.16.17.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.18.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.19.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.20.0 255.255.255.0 COST: 0					
+IP-Extended 172.16.21.0 255.255.255.0 COST: 0					

Total LSP(s): 1

*(In TLV)-Leaking Route, *(By LSPID)-Self LSP, +-Self LSP(Extended),
ATT-Attached, P-Partition, OL-Overload

- Use route tags to prevent any routing loops between ISIS and the RIPv2 domains.

AR4 & AR6:

[AR4]route-policy R2I deny node 5

Info: New Sequence of this List.

[AR4-route-policy]if-match tag 200

[AR4-route-policy]quit

[AR4]route-policy R2I permit node 10

Info: You are overwriting this sequence..

[AR4-route-policy]quit

[AR4]route-policy I2R deny node 5

Info: New Sequence of this List.

[AR4-route-policy]if-match tag 100

[AR4-route-policy]quit

[AR4]route-policy I2R permit node 10

Info: New Sequence of this List.

[AR4-route-policy]apply tag 200

[AR4-route-policy]quit

[AR4]rip 1

[AR4-rip-1]import-route isis route-policy I2R

[AR4-rip-1]quit

[AR4]isis 1

[AR4-isis-1]import-route rip 1 level-1-2 tag 100 route-policy R2I

[AR4-isis-1]quit

Verify the configuration:

AR4:

```
<AR6>display isis lsdb 0000.0000.0006.00-01 verbose
```

Database information for ISIS(1)

Level-1 Link State Database

LSPID	Seq Num	Checksum	Holdtime	Length	ATT/P/OL
0000.0000.0006.00-01*	0x0000006c	0x86e9	1096	135	0/0/0
SOURCE 0000.0000.0006.00					
+IP-Extended	172.16.16.0	255.255.255.0	COST: 0	Tag: 100	
+IP-Extended	172.16.16.4	255.255.255.252	COST: 0	Tag: 100	
+IP-Extended	172.16.17.0	255.255.255.0	COST: 0	Tag: 100	
+IP-Extended	172.16.18.0	255.255.255.0	COST: 0	Tag: 100	
+IP-Extended	172.16.19.0	255.255.255.0	COST: 0	Tag: 100	
+IP-Extended	172.16.20.0	255.255.255.0	COST: 0	Tag: 100	
+IP-Extended	172.16.21.0	255.255.255.0	COST: 0	Tag: 100	

Total LSP(s): 1

*(In TLV)-Leaking Route, *(By LSPID)-Self LSP, +-Self LSP(Extended),
ATT-Attached, P-Partition, OL-Overload

AR7:

```
<AR7>display rip 1 route
```

Route Flags : R - RIP

A - Aging, G - Garbage-collect

Peer 172.16.16.1 on Serial1/0/0

Destination/Mask	Nexthop	Cost	Tag	Flags	Sec
10.10.20.0/24	172.16.16.1	1	200	RA	32
10.10.10.8/30	172.16.16.1	1	200	RA	32
10.10.10.4/30	172.16.16.1	1	200	RA	32
10.10.10.0/30	172.16.16.1	1	200	RA	32
10.10.30.0/30	172.16.16.1	1	200	RA	32
10.10.30.4/30	172.16.16.1	1	200	RA	32

Peer 172.16.16.5 on Serial1/0/1

Destination/Mask	Nexthop	Cost	Tag	Flags	Sec
10.10.20.0/24	172.16.16.5	1	200	RA	24
10.10.10.8/30	172.16.16.5	1	200	RA	24
10.10.10.4/30	172.16.16.5	1	200	RA	24
10.10.10.0/30	172.16.16.5	1	200	RA	24

- Advertise the routes shown on the diagram from AR8 to IS-IS domain.

AR8:

```
<AR8>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR8]ip route-static 192.168.64.0 24 NULL 0  
  
[AR8]ip route-static 192.168.65.0 24 NULL 0  
  
[AR8]ip route-static 192.168.66.0 24 NULL 0  
  
[AR8]ip route-static 192.168.67.0 24 NULL 0  
  
[AR8]isis 1  
  
[AR8-isis-1]import-route static level-1  
  
[AR8-isis-1]quit
```

Verify the configuration:

AR1:

```
<AR1>display ip routing-table
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
  Destinations : 28    Routes : 28

Destination/Mask    Proto    Pre  Cost    Flags NextHop         Interface
-----
10.10.10.0/30 Direct  0    0      D  10.10.10.1 Serial1/0/0
10.10.10.1/32 Direct  0    0      D  127.0.0.1 Serial1/0/0
10.10.10.2/32 Direct  0    0      D  10.10.10.2 Serial1/0/0
10.10.10.3/32 Direct  0    0      D  127.0.0.1 Serial1/0/0
10.10.10.4/30 ISIS-L1 15   30      D  10.10.30.2 Serial1/0/1
10.10.10.8/30 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
10.10.20.0/24 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
10.10.30.0/30 Direct  0    0      D  10.10.30.1 Serial1/0/1
10.10.30.1/32 Direct  0    0      D  127.0.0.1 Serial1/0/1
10.10.30.2/32 Direct  0    0      D  10.10.30.2 Serial1/0/1
10.10.30.3/32 Direct  0    0      D  127.0.0.1 Serial1/0/1
10.10.30.4/30 ISIS-L1 15   20      D  10.10.30.2 Serial1/0/1
127.0.0.0/8 Direct  0    0      D  127.0.0.1 InLoopBack0
127.0.0.1/32 Direct  0    0      D  127.0.0.1 InLoopBack0
127.255.255.255/32 Direct  0    0      D  127.0.0.1 InLoopBack0
172.16.16.0/24 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
172.16.16.0/30 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
172.16.16.4/30 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
172.16.17.0/24 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
172.16.18.0/24 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
172.16.19.0/24 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
172.16.20.0/24 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
172.16.21.0/24 ISIS-L2 15   20      D  10.10.10.2 Serial1/0/0
192.168.64.0/24 ISIS-L1 15   10      D  10.10.30.2 Serial1/0/1
192.168.65.0/24 ISIS-L1 15   10      D  10.10.30.2 Serial1/0/1
192.168.66.0/24 ISIS-L1 15   10      D  10.10.30.2 Serial1/0/1
192.168.67.0/24 ISIS-L1 15   10      D  10.10.30.2 Serial1/0/1
255.255.255.255/32 Direct  0    0      D  127.0.0.1 InLoopBack0
```

- Make sure that only summary route 192.168.64.0/22 is advertised to Area 49.0000.

AR1 & AR2:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]isis 1

[AR1-isis-1]summary 192.168.64.0 255.255.252.0 level-2

[AR1-isis-1]quit
```

Verify the configuration:

AR1:

```
<AR1>display isis 1 lsdb 0000.0000.0001.00-00 verbose
```

Database information for ISIS(1)

Level-1 Link State Database

LSPID	Seq Num	Checksum	Holdtime	Length	ATT/P/OL
0000.0000.0001.00-00*	0x00000057	0xc1dc	563	79	1/0/0
SOURCE 0000.0000.0001.00					
NLPID IPV4					
AREA ADDR 49.0011					
INTF ADDR 10.10.10.1					
INTF ADDR 10.10.30.1					
+NBR ID 0000.0000.0008.00 COST: 10					
+IP-Extended 10.10.10.0 255.255.255.252 COST: 10					
+IP-Extended 10.10.30.0 255.255.255.252 COST: 10					

Total LSP(s): 1

*(In TLV)-Leaking Route, *(By LSPID)-Self LSP, +-Self LSP(Extended),
ATT-Attached, P-Partition, OL-Overload

Level-2 Link State Database

LSPID	Seq Num	Checksum	Holdtime	Length	ATT/P/OL
0000.0000.0001.00-00*	0x000000b6	0xdfc1	870	105	0/0/0
SOURCE 0000.0000.0001.00					
NLPID IPV4					
AREA ADDR 49.0011					
INTF ADDR 10.10.10.1					
INTF ADDR 10.10.30.1					
+NBR ID 0000.0000.0003.00 COST: 10					
+IP-Extended 10.10.10.0 255.255.255.252 COST: 10					
+IP-Extended 10.10.30.0 255.255.255.252 COST: 10					
+IP-Extended 10.10.30.4 255.255.255.252 COST: 20					
+IP-Extended 10.10.10.4 255.255.255.252 COST: 30					
+IP-Extended 192.168.64.0 255.255.252.0 COST: 10					

Total LSP(s): 1

*(In TLV)-Leaking Route, *(By LSPID)-Self LSP, +-Self LSP(Extended),
ATT-Attached, P-Partition, OL-Overload

- Ensure that AR8 does not have a default route in the routing table. AR8 must have knowledge for all routes. You are allowed to do changes only on AR1 and AR2.

AR1 & AR2:

<AR2>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR2]**isis 1**[AR2-isis-1]**summary 192.168.64.0 255.255.252.0 level-2**[AR2-isis-1]**import-route isis level-2 into level-1**[AR2-isis-1]**quit**

Verify the configuration:

AR8:

```
<AR8>display ip routing-table
```

Route Flags: R - relay, D - download to fib

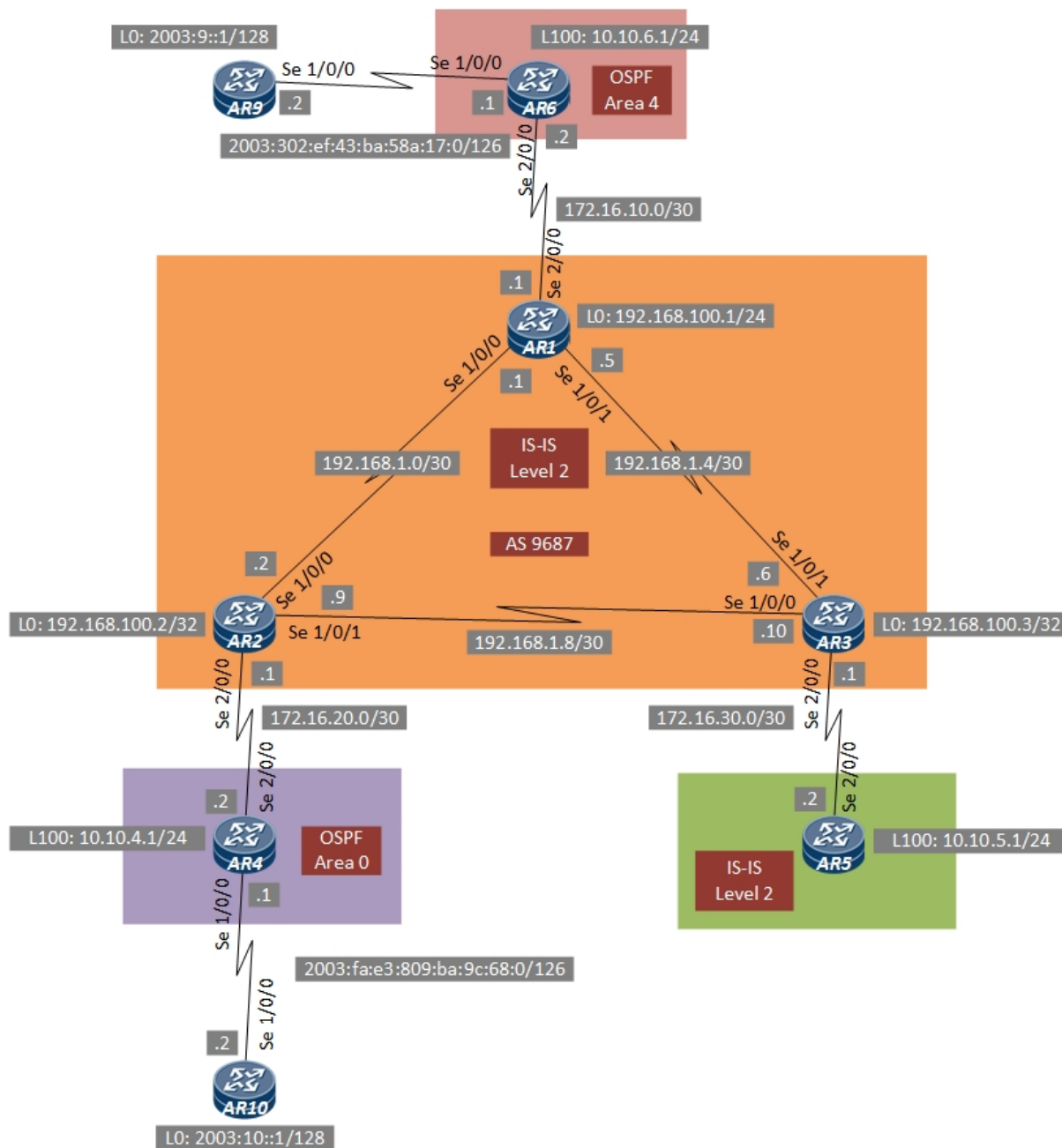
Routing Tables: Public

Destinations : 29 Routes : 29

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.10.0/30	ISIS-L1	15	20	D	10.10.30.1	Serial1/0/1
10.10.10.4/30	ISIS-L1	15	20	D	10.10.30.5	Serial1/0/0
10.10.10.8/30	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
10.10.20.0/24	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
10.10.30.0/30	Direct	0	0	D	10.10.30.2	Serial1/0/1
10.10.30.1/32	Direct	0	0	D	10.10.30.1	Serial1/0/1
10.10.30.2/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.10.30.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
10.10.30.4/30	Direct	0	0	D	10.10.30.6	Serial1/0/0
10.10.30.5/32	Direct	0	0	D	10.10.30.5	Serial1/0/0
10.10.30.6/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
10.10.30.7/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.16.0/24	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
172.16.16.0/30	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
172.16.16.4/30	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
172.16.17.0/24	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
172.16.18.0/24	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
172.16.19.0/24	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
172.16.20.0/24	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
172.16.21.0/24	ISIS-L1	15	30	D	10.10.30.1	Serial1/0/1
192.168.64.0/22	ISIS-L1	15	50	D	10.10.30.1	Serial1/0/1
192.168.64.0/24	Static	60	0	D	0.0.0.0	NULL0
192.168.65.0/24	Static	60	0	D	0.0.0.0	NULL0
192.168.66.0/24	Static	60	0	D	0.0.0.0	NULL0
192.168.67.0/24	Static	60	0	D	0.0.0.0	NULL0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

Chapter 3: BGP configuration and features - solution

NOTE: Load topology with name – BGP



NOTE: You are not allowed to do any changes on AR10 and AR11

3.2. BGP sessions establishment.

- Configure the interfaces from the diagram with the shown IP addresses.
- Configure IS-IS as IGP on routes in AS 888. All IS-IS adjacencies must be Level 2 only. Make sure that Loopback IP addresses are advertised as internal.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]interface LoopBack 0

[AR1-LoopBack0]ip address 192.168.5.1 32

[AR1-LoopBack0]quit

[AR1]interface Serial 1/0/0

[AR1-Serial1/0/0]ip address 192.168.1.5 30

[AR1-Serial1/0/0]quit

[AR1]interface Serial 1/0/1

[AR1-Serial1/0/1]ip address 192.168.1.1 30

[AR1-Serial1/0/1]quit

[AR1]interface Serial 2/0/0

[AR1-Serial2/0/0]ip address 3.3.3.2 30

[AR1-Serial2/0/0]quit

[AR1]interface Serial 2/0/1

[AR1-Serial2/0/1]ip address 4.4.4.2 30

[AR1-Serial2/0/1]quit

[AR1]isis 1

[AR1-isis-1]network-entity 49.0001.1920.1680.0005.0001.00
Dec 5 2015 23:09:53-08:00 AR1 %%01ISIS/4/START_ENABLE_ISIS(1)[0]:ISIS 256 enable
d all ISIS modules.

[AR1-isis-1]is-level level-2
Info: IS Level Changed, Resetting ISIS...
Dec 5 2015 23:10:13-08:00 AR1 %%01ISIS/4/START_DISABLE_ISIS(1)[1]:ISIS 256 disab
led all ISIS modules.

[AR1-isis-1]quit

[AR1]interface Serial 1/0/0

[AR1-Serial1/0/0]isis enable 1
```

```

[AR1-Serial1/0/0]interface Serial 1/0/1

[AR1-Serial1/0/1]isis enable 1

[AR1-Serial1/0/1]quit

[AR1]interface LoopBack 0

[AR1-LoopBack0]isis enable 1

[AR1-LoopBack0]quit

```

Verify the configuration:

AR1:

```

<AR1>display isis peer

                Peer information for ISIS(1)

System Id      Interface      Circuit Id      State HoldTime Type  PRI
-----
1680.0005.0003 S1/0/0          00000000001    Up 23s  L2   --
1680.0005.0002 S1/0/1          00000000002    Up 25s  L2   --

Total Peer(s): 2

<AR1>display isis route

                Route information for ISIS(1)
                -----

                ISIS(1) Level-2 Forwarding Table
                -----

IPv4 Destination  IntCost  ExtCost ExitInterface  NextHop      Flags
-----
192.168.5.3/32    10       NULL   S1/0/0          192.168.1.6  A/-/-/
192.168.5.2/32    10       NULL   S1/0/1          192.168.1.2  A/-/-/
192.168.1.0/30    10       NULL   S1/0/1          Direct       D/-/L/-
192.168.1.8/30    20       NULL   S1/0/1          192.168.1.2  A/-/-/
192.168.5.1/32    0        NULL   Loop0           Direct       D/-/L/-
192.168.1.16/30   20       NULL   S1/0/0          192.168.1.6  A/-/-/
                  S1/0/1          192.168.1.2
192.168.1.4/30    10       NULL   S1/0/0          Direct       D/-/L/-
192.168.1.12/30   20       NULL   S1/0/0          192.168.1.6  A/-/-/
192.168.5.4/32    20       NULL   S1/0/1          192.168.1.2  A/-/-/
                  S1/0/0          192.168.1.6

Flags: D-Direct, A-Added to URT, L-Advertised in LSPs, S-IGP Shortcut,
       U-Up/Down Bit Set

```


AR2:

<AR2>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
1680.0005.0004	S1/0/0	0000000001	Up	23s	L2	--
1680.0005.0001	S1/0/1	0000000002	Up	26s	L2	--
1680.0005.0003	S2/0/0	0000000003	Up	24s	L2	--

Total Peer(s): 3

<AR2>display isis route

Route information for ISIS(1)

ISIS(1) Level-2 Forwarding Table

IPv4 Destination	IntCost	ExtCost	ExitInterface	NextHop	Flags
192.168.5.3/32	10	NULL	S2/0/0	192.168.1.17	A/-/-/-
192.168.5.2/32	0	NULL	Loop0	Direct	D/-/L/-
192.168.1.0/30	10	NULL	S1/0/1	Direct	D/-/L/-
192.168.1.8/30	10	NULL	S1/0/0	Direct	D/-/L/-
192.168.5.1/32	10	NULL	S1/0/1	192.168.1.1	A/-/-/-
192.168.1.16/30	10	NULL	S2/0/0	Direct	D/-/L/-
192.168.1.4/30	20	NULL	S1/0/1	192.168.1.1	A/-/-/-
		S2/0/0	192.168.1.17		
192.168.1.12/30	20	NULL	S1/0/0	192.168.1.10	A/-/-/-
		S2/0/0	192.168.1.17		
192.168.5.4/32	10	NULL	S1/0/0	192.168.1.10	A/-/-/-

Flags: D-Direct, A-Added to URT, L-Advertised in LSPs, S-IGP Shortcut,
U-Up/Down Bit Set

- Configure OSPF Area 2 on the routers in AS 2222. Ensure that no Hello messages are sent on the Loopback interfaces and their IP addresses are advertised as internal routes.

AR8:

<AR8>system-view

Enter system view, return user view with Ctrl+Z.

[AR8]interface LoopBack 0

[AR8-LoopBack0]ip address 172.31.5.1 32

[AR8]interface Serial 1/0/0

[AR8-Serial1/0/0]ip address 172.31.1.2 30

[AR8-Serial1/0/0]quit

[AR8]interface Serial 2/0/1

```

[AR8-Serial2/0/1]ip address 5.5.5.2 30
[AR8-Serial2/0/1]quit
[AR8]ospf 1
[AR8-ospf-1]area 2
[AR8-ospf-1-area-0.0.0.2]network 172.31.5.1 0.0.0.0
[AR8-ospf-1-area-0.0.0.2]network 172.31.1.0 0.0.0.3
[AR8-ospf-1-area-0.0.0.2]quit
[AR8-ospf-1]silent-interface LoopBack 0
[AR8]interface LoopBack 0
[AR8-ospf-1]quit

```

Verify the configuration:

AR8:

```

<AR8>display ospf peer

      OSPF Process 1 with Router ID 172.31.5.1
        Neighbors

Area 0.0.0.2 interface 172.31.1.2(Serial1/0/0)'s neighbors
Router ID: 172.31.5.2   Address: 172.31.1.1
State: Full  Mode:Nbr is Master  Priority: 1
DR: None   BDR: None   MTU: 0
Dead timer due in 32 sec
Retrans timer interval: 5
Neighbor is up for 00:00:11
Authentication Sequence: [ 0 ]

<AR8>display ospf routing

      OSPF Process 1 with Router ID 172.31.5.1
        Routing Tables

Routing for Network
Destination    Cost  Type   NextHop   AdvRouter  Area
172.31.1.0/30  48   Stub   172.31.1.2 172.31.5.1 0.0.0.2
172.31.5.1/32  0    Stub   172.31.5.1 172.31.5.1 0.0.0.2
172.31.5.2/32  48   Stub   172.31.1.1 172.31.5.2 0.0.0.2

Total Nets: 3
Intra Area: 3 Inter Area: 0 ASE: 0 NSSA: 0

```

AR9:

<AR9>display ospf peer

OSPF Process 1 with Router ID 172.31.5.2
Neighbors

Area 0.0.0.2 interface 172.31.1.1(Serial1/0/0)'s neighbors
Router ID: 172.31.5.1 Address: 172.31.1.2
State: Full Mode:Nbr is Slave Priority: 1
DR: None BDR: None MTU: 0
Dead timer due in 34 sec
Retrans timer interval: 5
Neighbor is up for 00:17:54
Authentication Sequence: [0]

<AR9>display ospf routing

OSPF Process 1 with Router ID 172.31.5.2
Routing Tables

Routing for Network

Destination	Cost	Type	NextHop	AdvRouter	Area
172.31.1.0/30	48	Stub	172.31.1.1	172.31.5.2	0.0.0.2
172.31.5.2/32	0	Stub	172.31.5.2	172.31.5.2	0.0.0.2
172.31.5.1/32	48	Stub	172.31.1.2	172.31.5.1	0.0.0.2

Total Nets: 3

Intra Area: 3 Inter Area: 0 ASE: 0 NSSA: 0

- Configure OSPF Area 0 on routers in AS 7685. Ensure that no Hello messages are sent on the Loopback interfaces and their IP addresses are advertised as internal routes.

AR5:

<AR5>system-view

Enter system view, return user view with Ctrl+Z.

[AR5]interface LoopBack 0

[AR5-LoopBack0]ip address 172.16.5.1 32

[AR5-LoopBack0]quit

[AR5]interface Serial 1/0/0

[AR5-Serial1/0/0]ip address 172.16.1.1 30

[AR5-Serial1/0/0]quit

[AR5]interface Serial 2/0/1

[AR5-Serial2/0/1]ip address 7.7.7.2 30

[AR5-Serial2/0/1]quit

[AR5]ospf 1

[AR5-ospf-1]area 0

```
[AR5-ospf-1-area-0.0.0.0]network 172.16.5.1 0.0.0.0
[AR5-ospf-1-area-0.0.0.0]network 172.16.1.0 0.0.0.3
[AR5-ospf-1-area-0.0.0.0]quit
[AR5-ospf-1]silent LoopBack 0
[AR5-ospf-1]quit
```

Verify the configuration:

AR5:

```
<AR5>display ospf peer

      OSPF Process 1 with Router ID 172.16.5.1
        Neighbors

Area 0.0.0.0 interface 172.16.1.1(Serial1/0/0)'s neighbors
Router ID: 172.16.5.3   Address: 172.16.1.2
State: Full Mode:Nbr is Master Priority: 1
DR: None BDR: None MTU: 0
Dead timer due in 29 sec
Retrans timer interval: 5
Neighbor is up for 00:00:49
Authentication Sequence: [ 0 ]
```

```
<AR5>display ospf routing
```

```
      OSPF Process 1 with Router ID 172.16.5.1
        Routing Tables

Routing for Network
Destination   Cost Type   NextHop   AdvRouter Area
172.16.1.0/30 48  Stub   172.16.1.1 172.16.5.1 0.0.0.0
172.16.5.1/32 0   Stub   172.16.5.1 172.16.5.1 0.0.0.0
172.16.1.4/30 96  Stub   172.16.1.2 172.16.5.3 0.0.0.0
172.16.5.2/32 96  Stub   172.16.1.2 172.16.5.2 0.0.0.0
172.16.5.3/32 48  Stub   172.16.1.2 172.16.5.3 0.0.0.0

Total Nets: 5
Intra Area: 5 Inter Area: 0 ASE: 0 NSSA: 0
```

AR7:

<AR7>display ospf peer

OSPF Process 1 with Router ID 172.16.5.3
Neighbors

Area 0.0.0.0 interface 172.16.1.2(Serial1/0/0)'s neighbors
Router ID: 172.16.5.1 Address: 172.16.1.1
State: Full Mode:Nbr is Slave Priority: 1
DR: None BDR: None MTU: 0
Dead timer due in 29 sec
Retrans timer interval: 5
Neighbor is up for 00:16:56
Authentication Sequence: [0]

Neighbors

Area 0.0.0.0 interface 172.16.1.6(Serial1/0/1)'s neighbors
Router ID: 172.16.5.2 Address: 172.16.1.5
State: Full Mode:Nbr is Slave Priority: 1
DR: None BDR: None MTU: 0
Dead timer due in 38 sec
Retrans timer interval: 5
Neighbor is up for 00:16:47
Authentication Sequence: [0]

<AR7>display ospf routing

OSPF Process 1 with Router ID 172.16.5.3
Routing Tables

Routing for Network

Destination	Cost	Type	NextHop	AdvRouter	Area
172.16.1.0/30	48	Stub	172.16.1.2	172.16.5.3	0.0.0.0
172.16.1.4/30	48	Stub	172.16.1.6	172.16.5.3	0.0.0.0
172.16.5.3/32	0	Stub	172.16.5.3	172.16.5.3	0.0.0.0
172.16.5.1/32	48	Stub	172.16.1.1	172.16.5.1	0.0.0.0
172.16.5.2/32	48	Stub	172.16.1.5	172.16.5.2	0.0.0.0

Total Nets: 5

Intra Area: 5 Inter Area: 0 ASE: 0 NSSA: 0

- Configure iBGP sessions between the routers in AS 888. To limit the number of the session configure AR3 as route reflector. Configure BFD to ensure faster BGP neighbour detection.

AR1:

```
<AR1>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR1]bgp 888  
  
[AR1-bgp]peer 192.168.5.3 as-number 888  
  
[AR1-bgp]peer 192.168.5.3 connect-interface LoopBack 0  
  
[AR1]bfd  
  
[AR1-bfd]quit  
  
[AR1]bgp 888  
  
[AR1-bgp]peer 192.168.5.3 bfd enable  
  
[AR1-bgp]quit
```

AR2:

```
<AR2>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR2]bgp 888  
  
[AR2-bgp]peer 192.168.5.3 as-number 888  
  
[AR2-bgp]peer 192.168.5.3 connect-interface LoopBack 0  
  
[AR2-bgp]quit  
  
[AR2]bfd  
  
[AR2-bfd]quit  
  
[AR2]bgp 888  
  
[AR2-bgp]peer 192.168.5.3 bfd enable  
  
[AR2-bgp]quit
```

AR3:

```
<AR3>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR3]bgp 888  
  
[AR3-bgp]peer 192.168.5.1 as-number 888  
  
[AR3-bgp]peer 192.168.5.1 reflect-client  
  
[AR3-bgp]peer 192.168.5.2 as-number 888  
  
[AR3-bgp]peer 192.168.5.2 reflect-client  
  
[AR3-bgp]peer 192.168.5.4 as-number 888  
  
[AR3-bgp]peer 192.168.5.4 reflect-client
```

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<https://t.me/learningnets>

```

[AR3-bgp]peer 192.168.5.1 connect-interface LoopBack 0
[AR3-bgp]peer 192.168.5.4 connect-interface LoopBack 0
[AR3-bgp]peer 192.168.5.2 connect-interface LoopBack 0
[AR3-bgp]quit
[AR3]bfd
[AR3-bfd]quit
[AR3]bgp 888
[AR3-bgp]peer 192.168.5.1 bfd enable
[AR3-bgp]peer 192.168.5.2 bfd enable
[AR3-bgp]peer 192.168.5.4 bfd enable
[AR3-bgp]return

```

AR4:

```

<AR4>system-view
Enter system view, return user view with Ctrl+Z.
[AR4]bgp 888
[AR4-bgp]peer 192.168.5.3 as-number 888
[AR4-bgp]peer 192.168.5.3 connect-interface LoopBack 0
[AR4-bgp]quit
[AR4]bfd
[AR4-bfd]quit
[AR4]bgp 888
[AR4-bgp]quit

```

Verify the configuration:

AR1:

```

<AR1>display bgp peer

BGP local router ID : 192.168.5.1
Local AS number : 888
Total number of peers : 1          Peers in established state : 1

  Peer      V      AS  MsgRcvd  MsgSent  OutQ  Up/Down   State Pref
Rcv
  192.168.5.3  4    888    739    739    0 12:17:23 Established   0

<AR1>display bfd session all
-----
Local Remote  PeerIpAddr  State  Type  InterfaceName

```

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```
-----
8192 8192    192.168.5.3  Up    D_IP_PEER    -
-----
```

Total UP/DOWN Session Number : 1/0

AR2:

<AR2>display bgp peer

BGP local router ID : 192.168.5.2

Local AS number : 888

Total number of peers : 1 Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
Rcv								

192.168.5.3	4	888	740	741	0	12:18:45	Established	0

<AR2>display bfd session all

```
-----
Local Remote  PeerIpAddr  State  Type    InterfaceName
-----
```

```
8192 8193    192.168.5.3  Up    D_IP_PEER    -
-----
```

Total UP/DOWN Session Number : 1/0

AR3:

<AR3>display bgp peer

BGP local router ID : 192.168.5.3

Local AS number : 888

Total number of peers : 3 Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
Rcv								

192.168.5.1	4	888	760	761	0	12:38:25	Established	0
192.168.5.2	4	888	759	759	0	12:37:47	Established	0
192.168.5.4	4	888	760	760	0	12:38:03	Established	0

<AR3>display bfd session all

```
-----
Local Remote  PeerIpAddr  State  Type    InterfaceName
-----
```

```
8192 8192    192.168.5.1  Up    D_IP_PEER    -
8193 8192    192.168.5.2  Up    D_IP_PEER    -
8194 8192    192.168.5.4  Up    D_IP_PEER    -
-----
```

Total UP/DOWN Session Number : 3/0

AR4:

<AR4>display bgp peer

BGP local router ID : 192.168.5.4

Local AS number : 888

Total number of peers : 1 Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
192.168.5.3	4	888	761	762	0	12:39:30	Established	0

<AR4>display bfd session all

Local	Remote	PeerIpAddr	State	Type	InterfaceName
8192	8194	192.168.5.3	Up	D_IP_PEER	-

Total UP/DOWN Session Number : 1/0

- Configure iBGP between AR8 and AR9 in AS 2222 using the Loopback interfaces. Advertise the routes besides AR8 in BGP. Attach a unique community identifying the sourcing AS.

AR8:

<AR8>system-view

Enter system view, return user view with Ctrl+Z.

[AR8]bgp 2222

[AR8-bgp]peer 172.31.5.2 as-number 2222

[AR8-bgp]peer 172.31.5.2 connect-interface LoopBack 0

[AR8-bgp]peer 172.31.5.2 advertise-community

[AR8-bgp]network 132.12.12.0 24

[AR8-bgp]network 132.12.13.0 24

[AR8-bgp]network 132.12.14.0 24

[AR8-bgp]network 132.12.15.0 24

[AR8-bgp]quit

[AR8]ip route-static 132.12.12.0 24 null 0

[AR8]ip route-static 132.12.13.0 24 null 0

[AR8]ip route-static 132.12.14.0 24 null 0

[AR8]ip route-static 132.12.15.0 24 null 0

[AR8]ip ip-prefix AGGREGATE permit 132.12.12.0 24

[AR8]ip ip-prefix AGGREGATE permit 132.12.13.0 24

```
[AR8]ip ip-prefix AGGREGATE permit 132.12.14.0 24
```

```
[AR8]ip ip-prefix AGGREGATE permit 132.12.15.0 24
```

```
[AR8]route-policy TO-BGP permit node 5
```

Info: You are overwriting this sequence.

```
[AR8-route-policy]if-match ip-prefix AGGREGATE
```

```
AR8-route-policy]apply community 2222:2
```

```
[AR8]bgp 2222
```

```
[AR8-bgp]peer 172.31.5.2 route-policy TO-BGP export
```

AR9:

```
<AR9>system-view
```

Enter system view, return user view with Ctrl+Z.

```
[AR9]bgp 2222
```

```
[AR9-bgp]peer 172.31.5.1 as-number 2222
```

```
[AR9-bgp]peer 172.31.5.1 connect-interface LoopBack 0
```

```
[AR9-bgp]peer 172.31.5.1 advertise-community
```

```
[AR9-bgp]quit
```

Verify the configuration:

AR8:

```
<AR8>display bgp peer
```

BGP local router ID : 172.31.5.1

Local AS number : 2222

Total number of peers : 1 Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
Rev								

172.31.5.2	4	2222	38	42	0	00:35:58	Established	0

AR9:

```
<AR9>display bgp peer
```

BGP local router ID : 172.31.5.2

Local AS number : 2222

Total number of peers : 1 Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
Rev								

172.31.5.1	4	2222	60	57	0	00:54:46	Established	4

```
<AR9>display bgp routing-table
```

BGP Local router ID is 172.31.5.2

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 4

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>i 132.12.12.0/24	172.31.5.1	0	100	0	i
*>i 132.12.13.0/24	172.31.5.1	0	100	0	i
*>i 132.12.14.0/24	172.31.5.1	0	100	0	i
*>i 132.12.15.0/24	172.31.5.1	0	100	0	i

<AR9>display bgp routing-table 132.12.12.0

BGP local router ID : 172.31.5.2

Local AS number : 2222

Paths: 1 available, 1 best, 1 select

BGP routing table entry information of 132.12.12.0/24:

From: 172.31.5.1 (172.31.5.1)

Route Duration: 00h47m38s

Relay IP Nexthop: 172.31.1.2

Relay IP Out-Interface: Serial1/0/0

Original nexthop: 172.31.5.1

Qos information : 0x0

Community:<2222:2>

AS-path Nil, origin igp, MED 0, localpref 100, pref-val 0, valid, internal, best

, select, active, pre 255, IGP cost 48

Not advertised to any peer yet

- Configure eBGP sessions between AS 888, AS 2222 and AS 7685. Ensure all eBGP sessions state is logged and communities could be send and received across.

AR2:

<AR2>system-view

Enter system view, return user view with Ctrl+Z.

[AR2]bgp 888

[AR2-bgp]peer 7.7.7.2 as-number 7685

[AR2-bgp]peer 7.7.7.2 advertise-community

[AR2-bgp]peer 7.7.7.2 log-change

[AR2-bgp]quit

AR3:

<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]bgp 888

[AR3-bgp]peer 5.5.5.2 as-number 2222

[AR3-bgp]peer 5.5.5.2 advertise-community

[AR3-bgp]peer 5.5.5.2 log-change

[AR3-bgp]quit

AR4:

<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]bgp 888

[AR4-bgp]peer 6.6.6.2 as-number 2222

[AR4-bgp]peer 6.6.6.2 advertise-community

[AR4-bgp]peer 6.6.6.2 log-change

[AR4-bgp]peer 8.8.8.2 as-number 7685

[AR4-bgp]peer 8.8.8.2 advertise-community

[AR4-bgp]peer 8.8.8.2 log-change

[AR4-bgp]quit

AR5:

[AR5]bgp 7685

[AR5-bgp]peer 7.7.7.1 as-number 888

[AR5-bgp]peer 7.7.7.1 advertise-community

[AR5-bgp]peer 7.7.7.1 log-change

[AR5-bgp]quit

AR6:

[AR6]bgp 7685

[AR6-bgp]peer 8.8.8.1 as-number 888

[AR6-bgp]peer 8.8.8.1 advertise-community

[AR6-bgp]peer 8.8.8.1 log-change

[AR6-bgp]peer 9.9.9.1 as-number 2222

[AR6-bgp]peer 9.9.9.1 advertise-community

```
[AR6-bgp]peer 9.9.9.1 log-change
[AR6-bgp]quit
```

AR8:

```
[AR8]bgp 2222
[AR8-bgp]peer 5.5.5.1 as-number 888
[AR8-bgp]peer 5.5.5.1 advertise-community
[AR8-bgp]peer 5.5.5.1 log-change
[AR8-bgp]quit
```

AR9:

```
<AR9>system-view
Enter system view, return user view with Ctrl+Z.

[AR9]bgp 2222
[AR9-bgp]peer 9.9.9.2 as-number 7685
[AR9-bgp]peer 9.9.9.2 advertise-community
[AR9-bgp]peer 9.9.9.2 log-change
[AR9-bgp]peer 6.6.6.1 as-number 888
[AR9-bgp]peer 6.6.6.1 advertise-community
[AR9-bgp]peer 6.6.6.1 log-change
[AR9-bgp]quit
```

Verify the configuration:

AR2:

```
<AR2>display bgp peer

BGP local router ID : 192.168.5.2
Local AS number : 888
Total number of peers : 2          Peers in established state : 2

Peer      V      AS  MsgRcvd  MsgSent  OutQ  Up/Down    State Pref
Rev
7.7.7.2   4      7685    55      56    0 00:53:31 Established  0
192.168.5.3 4      888   1061    1061    0 17:38:46 Established  4
```

AR3:

<AR3>dis bgp peer

BGP local router ID : 192.168.5.3

Local AS number : 888

Total number of peers : 4 Peers in established state : 4

Peer Rcv	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
5.5.5.2	4	2222	49	48	0	00:45:06	Established	4
192.168.5.1	4	888	1062	1064	0	17:40:02	Established	0
192.168.5.2	4	888	1061	1062	0	17:39:24	Established	0
192.168.5.4	4	888	1063	1062	0	17:39:40	Established	4

AR4:

<AR4>display bgp peer

BGP local router ID : 192.168.5.4

Local AS number : 888

Total number of peers : 3 Peers in established state : 3

Peer Rcv	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
6.6.6.2	4	2222	47	49	0	00:44:30	Established	4
8.8.8.2	4	7685	58	60	0	00:55:33	Established	4
192.168.5.3	4	888	1064	1067	0	17:42:07	Established	4

AR5:

<AR5>display bgp peer

BGP local router ID : 172.16.5.1

Local AS number : 7685

Total number of peers : 1 Peers in established state : 1

Peer Rcv	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
7.7.7.1	4	888	59	59	0	00:57:49	Established	0

AR6:

<AR6>display bgp peer

BGP local router ID : 172.16.5.2

Local AS number : 7685

Total number of peers : 2 Peers in established state : 2

Peer Rcv	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
8.8.8.1	4	888	61	60	0	00:57:52	Established	4
9.9.9.1	4	2222	50	51	0	00:47:25	Established	4

AR8:

<AR8>display bgp peer

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BGP local router ID : 172.31.5.1

Local AS number : 2222

Total number of peers : 2 Peers in established state : 2

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
5.5.5.1	4	888	83	85	0	01:21:48	Established	0
172.31.5.2	4	2222	219	223	0	03:36:26	Established	0

AR9:

<AR9>display bgp peer

BGP local router ID : 172.31.5.2

Local AS number : 2222

Total number of peers : 3 Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
6.6.6.1	4	888	83	82	0	01:19:53	Established	0
9.9.9.2	4	7685	83	83	0	01:20:30	Established	0
172.31.5.1	4	2222	223	220	0	03:37:12	Established	4

- Configure eBGP sessions between AS 888 and AS 3245. Use two separate sessions with BGP load balancing across both. Enable logging of the state of the sessions. Ensure that 8 routes are received from AS 3245.

AR1:

<AR1>system-view

Enter system view, return user view with Ctrl+Z.

[AR1]bgp 888

[AR1-bgp]peer 3.3.3.1 as-number 3245

[AR1-bgp]peer 4.4.4.1 as-number 3245

[AR1-bgp]peer 3.3.3.1 log-change

[AR1-bgp]peer 4.4.4.1 log-change

[AR1-bgp]ipv4-family unicast

[AR1-bgp-af-ipv4]maximum load-balancing 2

[AR1-bgp-af-ipv4]quit

[AR1-bgp]quit

Verify the configuration:

AR1:

<AR1>display bgp peer

BGP local router ID : 192.168.5.1

Local AS number : 888

Total number of peers : 3 Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
3.3.3.1	4	3245	29	29	0	00:25:58	Established	
8								
4.4.4.1	4	3245	29	30	0	00:26:14	Established	
8								
192.168.5.3	4	888	1163	1165	0	19:20:20	Established	
4								

<AR1>display bgp routing-table

BGP Local router ID is 192.168.5.1

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 20

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
i 132.12.12.0/24	5.5.5.2	0	100	0	2222i
i 132.12.13.0/24	5.5.5.2	0	100	0	2222i
i 132.12.14.0/24	5.5.5.2	0	100	0	2222i
i 132.12.15.0/24	5.5.5.2	0	100	0	2222i
*> 185.16.16.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i
*> 185.16.17.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i
*> 185.16.18.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i
*> 185.16.19.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i
*> 185.16.20.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i
*> 185.16.21.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i
*> 185.16.22.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i
*> 185.16.23.0/24	3.3.3.1	0		0	3245i
*	4.4.4.1	0		0	3245i

<AR1>display bgp routing-table 185.16.16.0

BGP local router ID : 192.168.5.1

Local AS number : 888

Paths: 2 available, 1 best, 2 select

BGP routing table entry information of 185.16.16.0/24:

From: 3.3.3.1 (3.3.3.1)

Route Duration: 00h26m36s


```

Direct Out-interface: Serial2/0/0
Original nexthop: 3.3.3.1
Qos information : 0x0
AS-path 3245, origin igp, MED 0, pref-val 0, valid, external, best, select, active, pre 255
Advertised to such 3 peers:
  192.168.5.3
  4.4.4.1
  3.3.3.1
BGP routing table entry information of 185.16.16.0/24:
From: 4.4.4.1 (3.3.3.1)
Route Duration: 00h26m51s
Direct Out-interface: Serial2/0/1
Original nexthop: 4.4.4.1
Qos information : 0x0
AS-path 3245, origin igp, MED 0, pref-val 0, valid, external, select, active, pre 255, not preferred for
peer address
Not advertised to any peer yet

```

- Configure eBGP sessions between AS 2222 and AS 7685 with AS 18234 router AR10. Enable logging of the state of the sessions. Ensure that 8 routes are received from AS 3245.

AR6:

```

<AR6>system-view
Enter system view, return user view with Ctrl+Z.

[AR6]bgp 7685

[AR6-bgp]peer 12.12.12.2 as-number 18234

[AR6-bgp]peer 12.12.12.2 log-change

[AR6-bgp]return

```

AR9:

```

<AR9>system-view
Enter system view, return user view with Ctrl+Z.

[AR9]bgp 2222

[AR9-bgp]peer 11.11.11.2 as-number 18234

[AR9-bgp]peer 11.11.11.2 log-change

[AR9-bgp]quit

```

Verify the configuration:

AR6:

<AR6>display bgp peer

BGP local router ID : 172.16.5.2

Local AS number : 7685

Total number of peers : 3 Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
8.8.8.1	4	888	196	195	0	03:07:10	Established	12
9.9.9.1	4	2222	185	185	0	02:56:43	Established	20
12.12.12.2	4	18234	6	5	0	00:00:36	Established	12

<AR6>display bgp routing-table peer 12.12.12.2 received-routes

BGP Local router ID is 172.16.5.2

Status codes: * - valid, > - best, d - damped,
h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 12

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 25.25.160.0/24	12.12.12.2	0		0	18234?
*> 25.25.161.0/24	12.12.12.2	0		0	18234?
*> 25.25.162.0/24	12.12.12.2	0		0	18234?
*> 25.25.163.0/24	12.12.12.2	0		0	18234?
*> 25.25.164.0/24	12.12.12.2	0		0	18234?
*> 25.25.165.0/24	12.12.12.2	0		0	18234?
*> 25.25.166.0/24	12.12.12.2	0		0	18234?
*> 25.25.167.0/24	12.12.12.2	0		0	18234?
* 132.12.12.0/24	12.12.12.2			0	18234 2222i
* 132.12.13.0/24	12.12.12.2			0	18234 2222i
* 132.12.14.0/24	12.12.12.2			0	18234 2222i
* 132.12.15.0/24	12.12.12.2			0	18234 2222i

AR9:

<AR9>display bgp peer

BGP local router ID : 172.31.5.2

Local AS number : 2222

Total number of peers : 4 Peers in established state : 4

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
6.6.6.1	4	888	328	327	0	05:18:59	Established	16
9.9.9.2	4	7685	328	328	0	05:19:36	Established	16
11.11.11.2	4	18234	149	148	0	02:23:42	Established	16
172.31.5.1	4	2222	462	465	0	07:36:18	Established	4

<AR9>display bgp routing-table peer 11.11.11.2 received-routes

BGP Local router ID is 172.31.5.2

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 16

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 25.25.160.0/24	11.11.11.2	0	0	18234?	
*> 25.25.161.0/24	11.11.11.2	0	0	18234?	
*> 25.25.162.0/24	11.11.11.2	0	0	18234?	
*> 25.25.163.0/24	11.11.11.2	0	0	18234?	
*> 25.25.164.0/24	11.11.11.2	0	0	18234?	
*> 25.25.165.0/24	11.11.11.2	0	0	18234?	
*> 25.25.166.0/24	11.11.11.2	0	0	18234?	
*> 25.25.167.0/24	11.11.11.2	0	0	18234?	
* 185.16.16.0/24	11.11.11.2		0	18234 7685 888 3245i	
* 185.16.17.0/24	11.11.11.2		0	18234 7685 888 3245i	
* 185.16.18.0/24	11.11.11.2		0	18234 7685 888 3245i	
* 185.16.19.0/24	11.11.11.2		0	18234 7685 888 3245i	
* 185.16.20.0/24	11.11.11.2		0	18234 7685 888 3245i	
* 185.16.21.0/24	11.11.11.2		0	18234 7685 888 3245i	
* 185.16.22.0/24	11.11.11.2		0	18234 7685 888 3245i	
* 185.16.23.0/24	11.11.11.2		0	18234 7685 888 3245i	

3.3. BGP route manipulation.

- Make sure that AS 18234 routes are advertised to AS 3245 in redundant fashion. To resolve the next-hop addresses in AS 2222 you must not configure anything under bgp configuration mode. To resolve the next-hop addresses in AS 888 you must use configuration only under bgp mode. To provide connectivity through AS 7685 you can configure iBGP session only between AR5 and AR6. Assume that AR7 do not support BGP protocol.

AR8:

<AR8>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR8]**ospf 1**

[AR8-ospf-1]**area 2**

[AR8-ospf-1-area-0.0.0.2]**network 5.5.5.0 0.0.0.3**

[AR8-ospf-1-area-0.0.0.2]**quit**

[AR8-ospf-1]**silent-interface Serial 2/0/1**

[AR8-ospf-1]**quit**

AR9:

<AR9>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR9]**ospf 1**

[AR9-ospf-1]**area 2**

[AR9-ospf-1-area-0.0.0.2]**network 6.6.6.0 0.0.0.3**

```
[AR9-ospf-1-area-0.0.0.2]network 9.9.9.0 0.0.0.3
[AR9-ospf-1-area-0.0.0.2]network 11.11.11.0 0.0.0.3
[AR9-ospf-1-area-0.0.0.2]quit
[AR9-ospf-1]silent-interface serial 2/0/1
[AR9-ospf-1]silent-interface serial 1/0/1
[AR9-ospf-1]silent-interface serial 2/0/0
[AR9-ospf-1-area-0.0.0.2]quit
[AR9-ospf-1]quit
```

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]bgp 888
[AR1-bgp]peer 192.168.5.3 next-hop-local
[AR1-bgp]quit
```

AR2:

```
<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]bgp 888
[AR2-bgp]peer 192.168.5.3 next-hop-local
[AR2-bgp]quit
```

AR3:

```
<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]bgp 888
[AR3-bgp]peer 192.168.5.1 next-hop-local
[AR3-bgp]peer 192.168.5.2 next-hop-local
[AR3-bgp]peer 192.168.5.4 next-hop-local
[AR3-bgp]quit
```

AR4:

```

<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]bgp 888

[AR4-bgp]peer 192.168.5.3 next-hop-local

[AR4-bgp]quit

```

AR5:

```

<AR5>system-view
Enter system view, return user view with Ctrl+Z.

[AR5]interface Tunnel 0/0/1

[AR5-Tunnel0/0/1]tunnel-protocol gre

[AR5-Tunnel0/0/1]ip address 172.16.6.1 30

[AR5-Tunnel0/0/1]source 172.16.5.1

[AR5-Tunnel0/0/1]destination 172.16.5.2

[AR5-Tunnel0/0/1]quit

[AR5]bgp 7685

[AR5-bgp]peer 172.16.6.2 as-number 7685

[AR5-bgp]peer 172.16.6.2 next-hop-local

[AR5-bgp]return

```

AR6:

```

[AR6]interface Tunnel 0/0/1

[AR6-Tunnel0/0/1]tunnel-protocol gre

[AR6-Tunnel0/0/1]ip address 172.16.6.2 30

[AR6-Tunnel0/0/1]source 172.16.5.2

[AR6-Tunnel0/0/1]destination 172.16.5.1

[AR6-Tunnel0/0/1]quit

[AR6]bgp 7685

[AR6-bgp]peer 172.16.6.1 as-number 7685

[AR6-bgp]peer 172.16.6.1 next-hop-local

[AR6-bgp]quit

```

Verify the configuration:

AR5:

<AR5>display interface Tunnel 0/0/1

```
Tunnel0/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-12-07 05:34:46 UTC-08:00
Description:HUAWEI, AR Series, Tunnel0/0/1 Interface
Route Port, The Maximum Transmit Unit is 1500
Internet Address is 172.16.6.1/30
Encapsulation is TUNNEL, loopback not set
Tunnel source 172.16.5.1 (LoopBack0), destination 172.16.5.2
Tunnel protocol/transport GRE/IP, key disabled
keepalive disabled
Checksumming of packets disabled
Current system time: 2015-12-07 06:28:06-08:00
  300 seconds input rate 0 bits/sec, 0 packets/sec
  300 seconds output rate 16 bits/sec, 0 packets/sec
  0 seconds input rate 0 bits/sec, 0 packets/sec
  0 seconds output rate 0 bits/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  309 packets output, 18133 bytes
  0 output error
  Input bandwidth utilization : --
  Output bandwidth utilization : --
```

<AR5>display bgp peer

```
BGP local router ID : 172.16.5.1
Local AS number : 7685
Total number of peers : 2                Peers in established state : 2
```

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
7.7.7.1	4	888	457	452	0	07:30:22	Established	20
172.16.6.2	4	7685	53	55	0	00:48:18	Established	20

<AR5>display bgp routing-table peer 172.16.6.2 received-routes

```
BGP Local router ID is 172.16.5.1
Status codes: * - valid, > - best, d - damped,
              h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete
```

Total Number of Routes: 20

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>i 25.25.160.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.161.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.162.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.163.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.164.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.165.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.166.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.167.0/24	172.16.6.2	0	100	0	18234?

```
*>i 132.12.12.0/24 172.16.6.2 100 0 2222i
*>i 132.12.13.0/24 172.16.6.2 100 0 2222i
*>i 132.12.14.0/24 172.16.6.2 100 0 2222i
*>i 132.12.15.0/24 172.16.6.2 100 0 2222i
*i 185.16.16.0/24 172.16.6.2 100 0 888 3245i
*i 185.16.17.0/24 172.16.6.2 100 0 888 3245i
*i 185.16.18.0/24 172.16.6.2 100 0 888 3245i
*i 185.16.19.0/24 172.16.6.2 100 0 888 3245i
*i 185.16.20.0/24 172.16.6.2 100 0 888 3245i
*i 185.16.21.0/24 172.16.6.2 100 0 888 3245i
*i 185.16.22.0/24 172.16.6.2 100 0 888 3245i
*i 185.16.23.0/24 172.16.6.2 100 0 888 3245i
```

AR1:

<AR1>display bgp routing-table peer 3.3.3.1 advertised-routes

BGP Local router ID is 192.168.5.1

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 20

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>i 25.25.160.0/24	3.3.3.2		0	888 2222	18234?
*>i 25.25.161.0/24	3.3.3.2		0	888 2222	18234?
*>i 25.25.162.0/24	3.3.3.2		0	888 2222	18234?
*>i 25.25.163.0/24	3.3.3.2		0	888 2222	18234?
*>i 25.25.164.0/24	3.3.3.2		0	888 2222	18234?
*>i 25.25.165.0/24	3.3.3.2		0	888 2222	18234?
*>i 25.25.166.0/24	3.3.3.2		0	888 2222	18234?
*>i 25.25.167.0/24	3.3.3.2		0	888 2222	18234?
*>i 132.12.12.0/24	3.3.3.2		0	888 2222i	
*>i 132.12.13.0/24	3.3.3.2		0	888 2222i	
*>i 132.12.14.0/24	3.3.3.2		0	888 2222i	
*>i 132.12.15.0/24	3.3.3.2		0	888 2222i	
*> 185.16.16.0/24	3.3.3.2		0	888 3245i	
*> 185.16.17.0/24	3.3.3.2		0	888 3245i	
*> 185.16.18.0/24	3.3.3.2		0	888 3245i	
*> 185.16.19.0/24	3.3.3.2		0	888 3245i	
*> 185.16.20.0/24	3.3.3.2		0	888 3245i	
*> 185.16.21.0/24	3.3.3.2		0	888 3245i	
*> 185.16.22.0/24	3.3.3.2		0	888 3245i	
*> 185.16.23.0/24	3.3.3.2		0	888 3245i	

- Configure AR8 and AR9 to advertise only aggregate route 132.12.12.0/22 and adding *as-set* attribute to the route.

AR8:

[AR8]bgp 2222**[AR8-bgp]ipv4-family unicast****[AR8-bgp-af-ipv4]aggregate 132.12.12.0 22 detail-suppressed as-set****[AR8-bgp-af-ipv4]quit****[AR8-bgp]quit****[AR8]route-policy TO-BGP permit node 10**

Info: New Sequence of this List.

[AR8-route-policy]apply community 2222:2**[AR8-route-policy]quit**

Verify the configuration:

AR8:

<AR8>display bgp routing-table peer 5.5.5.1 advertised-routes

BGP Local router ID is 172.31.5.1

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 9

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>i 25.25.160.0/24	5.5.5.2		0	2222	18234?
*>i 25.25.161.0/24	5.5.5.2		0	2222	18234?
*>i 25.25.162.0/24	5.5.5.2		0	2222	18234?
*>i 25.25.163.0/24	5.5.5.2		0	2222	18234?
*>i 25.25.164.0/24	5.5.5.2		0	2222	18234?
*>i 25.25.165.0/24	5.5.5.2		0	2222	18234?
*>i 25.25.166.0/24	5.5.5.2		0	2222	18234?
*>i 25.25.167.0/24	5.5.5.2		0	2222	18234?
*> 132.12.12.0/22	5.5.5.2		0	2222i	

<AR8>display bgp routing-table peer 172.31.5.2 advertised-routes

BGP Local router ID is 172.31.5.1

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 9

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 132.12.12.0/22	172.31.5.1		100	0	i
*> 185.16.16.0/24	5.5.5.1		100	0	888 3245i
*> 185.16.17.0/24	5.5.5.1		100	0	888 3245i
*> 185.16.18.0/24	5.5.5.1		100	0	888 3245i
*> 185.16.19.0/24	5.5.5.1		100	0	888 3245i
*> 185.16.20.0/24	5.5.5.1		100	0	888 3245i


```
*> 185.16.21.0/24 5.5.5.1 100 0 888 3245i
*> 185.16.22.0/24 5.5.5.1 100 0 888 3245i
*> 185.16.23.0/24 5.5.5.1 100 0 888 3245i
```

- Make sure that AS 18234 is not transit for routes originated from AS 3245. Use the as-path attribute to accomplish that.

AR6 & AR9:

```
<AR6>system-view
Enter system view, return user view with Ctrl+Z.

[AR6]ip as-path-filter NO-AS3245 deny _3245$

[AR6]ip as-path-filter NO-AS3245 permit .*

[AR6]route-policy FROM-AS18234 permit node 5
Info: New Sequence of this List.

[AR6-route-policy]if-match as-path-filter NO-AS3245

[AR6-route-policy]quit

[AR6]bgp 7685

[AR6-bgp]peer 12.12.12.2 route-policy FROM-AS18234 import

[AR6-bgp]quit
```

Verify the configuration:

AR6:

```
<AR6>display bgp routing-table peer 12.12.12.2 received-routes

BGP Local router ID is 172.16.5.2
Status codes: * - valid, > - best, d - damped,
               h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 9
  Network      NextHop    MED      LocPrf  PrefVal Path/Ogn
*> 25.25.160.0/24 12.12.12.2  0          0      18234?
*> 25.25.161.0/24 12.12.12.2  0          0      18234?
*> 25.25.162.0/24 12.12.12.2  0          0      18234?
*> 25.25.163.0/24 12.12.12.2  0          0      18234?
*> 25.25.164.0/24 12.12.12.2  0          0      18234?
*> 25.25.165.0/24 12.12.12.2  0          0      18234?
*> 25.25.166.0/24 12.12.12.2  0          0      18234?
*> 25.25.167.0/24 12.12.12.2  0          0      18234?
* 132.12.12.0/22 12.12.12.2          0      18234 2222i
```

AR9:

<AR9>display bgp routing-table peer 11.11.11.2 received-routes

BGP Local router ID is 172.31.5.2

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 8

	Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>	25.25.160.0/24	11.11.11.2	0	0	18234?	
*>	25.25.161.0/24	11.11.11.2	0	0	18234?	
*>	25.25.162.0/24	11.11.11.2	0	0	18234?	
*>	25.25.163.0/24	11.11.11.2	0	0	18234?	
*>	25.25.164.0/24	11.11.11.2	0	0	18234?	
*>	25.25.165.0/24	11.11.11.2	0	0	18234?	
*>	25.25.166.0/24	11.11.11.2	0	0	18234?	
*>	25.25.167.0/24	11.11.11.2	0	0	18234?	

- Make sure that the summary route originated from AS 2222 is send to AS 3245 without any communities attached. But the route with the original community should be present in the AR1 routing table.

AR1:

```

<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]bgp 888

[AR1-bgp]peer 192.168.5.3 advertise-community

[AR1-bgp]quit

[AR1]route-policy TO-AS3245 permit node 5
Info: New Sequence of this List.

[AR1-route-policy]apply community none

[AR1-route-policy]quit

[AR1]bgp 888

[AR1-bgp]peer 3.3.3.1 route-policy TO-AS3245 export

[AR1-bgp]peer 4.4.4.1 route-policy TO-AS3245 export

[AR1-bgp]return

```

AR2:

```

<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]bgp 888

[AR2-bgp]peer 192.168.5.3 advertise-community

[AR2-bgp]quit

```

AR3:

```

<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]bgp 888

[AR3-bgp]peer 192.168.5.1 advertise-community

[AR3-bgp]peer 192.168.5.2 advertise-community

[AR3-bgp]peer 192.168.5.4 advertise-community

[AR3-bgp]quit

```

AR4:

```

<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]bgp 888

[AR4-bgp]peer 192.168.5.3 advertise-community

[AR4-bgp]quit

```

Verify the configuration:

AR1:

```
<AR1>display bgp routing-table 132.12.12.0

BGP local router ID : 192.168.5.1
Local AS number : 888
Paths: 1 available, 1 best, 1 select
BGP routing table entry information of 132.12.12.0/22:
From: 192.168.5.3 (192.168.5.3)
Route Duration: 00h04m25s
Relay IP Nexthop: 192.168.1.6
Relay IP Out-Interface: Serial1/0/0
Original nexthop: 192.168.5.3
Qos information : 0x0
Community:<2222:2>
AS-path 2222, origin igp, localpref 100, pref-val 0, valid, internal, best, select, active, pre 255, IGP cost 10
Aggregator: AS 2222, Aggregator ID 172.31.5.1, Atomic-aggregate
Advertised to such 2 peers:
 4.4.4.1
 3.3.3.1

<AR1>display bgp routing-table peer 3.3.3.1 advertised-routes 132.12.12.0

BGP local router ID : 192.168.5.1
Local AS number : 888
BGP routing table entry information of 132.12.12.0/22:
From: 192.168.5.3 (192.168.5.3)
Route Duration: 00h05m10s
Relay IP Nexthop: 192.168.1.6
Relay IP Out-Interface: Serial1/0/0
Original nexthop: 192.168.5.3
Advertised nexthop: 3.3.3.2
Qos information : 0x0
AS-path 888 2222, origin igp
Aggregator: AS 2222, Aggregator ID 172.31.5.1, Atomic-aggregate
```

- Make sure that AS 2222 receives and send traffic from AR9 when network is fully converged and all links are operational. You are allowed to do changes only on AR8 to accomplish that.

AR8:

<AR8>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR8]**route-policy FROM-AS888 permit node 5**

Info: New Sequence of this List.

[AR8-route-policy]**apply local-preference 200**[AR8-route-policy]**quit**[AR8]**route-policy TO-BGP permit node 5**

Info: You are overwriting this sequence.

AR8-route-policy**apply as-path 2222 2222 2222 additive**[AR8-route-policy]**quit**[AR8]**route-policy TO-BGP permit node 10**

Info: You are overwriting this sequence.

[AR8-route-policy]**apply as-path 2222 2222 2222 additive**[AR8-route-policy]**quit**[AR8]**bgp 2222**[AR8-bgp]**peer 5.5.5.1 route-policy FROM-AS888 import**[AR8-bgp]**quit**

Verify the configuration:

AR8:

<AR8>**display bgp routing-table peer 5.5.5.1 advertised-routes**

BGP Local router ID is 172.31.5.1

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 1

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 132.12.12.0/22	5.5.5.2		0	2222 2222 2222 2222	i

<AR8>**display bgp routing-table**

BGP Local router ID is 172.31.5.1

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 21

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn

```

*> 25.25.160.0/24 5.5.5.1 200 0 888 7685 18234?
*> 25.25.161.0/24 5.5.5.1 200 0 888 7685 18234?
*> 25.25.162.0/24 5.5.5.1 200 0 888 7685 18234?
*> 25.25.163.0/24 5.5.5.1 200 0 888 7685 18234?
*> 25.25.164.0/24 5.5.5.1 200 0 888 7685 18234?
*> 25.25.165.0/24 5.5.5.1 200 0 888 7685 18234?
*> 25.25.166.0/24 5.5.5.1 200 0 888 7685 18234?
*> 25.25.167.0/24 5.5.5.1 200 0 888 7685 18234?
*> 132.12.12.0/22 127.0.0.1 0 0 i
s> 132.12.12.0/24 0.0.0.0 0 0 i
s> 132.12.13.0/24 0.0.0.0 0 0 i
s> 132.12.14.0/24 0.0.0.0 0 0 i
s> 132.12.15.0/24 0.0.0.0 0 0 i
*> 185.16.16.0/24 5.5.5.1 200 0 888 3245i
*> 185.16.17.0/24 5.5.5.1 200 0 888 3245i
*> 185.16.18.0/24 5.5.5.1 200 0 888 3245i
*> 185.16.19.0/24 5.5.5.1 200 0 888 3245i
*> 185.16.20.0/24 5.5.5.1 200 0 888 3245i
*> 185.16.21.0/24 5.5.5.1 200 0 888 3245i
*> 185.16.22.0/24 5.5.5.1 200 0 888 3245i
*> 185.16.23.0/24 5.5.5.1 200 0 888 3245i

```

- Prefixes advertised from AS 3245 have set metric of 150. Make sure that AS 7685 prefers to send traffic to AS 3245 via AR4. You are allowed only to change metric BGP attribute on AR2 and AR4.

AR4:

```

<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]route-policy TO-AS7685 permit node 5

[AR4-route-policy]apply cost + 0

[AR4-route-policy]quit

[AR4]bgp 888

[AR4-bgp]peer 8.8.8.2 route-policy TO-AS7685 export

[AR4-bgp]quit

```

AR2:

```

<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]route-policy TO-AS7685 permit node 5
Info: New Sequence of this List.

[AR2-route-policy]apply cost + 50

[AR2-route-policy]quit

[AR2]bgp 888

[AR2-bgp]peer 7.7.7.2 route-policy TO-AS7685 export

[AR2-bgp]quit

```

Verify the configuration:

AR5:

<AR5>display bgp routing-table

BGP Local router ID is 172.16.5.1

Status codes: * - valid, > - best, d - damped,
h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 26

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>i 25.25.160.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.161.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.162.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.163.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.164.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.165.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.166.0/24	172.16.6.2	0	100	0	18234?
*>i 25.25.167.0/24	172.16.6.2	0	100	0	18234?
*>i 132.12.12.0/22	172.16.6.2		100	0	2222 2222 2222 2222i
*	7.7.7.1	50		0	888 2222 2222 2222 2222i
*>i 185.16.16.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i
*>i 185.16.17.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i
*>i 185.16.18.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i
*>i 185.16.19.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i
*>i 185.16.20.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i
*>i 185.16.21.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i
*>i 185.16.22.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i
*>i 185.16.23.0/24	172.16.6.2	150	100	0	888 3245i
*	7.7.7.1	200		0	888 3245i

AR6:

<AR6>display bgp routing-table

BGP Local router ID is 172.16.5.2

Status codes: * - valid, > - best, d - damped,
h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 27

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 25.25.160.0/24	12.12.12.2	0		0	18234?
*> 25.25.161.0/24	12.12.12.2	0		0	18234?
*> 25.25.162.0/24	12.12.12.2	0		0	18234?
*> 25.25.163.0/24	12.12.12.2	0		0	18234?

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```

*> 25.25.164.0/24 12.12.12.2 0 0 18234?
*> 25.25.165.0/24 12.12.12.2 0 0 18234?
*> 25.25.166.0/24 12.12.12.2 0 0 18234?
*> 25.25.167.0/24 12.12.12.2 0 0 18234?
*> 132.12.12.0/22 9.9.9.1 0 2222 2222 2222 2222i
* 12.12.12.2 0 18234 2222 2222 2222 2222i
* 8.8.8.1 0 888 2222 2222 2222 2222i
*> 185.16.16.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i
*> 185.16.17.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i
*> 185.16.18.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i
*> 185.16.19.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i
*> 185.16.20.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i
*> 185.16.21.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i
*> 185.16.22.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i
*> 185.16.23.0/24 8.8.8.1 150 0 888 3245i
* 9.9.9.1 0 2222 2222 2222 2222 888 3245i

```

- Ensure that AR7 can reach routes 132.12.12.0/22 advertised by AR8. AR7 should prefer the shortest path in terms of hop count.

AR5:

```

<AR5>system-view
Enter system view, return user view with Ctrl+Z.

[AR5]ip ip-prefix 132.12.12.0_22 permit 132.12.12.0 22

[AR5]route-policy TO-OSPF permit node 5
Info: New Sequence of this List.

[AR5-route-policy]if-match ip-prefix 132.12.12.0_22

[AR5-route-policy]quit

[AR5]ospf 1

[AR5-ospf-1]import-route bgp cost 50 route-policy TO-OSPF

[AR5-ospf-1]quit

[AR5]bgp 7685

[AR5-bgp]preference 50 50 50

[AR5-bgp]network 172.16.0.0 16

[AR5-bgp]quit

[AR5]ip route-static 172.16.0.0 16 null 0

```

AR6:

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```

<AR6>system-view
Enter system view, return user view with Ctrl+Z.

[AR6]ip ip-prefix 132.12.12.0_22 permit 132.12.12.0 22

[AR6]route-policy TO-OSPF permit node 5
Info: New Sequence of this List.

[AR6-route-policy]if-match ip-prefix 132.12.12.0_22

[AR6-route-policy]quit

[AR6]ospf 1

[AR6-ospf-1]import-route bgp route-policy TO-OSPF

[AR6-ospf-1]quit

[AR6]bgp 7685

[AR6-bgp]preference 50 50 50

[AR6-bgp]network 172.16.0.0 16

[AR6-bgp]quit

[AR6]ip route-static 172.16.0.0 16 null 0

```

Verify the configuration:

AR7:

```

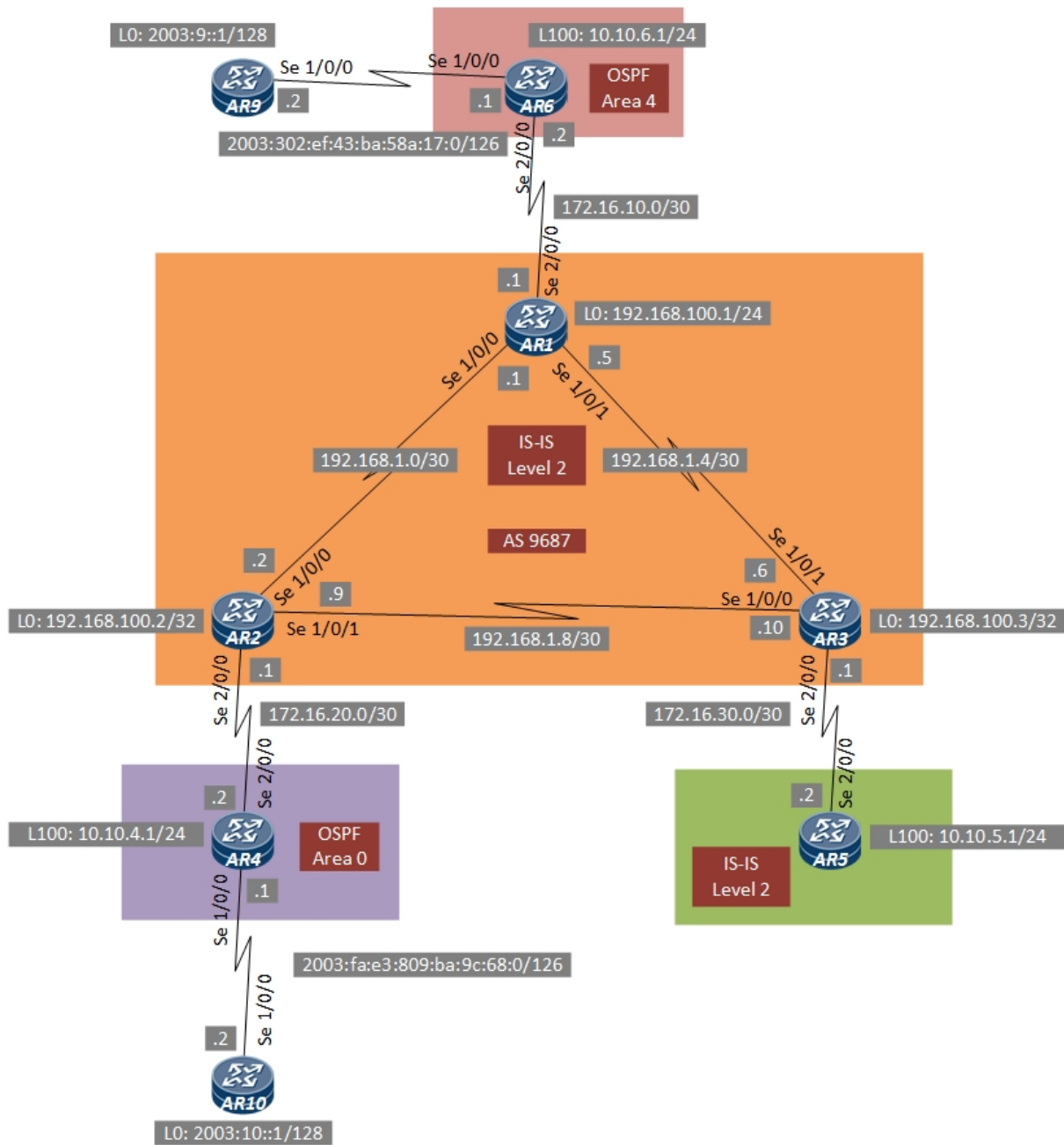
<AR7>display ip routing-table
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Public
  Destinations : 16    Routes : 16

Destination/Mask    Proto Pre Cost   Flags NextHop         Interface
-----
127.0.0.0/8        Direct 0   0       D 127.0.0.1      InLoopBack0
127.0.0.1/32       Direct 0   0       D 127.0.0.1      InLoopBack0
127.255.255.255/32 Direct 0   0       D 127.0.0.1      InLoopBack0
132.12.12.0/22     O ASE  150 1       D 172.16.1.5     Serial1/0/1
172.16.1.0/30      Direct 0   0       D 172.16.1.2     Serial1/0/0
172.16.1.1/32      Direct 0   0       D 172.16.1.1     Serial1/0/0
172.16.1.2/32      Direct 0   0       D 127.0.0.1     Serial1/0/0
172.16.1.3/32      Direct 0   0       D 127.0.0.1     Serial1/0/0
172.16.1.4/30      Direct 0   0       D 172.16.1.6     Serial1/0/1
172.16.1.5/32      Direct 0   0       D 172.16.1.5     Serial1/0/1
172.16.1.6/32      Direct 0   0       D 127.0.0.1     Serial1/0/1
172.16.1.7/32      Direct 0   0       D 127.0.0.1     Serial1/0/1
172.16.5.1/32      OSPF   10 48       D 172.16.1.1     Serial1/0/0
172.16.5.2/32      OSPF   10 48       D 172.16.1.5     Serial1/0/1
172.16.5.3/32      Direct 0   0       D 127.0.0.1     LoopBack0
255.255.255.255/32 Direct 0   0       D 127.0.0.1     InLoopBack0

```

Chapter 4: MPLS and IPv6 configuration and features - solutions

NOTE: Load topology with name – *MPLS_IPv6*



4.2. MPLS configuration.

- Configure the interfaces from the diagram with the shown IP addresses.
- Configure IS-IS Level 2 routing protocol on the routers in AS 9687.

AR1:

```
<AR1>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR1]interface serial 1/0/0  
[AR1-Serial1/0/0]ip address 192.168.1.1 30  
[AR1-Serial1/0/0]quit  
[AR1]interface serial 1/0/1  
[AR1-Serial1/0/1]ip address 192.168.1.5 30  
[AR1-Serial1/0/1]quit  
[AR1]interface serial 2/0/0  
[AR1-Serial2/0/0]ip address 172.16.10.1 30  
[AR1-Serial2/0/0]quit  
[AR1]interface LoopBack 0  
[AR1-LoopBack0]ip address 192.168.100.1 32  
[AR1-LoopBack0]quit  
[AR1-isis-1]network-entity 49.0001.1920.1680.1001.00  
[AR1-isis-1]is-level level-2  
[AR1-isis-1]quit  
[AR1]interface Serial 1/0/0  
[AR1-Serial1/0/0]isis enable 1  
[AR1-Serial1/0/0]quit  
[AR1]interface Serial 1/0/1  
[AR1-Serial1/0/1]isis enable 1  
[AR1]interface LoopBack 0  
[AR1-LoopBack0]isis enable 1  
[AR1-Serial1/0/1]quit
```

Verify the configuration:

AR1:

<AR1>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
1920.1680.1002	S1/0/0	0000000001	Up	23s	L2	--
1920.1680.1003	S1/0/1	0000000002	Up	28s	L2	--

Total Peer(s): 2

AR2:

<AR2>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
1920.1680.1001	S1/0/0	0000000001	Up	30s	L2	--
1920.1680.1003	S1/0/1	0000000001	Up	28s	L2	--

Total Peer(s): 2

<AR1>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 16 Routes : 17

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
192.168.1.0/30	Direct	0	0	D	192.168.1.1	Serial1/0/0
192.168.1.1/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
192.168.1.2/32	Direct	0	0	D	192.168.1.2	Serial1/0/0
192.168.1.3/32	Direct	0	0	D	127.0.0.1	Serial1/0/0
192.168.1.4/30	Direct	0	0	D	192.168.1.5	Serial1/0/1
192.168.1.5/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
192.168.1.6/32	Direct	0	0	D	192.168.1.6	Serial1/0/1
192.168.1.7/32	Direct	0	0	D	127.0.0.1	Serial1/0/1
192.168.1.8/30	ISIS-L2	15	20	D	192.168.1.2	Serial1/0/0
	ISIS-L2	15	20	D	192.168.1.6	Serial1/0/1
192.168.100.1/32	Direct	0	0	D	127.0.0.1	LoopBack0
192.168.100.2/32	ISIS-L2	15	10	D	192.168.1.2	Serial1/0/0
192.168.100.3/32	ISIS-L2	15	10	D	192.168.1.6	Serial1/0/1
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

AR3:

<AR3>**display isis peer**

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
1920.1680.1002	S1/0/0	0000000002	Up	22s	L2	--
1920.1680.1001	S1/0/1	0000000002	Up	28s	L2	--

Total Peer(s): 2

- Enable MPLS across AS 9687. Configure LDP as label distribution protocol.

AR1:

<AR1>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR1]**mpls lsr-id 192.168.100.1**

[AR1]**mpls**

Info: Mpls starting, please wait... OK!

[AR1-mpls]**quit**

[AR1]**mpls ldp**

[AR1-mpls-ldp]**quit**

[AR1]**interface Serial 1/0/0**

[AR1-Serial1/0/0]**mpls**

[AR1-Serial1/0/0]**mpls ldp**

[AR1-Serial1/0/0]**quit**

[AR1]**interface Serial 1/0/1**

[AR1-Serial1/0/1]**mpls ldp**

[AR1-Serial1/0/1]**quit**

[AR1]**quit**

AR2:

```
<AR2>system-view  
Enter system view, return user view with Ctrl+Z.
```

```
[AR2]mpls lsr-id 192.168.100.2
```

```
[AR2]mpls  
Info: Mpls starting, please wait... OK!
```

```
[AR2-mpls]quit
```

```
[AR2]mpls ldp
```

```
[AR2-mpls-ldp]quit
```

```
[AR2]interface Serial 1/0/0
```

```
[AR2-Serial1/0/0]mpls
```

```
[AR2-Serial1/0/0]mpls ldp
```

```
[AR2-Serial1/0/0]quit
```

```
[AR2]interface Serial 1/0/1
```

```
[AR2-Serial1/0/1]mpls
```

```
[AR2-Serial1/0/1]mpls ldp
```

```
[AR2-Serial1/0/1]quit
```

```
[AR2]quit
```

AR3:

```
<AR3>system-view  
Enter system view, return user view with Ctrl+Z.
```

```
[AR3]mpls lsr-id 192.168.100.3
```

```
[AR3]mpls  
Info: Mpls starting, please wait... OK!
```

```
[AR3-mpls]quit
```

```
[AR3]mpls ldp
```

```
[AR3-mpls-ldp]quit
```

```
[AR3]interface Serial 1/0/0
```

```
[AR3-Serial1/0/0]mpls
```

```
[AR3-Serial1/0/0]mpls ldp
```

```
[AR3-Serial1/0/0]quit
```

```
[AR3]interface Serial 1/0/1
```

```
[AR3-Serial1/0/1]mpls
```

```
[AR3-Serial1/0/1]mpls ldp
```

```
[AR3-Serial1/0/1]quit
```

```
[AR3]quit
```

Verify the configuration:

AR1:

```
<AR1>display mpls ldp peer
```

LDP Peer Information in Public network
A '*' before a peer means the peer is being deleted.

PeerID	TransportAddress	DiscoverySource
192.168.100.2:0	192.168.100.2	Serial1/0/0
192.168.100.3:0	192.168.100.3	Serial1/0/1

TOTAL: 2 Peer(s) Found.

```
<AR1>display mpls ldp lsp
```

LDP LSP Information

DestAddress/Mask	In/OutLabel	UpstreamPeer	NextHop	OutInterface
192.168.100.1/32	3/NULL	192.168.100.2	127.0.0.1	InLoop0
192.168.100.1/32	3/NULL	192.168.100.3	127.0.0.1	InLoop0
*192.168.100.1/32	Liberal/1024		DS/192.168.100.2	
*192.168.100.1/32	Liberal/1024		DS/192.168.100.3	
192.168.100.2/32	NULL/3	-	192.168.1.2	S1/0/0
192.168.100.2/32	1024/3	192.168.100.2	192.168.1.2	S1/0/0
192.168.100.2/32	1024/3	192.168.100.3	192.168.1.2	S1/0/0
*192.168.100.2/32	Liberal/1025		DS/192.168.100.3	
192.168.100.3/32	NULL/3	-	192.168.1.6	S1/0/1
192.168.100.3/32	1025/3	192.168.100.2	192.168.1.6	S1/0/1
192.168.100.3/32	1025/3	192.168.100.3	192.168.1.6	S1/0/1
*192.168.100.3/32	Liberal/1025		DS/192.168.100.2	

TOTAL: 8 Normal LSP(s) Found.

TOTAL: 4 Liberal LSP(s) Found.

TOTAL: 0 Frr LSP(s) Found.

A '*' before an LSP means the LSP is not established

A '*' before a Label means the USCB or DSCB is stale

A '*' before a UpstreamPeer means the session is stale

A '*' before a DS means the session is stale

A '*' before a NextHop means the LSP is FRR LSP

AR2:

<AR2>display mpls ldp peer

LDP Peer Information in Public network
A '*' before a peer means the peer is being deleted.

PeerID	TransportAddress	DiscoverySource
192.168.100.1:0	192.168.100.1	Serial1/0/0
192.168.100.3:0	192.168.100.3	Serial1/0/1

TOTAL: 2 Peer(s) Found.

<AR2>display mpls ldp lsp

LDP LSP Information

DestAddress/Mask	In/OutLabel	UpstreamPeer	NextHop	OutInterface
192.168.100.1/32	NULL/3	-	192.168.1.1	S1/0/0
192.168.100.1/32	1024/3	192.168.100.1	192.168.1.1	S1/0/0
192.168.100.1/32	1024/3	192.168.100.3	192.168.1.1	S1/0/0
*192.168.100.1/32	Liberal/1024		DS/192.168.100.3	
192.168.100.2/32	3/NULL	192.168.100.1	127.0.0.1	InLoop0
192.168.100.2/32	3/NULL	192.168.100.3	127.0.0.1	InLoop0
*192.168.100.2/32	Liberal/1024		DS/192.168.100.1	
*192.168.100.2/32	Liberal/1025		DS/192.168.100.3	
192.168.100.3/32	NULL/3	-	192.168.1.10	S1/0/1
192.168.100.3/32	1025/3	192.168.100.1	192.168.1.10	S1/0/1
192.168.100.3/32	1025/3	192.168.100.3	192.168.1.10	S1/0/1
*192.168.100.3/32	Liberal/1025		DS/192.168.100.1	

TOTAL: 8 Normal LSP(s) Found.

TOTAL: 4 Liberal LSP(s) Found.

TOTAL: 0 Frr LSP(s) Found.

A '*' before an LSP means the LSP is not established

A '*' before a Label means the USCB or DSCB is stale

A '*' before a UpstreamPeer means the session is stale

A '*' before a DS means the session is stale

A '*' before a NextHop means the LSP is FRR LSP

AR3:

<AR3>display mpls ldp peer

LDP Peer Information in Public network
A '*' before a peer means the peer is being deleted.

PeerID	TransportAddress	DiscoverySource
192.168.100.1:0	192.168.100.1	Serial1/0/1
192.168.100.2:0	192.168.100.2	Serial1/0/0

TOTAL: 2 Peer(s) Found.

<AR3>display mpls ldp lsp

LDP LSP Information

DestAddress/Mask	In/OutLabel	UpstreamPeer	NextHop	OutInterface


```

192.168.100.1/32 NULL/3 - 192.168.1.5 S1/0/1
192.168.100.1/32 1024/3 192.168.100.1 192.168.1.5 S1/0/1
192.168.100.1/32 1024/3 192.168.100.2 192.168.1.5 S1/0/1
*192.168.100.1/32 Liberal/1024 DS/192.168.100.2
192.168.100.2/32 NULL/3 - 192.168.1.9 S1/0/0
192.168.100.2/32 1025/3 192.168.100.1 192.168.1.9 S1/0/0
192.168.100.2/32 1025/3 192.168.100.2 192.168.1.9 S1/0/0
*192.168.100.2/32 Liberal/1024 DS/192.168.100.1
192.168.100.3/32 3/NULL 192.168.100.1 127.0.0.1 InLoop0
192.168.100.3/32 3/NULL 192.168.100.2 127.0.0.1 InLoop0
*192.168.100.3/32 Liberal/1025 DS/192.168.100.1
*192.168.100.3/32 Liberal/1025 DS/192.168.100.2

```

TOTAL: 8 Normal LSP(s) Found.

TOTAL: 4 Liberal LSP(s) Found.

TOTAL: 0 Frr LSP(s) Found.

A '*' before an LSP means the LSP is not established

A '*' before a Label means the USCB or DSCB is stale

A '*' before a UpstreamPeer means the session is stale

A '*' before a DS means the session is stale

A '*' before a NextHop means the LSP is FRR LSP

- Configure full-mesh iBGP across AS 9687. Make sure that BGP supports transport of routes with labels.

AR1:

```

<AR1>system-view
Enter system view, return user view with Ctrl+Z.
[AR1]bgp 9687

[AR1-bgp]peer 192.168.100.2 as-number 9687

[AR1-bgp]peer 192.168.100.2 connect-interface LoopBack 0

[AR1-bgp]peer 192.168.100.2 advertise-ext-community

[AR1-bgp]peer 192.168.100.3 as-number 9687

[AR1-bgp]peer 192.168.100.3 connect-interface LoopBack 0

[AR1-bgp]peer 192.168.100.3 advertise-ext-community

[AR1-bgp]ipv4-family vpnv4

[AR1-bgp-af-vpnv4]peer 192.168.100.2 enable

[AR1-bgp-af-vpnv4]peer 192.168.100.3 enable

[AR1-bgp-af-vpnv4]quit

[AR1-bgp]quit

```

AR2:

```

<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]bgp 9687

```

```

[AR2-bgp]peer 192.168.100.1 as-number 9687
[AR2-bgp]peer 192.168.100.1 connect-interface LoopBack 0
[AR2-bgp]peer 192.168.100.1 advertise-ext-community
[AR2-bgp]peer 192.168.100.3 as-number 9687
[AR2-bgp]peer 192.168.100.3 connect-interface LoopBack 0
[AR2-bgp]peer 192.168.100.3 advertise-ext-community
[AR2-bgp]ipv4-family vpnv4
[AR2-bgp-af-vpnv4]peer 192.168.100.1 enable
[AR2-bgp-af-vpnv4]peer 192.168.100.3 enable
[AR2-bgp-af-vpnv4]quit
[AR2-bgp]quit

```

AR3:

```

<AR3>system-view
Enter system view, return user view with Ctrl+Z.
[AR3]bgp 9687
[AR3-bgp]peer 192.168.100.1 as-number 9687
[AR3-bgp]peer 192.168.100.1 connect-interface LoopBack 0
[AR3-bgp]peer 192.168.100.1 advertise-ext-community
[AR3-bgp]peer 192.168.100.2 as-number 9687
[AR3-bgp]peer 192.168.100.2 connect-interface LoopBack 0
[AR3-bgp]peer 192.168.100.2 advertise-ext-community
[AR3-bgp]ipv4-family vpnv4
[AR3-bgp-af-vpnv4]peer 192.168.100.1 enable
[AR3-bgp-af-vpnv4]peer 192.168.100.2 enable
[AR3-bgp-af-vpnv4]quit
[AR3-bgp]quit

```

Verify the configuration:

AR1:

```
<AR1>display bgp peer
```

BGP local router ID : 192.168.1.1

Local AS number : 9687

Total number of peers : 2 Peers in established state : 2

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
192.168.100.2	4	9687	1381	1384	0	23:00:59	Established	0
192.168.100.3	4	9687	18	19	0	00:16:20	Established	0

```
<AR1>display bgp peer 192.168.100.2 verbose
```

BGP Peer is 192.168.100.2, remote AS 9687

Type: IBGP link

BGP version 4, Remote router ID 192.168.1.2

Update-group ID: 2

BGP current state: Established, Up for 23h01m19s

BGP current event: RecvKeepalive

BGP last state: OpenConfirm

BGP Peer Up count: 3

Received total routes: 0

Received active routes total: 0

Advertised total routes: 0

Port: Local - 179 Remote - 50327

Configured: Connect-retry Time: 32 sec

Configured: Active Hold Time: 180 sec Keepalive Time: 60 sec

Received : Active Hold Time: 180 sec

Negotiated: Active Hold Time: 180 sec Keepalive Time: 60 sec

Peer optional capabilities:

Peer supports bgp multi-protocol extension

Peer supports bgp route refresh capability

Peer supports bgp 4-byte-as capability

Address family IPv4 Unicast: advertised and received

Address family VPNv4: advertised and received

Received: Total 1382 messages

Update messages	0
Open messages	1
KeepAlive messages	1381
Notification messages	0
Refresh messages	0

Sent: Total 1385 messages

Update messages	0
Open messages	2
KeepAlive messages	1382
Notification messages	1
Refresh messages	0

Authentication type configured: None

Last keepalive received: 2015/12/12 00:23:48 UTC-08:00

Last keepalive sent : 2015/12/12 00:23:45 UTC-08:00

Minimum route advertisement interval is 15 seconds

Optional capabilities:

Route refresh capability has been enabled

4-byte-as capability has been enabled

Send extend community has been configured

Connect-interface has been configured
 Peer Preferred Value: 0
 Routing policy configured:
 No routing policy is configured

AR2:

<AR2>display bgp peer

BGP local router ID : 192.168.1.2
 Local AS number : 9687
 Total number of peers : 2 Peers in established state : 2

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
192.168.100.1	4	9687	1389	1388	0	23:04:57	Established	0
192.168.100.3	4	9687	23	23	0	00:21:15	Established	0

AR3:

<AR3>display bgp peer

BGP local router ID : 192.168.1.10
 Local AS number : 9687
 Total number of peers : 2 Peers in established state : 2

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
192.168.100.1	4	9687	41	41	0	00:39:43	Established	0
192.168.100.2	4	9687	41	42	0	00:39:37	Established	0

- Configure routers AR4, AR5 and AR6 connectivity to the MPLS core network. Use the IP addresses shown on the diagram including interfaces Loopback 100 on each router.

AR4:

<AR4>system-view

Enter system view, return user view with Ctrl+Z.

[AR4]interface Serial 2/0/0

[AR4-Serial2/0/0]ip address 172.16.20.2 30

[AR4-Serial2/0/0]quit

[AR4]interface loopback 100

[AR4-LoopBack100]ip address 10.10.4.1 24

[AR4-LoopBack100]quit

[AR4]quit

AR5:

```
<AR5>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR5]interface Serial 2/0/0  
  
[AR5-Serial2/0/0]ip address 172.16.30.2 30  
  
[AR5-Serial2/0/0]quit  
  
[AR5]interface LoopBack 100  
  
[AR5-LoopBack100]ip address 10.10.5.1 24  
  
[AR5-LoopBack100]quit  
  
[AR5]quit
```

AR6:

```
<AR6>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR6]interface Serial 2/0/0  
  
[AR6-Serial2/0/0]ip address 172.16.10.2 30  
  
[AR6-Serial2/0/0]quit  
  
[AR6]interface LoopBack 100  
  
[AR6-LoopBack100]ip address 10.10.6.1 24  
  
[AR6-LoopBack100]quit  
  
[AR6]quit
```

Verify the configuration:

AR4:

```
<AR4>ping 172.16.0.12  
PING 172.16.20.1: 56 data bytes, press CTRL_C to break  
Reply from 172.16.20.1: bytes=56 Sequence=1 ttl=255 time=60 ms  
Reply from 172.16.20.1: bytes=56 Sequence=2 ttl=255 time=10 ms  
Reply from 172.16.20.1: bytes=56 Sequence=3 ttl=255 time=10 ms  
Reply from 172.16.20.1: bytes=56 Sequence=4 ttl=255 time=10 ms  
Reply from 172.16.20.1: bytes=56 Sequence=5 ttl=255 time=10 ms  
  
--- 172.16.20.1 ping statistics ---  
5 packet(s) transmitted  
5 packet(s) received  
0.00% packet loss  
round-trip min/avg/max = 10/20/60 ms
```

AR5:

```
<AR5>ping 172.16.30.1
PING 172.16.30.1: 56 data bytes, press CTRL_C to break
  Reply from 172.16.30.1: bytes=56 Sequence=1 ttl=255 time=40 ms
  Reply from 172.16.30.1: bytes=56 Sequence=2 ttl=255 time=10 ms
  Reply from 172.16.30.1: bytes=56 Sequence=3 ttl=255 time=1 ms
  Reply from 172.16.30.1: bytes=56 Sequence=4 ttl=255 time=10 ms
  Reply from 172.16.30.1: bytes=56 Sequence=5 ttl=255 time=10 ms

--- 172.16.30.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 1/14/40 ms
```

AR6:

```
<AR6>ping 172.16.10.1
PING 172.16.10.1: 56 data bytes, press CTRL_C to break
  Reply from 172.16.10.1: bytes=56 Sequence=1 ttl=255 time=40 ms
  Reply from 172.16.10.1: bytes=56 Sequence=2 ttl=255 time=10 ms
  Reply from 172.16.10.1: bytes=56 Sequence=3 ttl=255 time=10 ms
  Reply from 172.16.10.1: bytes=56 Sequence=4 ttl=255 time=10 ms
  Reply from 172.16.10.1: bytes=56 Sequence=5 ttl=255 time=10 ms

--- 172.16.10.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 10/16/40 ms
```

- Configure L3VPN across the MPLS core network. Use the appropriate PE-CE routing protocol as shown on the diagram. Make sure there is full reachability between the CEs Loopback 100 interfaces.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]ip vpn-instance Customer-1

[AR1-vpn-instance-Customer-1]ipv4-family

[AR1-vpn-instance-Customer-1-af-ipv4]route-distinguisher 9687:1

[AR1-vpn-instance-Customer-1-af-ipv4]vpn-target 9687:1 export-extcommunity
EVT Assignment result:
Info: VPN-Target assignment is successful.

[AR1-vpn-instance-Customer-1-af-ipv4]vpn-target 9687:1 import-extcommunity
IVT Assignment result:
Info: VPN-Target assignment is successful.

[AR1-vpn-instance-Customer-1-af-ipv4]quit

[AR1-vpn-instance-Customer-1]quit
```

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```
[AR1]interface Serial 2/0/0
```

```
[AR1-Serial2/0/0]ip binding vpn-instance Customer-1
```

Info: All IPv4 related configurations on this interface are removed!

Info: All IPv6 related configurations on this interface are removed!

Dec 12 2015 18:51:43-08:00 AR1 %%01IFNET/4/LINK_STATE(l)[18]:The line protocol PP P IPCP on the interface Serial2/0/0 has entered the DOWN state.

```
[AR1-Serial2/0/0]display this
```

```
[V200R003C00]
```

```
#
```

```
interface Serial2/0/0
```

```
link-protocol ppp
```

```
ip binding vpn-instance Customer-1
```

```
#
```

```
return
```

```
[AR1-Serial2/0/0]ip address 172.16.10.1 30
```

```
[AR1-Serial2/0/0]quit
```

```
[AR1]bgp 9687
```

```
[AR1-bgp]ipv4-family vpn-instance Customer-1
```

```
[AR1-bgp-Customer-1]peer 172.16.10.2 as-number 333
```

```
[AR1-bgp-Customer-1]import direct
```

```
[AR1-bgp-Customer-1]quit
```

AR6:

```
<AR6>system-view
```

Enter system view, return user view with Ctrl+Z.

```
[AR6]interface Serial 2/0/0
```

```
[AR6-Serial2/0/0]ip address 172.16.10.2 30
```

```
[AR6-Serial2/0/0]quit
```

```
[AR6]interface LoopBack 100
```

```
[AR6-LoopBack100]ip address 10.10.6.1 24
```

```
[AR6-LoopBack100]quit
```

```
[AR6]bgp 333
```

```
[AR6-bgp]peer 172.16.10.1 as-number 9687
```

```
[AR6-bgp]import-route direct
```

```
[AR6-bgp]quit
```

AR2:

```

<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]ip vpn-instance Customer-1

[AR2-vpn-instance-Customer-1]ipv4-family

[AR2-vpn-instance-Customer-1-af-ipv4]route-distinguisher 9687:1

[AR2-vpn-instance-Customer-1-af-ipv4]vpn-target 9687:1 export-extcommunity
EVT Assignment result:
Info: VPN-Target assignment is successful.

[AR2-vpn-instance-Customer-1-af-ipv4]vpn-target 9687:1 import-extcommunity
IVT Assignment result:
Info: VPN-Target assignment is successful.

[AR2-vpn-instance-Customer-1-af-ipv4]quit

[AR2-vpn-instance-Customer-1]quit

[AR2]ospf 1 vpn-instance Customer-1

[AR2-ospf-1]area 0

[AR2-ospf-1-area-0.0.0.0]network 172.16.20.0 0.0.0.3

[AR2-ospf-1-area-0.0.0.0]quit

[AR2-ospf-1]import bgp

[AR2-ospf-1]quit

[AR2]bgp 9687

[AR2-bgp]

[AR2-bgp-Customer-1]import-route direct

[AR2-bgp-Customer-1]import-route ospf 1

[AR2-bgp-Customer-1]quit

[AR2-bgp]quit

[AR2]interface Serial 2/0/0

[AR2-Serial2/0/0]display this
[V200R003C00]
#
interface Serial2/0/0
 link-protocol ppp
 ip address 172.16.20.1 255.255.255.252
#
return

[AR2-Serial2/0/0]ip binding vpn-instance Customer-1
Info: All IPv4 related configurations on this interface are removed!
Info: All IPv6 related configurations on this interface are removed!
Dec 12 2015 21:56:25-08:00 AR2 %%%01IFNET/4/LINK_STATE(l)[18]:The line protocol PP

```


P IPCP on the interface Serial2/0/0 has entered the DOWN state.

[AR2-Serial2/0/0]**ip address 172.16.20.1 255.255.255.252**

Dec 12 2015 21:56:35-08:00 AR2 %%01IFNET/4/LINK_STATE(l)[19]:The line protocol PP

P IPCP on the interface Serial2/0/0 has entered the UP state.

[AR2-Serial2/0/0]**quit**

[AR2]**quit**

AR4:

```

<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]interface Serial 2/0/0

[AR4-Serial2/0/0]ip address 172.16.20.2 30

[AR4-Serial2/0/0]quit

[AR4]interface LoopBack 100

[AR4-LoopBack100]ip address 10.10.4.1 24

[AR4-LoopBack100]ospf network-type broadcast

[AR4-LoopBack100]quit

[AR4]ospf 1

[AR4-ospf-1]area 0

[AR4-ospf-1-area-0.0.0.0]network 172.16.20.0 0.0.0.3

[AR4-ospf-1-area-0.0.0.0]network 10.10.4.0 0.0.0.255

[AR4-ospf-1-area-0.0.0.0]quit

[AR4-ospf-1]quit

[AR4]quit

```

AR3:

```

<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]ip vpn-instance Customer-1

[AR3-vpn-instance-Customer-1]ipv4-family

[AR3-vpn-instance-Customer-1-af-ipv4]route-distinguisher 9687:1

[AR3-vpn-instance-Customer-1-af-ipv4]vpn-target 9687:1 export-extcommunity
EVT Assignment result:
Info: VPN-Target assignment is successful.

[AR3-vpn-instance-Customer-1-af-ipv4]vpn-target 9687:1 import-extcommunity
IVT Assignment result:
Info: VPN-Target assignment is successful.

[AR3-vpn-instance-Customer-1-af-ipv4]quit

[AR3-vpn-instance-Customer-1]quit
[
[AR3]interface Serial 2/0/0

[AR3-Serial2/0/0]ip binding vpn-instance Customer-1
Info: All IPv4 related configurations on this interface are removed!
Info: All IPv6 related configurations on this interface are removed!

```

```

[AR3-Serial2/0/0]ip address 172.16.30.1 30
[AR3-Serial2/0/0]quit
[AR3]bgp 9687
[AR3-bgp]ipv4-family vpn-instance Customer-1
[AR3-bgp-Customer-1]import-route direct
[AR3-bgp-Customer-1]import-route isis 2
[AR3-bgp-Customer-1]quit
[AR3-bgp]quit
[AR3]isis 2 vpn-instance Customer-1
[AR3-isis-2]network-entity 49.0005.1720.1600.3001.00
Dec 13 2015 03:42:37-08:00 AR3 %%01ISIS/4/START_ENABLE_ISIS(1)[10]:ISIS 512 enabled all ISIS modules.
[AR3-isis-2]is-level level-2
[AR3-isis-2]import-route bgp
[AR3-isis-2]quit
[AR3]interface Serial 2/0/0
[AR3-Serial2/0/0]isis enable 2
[AR3-Serial2/0/0]quit
[AR3]quit

```

AR5:

```

<AR5>system-view
Enter system view, return user view with Ctrl+Z.
[AR5]interface Serial 2/0/0
[AR5-Serial2/0/0]ip address 172.16.30.2 30
[AR5-Serial2/0/0]quit
[AR5]interface LoopBack 100
[AR5-LoopBack100]ip address 10.10.5.1 24
[AR5-LoopBack100]quit
[AR5]isis 2
[AR5-isis-2]network-entity 49.0005.1720.1600.3002.00
[AR5-isis-2]is-level level-2

```

```

[AR5-isis-2]import-route direct

[AR5-isis-2]quit

[AR5]interface Serial 2/0/0

[AR5-Serial2/0/0]isis enable 2

[AR5-Serial2/0/0]quit

[AR5]quit

```

Verify the configuration:

AR1:

```

<AR1>display bgp vpnv4 vpn-instance Customer-1 peer

BGP local router ID : 192.168.100.1
Local AS number : 9687

VPN-Instance Customer-1, Router ID 192.168.100.1:
Total number of peers : 1          Peers in established state : 1

Peer      V      AS  MsgRcvd  MsgSent  OutQ  Up/Down    State Pref  Rcv
-----
172.16.10.2  4    333    961    967    0 15:56:33 Established   3

<AR1>display bgp vpnv4 vpn-instance Customer-1 routing-table

BGP Local router ID is 192.168.100.1
Status codes: * - valid, > - best, d - damped,
               h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

VPN-Instance Customer-1, Router ID 192.168.100.1:

Total Number of Routes: 12
  Network      NextHop      MED      LocPrf  PrefVal Path/Ogn
-----
*>i 10.10.4.0/24  192.168.100.2 49      100     0      ?
*>i 10.10.5.0/24  192.168.100.3 74      100     0      ?
*> 10.10.6.0/24  172.16.10.2  0        0      333?
*> 172.16.10.0/30 0.0.0.0      0        0      ?
*      172.16.10.2  0        0      333?
*> 172.16.10.1/32 0.0.0.0      0        0      ?
*      172.16.10.2  0        0      333?
*> 172.16.10.2/32 0.0.0.0      0        0      ?
*>i 172.16.20.0/30 192.168.100.2 0       100     0      ?
*>i 172.16.20.2/32 192.168.100.2 0       100     0      ?
*>i 172.16.30.0/30 192.168.100.3 0       100     0      ?
*>i 172.16.30.2/32 192.168.100.3 0       100     0      ?

```

AR2:

<AR2>display ospf peer

OSPF Process 1 with Router ID 172.16.20.1
Neighbors

Area 0.0.0.0 interface 172.16.20.1(Serial2/0/0)'s neighbors
Router ID: 172.16.20.2 Address: 172.16.20.2
State: Full Mode:Nbr is Master Priority: 1
DR: None BDR: None MTU: 0
Dead timer due in 39 sec
Retrans timer interval: 5
Neighbor is up for 14:41:39
Authentication Sequence: [0]

<AR2>display ip routing-table vpn-instance Customer-1

Route Flags: R - relay, D - download to fib

Routing Tables: Customer-1

Destinations : 12 Routes : 12

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.4.0/24	OSPF	10	48	D	172.16.20.2	Serial2/0/0
10.10.5.0/24	IBGP	255	74	RD	192.168.100.3	Serial1/0/1
10.10.6.0/24	IBGP	255	0	RD	192.168.100.1	Serial1/0/0
172.16.10.0/30	IBGP	255	0	RD	192.168.100.1	Serial1/0/0
172.16.10.2/32	IBGP	255	0	RD	192.168.100.1	Serial1/0/0
172.16.20.0/30	Direct	0	0	D	172.16.20.1	Serial2/0/0
172.16.20.1/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
172.16.20.2/32	Direct	0	0	D	172.16.20.2	Serial2/0/0
172.16.20.3/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
172.16.30.0/30	IBGP	255	0	RD	192.168.100.3	Serial1/0/1
172.16.30.2/32	IBGP	255	0	RD	192.168.100.3	Serial1/0/1
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

AR3:

<AR3>display isis peer vpn-instance Customer-1

Peer information for ISIS(Customer-1-2)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
1720.1600.3002	S2/0/0	0000000001	Up	26s	L2	--

Total Peer(s): 1

<AR3>display ip routing-table vpn-instance Customer-1

Route Flags: R - relay, D - download to fib

Routing Tables: Customer-1

Destinations : 12 Routes : 12

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.4.0/24	IBGP	255	49	RD	192.168.100.2	Serial1/0/0
10.10.5.0/24	ISIS-L2	15	74	D	172.16.30.2	Serial2/0/0
10.10.6.0/24	IBGP	255	0	RD	192.168.100.1	Serial1/0/1
172.16.10.0/30	IBGP	255	0	RD	192.168.100.1	Serial1/0/1

```

172.16.10.2/32 IBGP 255 0 RD 192.168.100.1 Serial1/0/1
172.16.20.0/30 IBGP 255 0 RD 192.168.100.2 Serial1/0/0
172.16.20.2/32 IBGP 255 0 RD 192.168.100.2 Serial1/0/0
172.16.30.0/30 Direct 0 0 D 172.16.30.1 Serial2/0/0
172.16.30.1/32 Direct 0 0 D 127.0.0.1 Serial2/0/0
172.16.30.2/32 Direct 0 0 D 172.16.30.2 Serial2/0/0
172.16.30.3/32 Direct 0 0 D 127.0.0.1 Serial2/0/0
255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

```

AR4:

<AR4>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 17 Routes : 17

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.4.0/24	Direct	0	0	D	10.10.4.1	LoopBack100
10.10.4.1/32	Direct	0	0	D	127.0.0.1	LoopBack100
10.10.4.255/32	Direct	0	0	D	127.0.0.1	LoopBack100
10.10.5.0/24	O_ASE	150	74	D	172.16.20.1	Serial2/0/0
10.10.6.0/24	O_ASE	150	1	D	172.16.20.1	Serial2/0/0
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.10.0/30	O_ASE	150	1	D	172.16.20.1	Serial2/0/0
172.16.10.2/32	O_ASE	150	1	D	172.16.20.1	Serial2/0/0
172.16.20.0/30	Direct	0	0	D	172.16.20.2	Serial2/0/0
172.16.20.1/32	Direct	0	0	D	172.16.20.1	Serial2/0/0
172.16.20.2/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
172.16.20.3/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
172.16.30.0/30	O_ASE	150	1	D	172.16.20.1	Serial2/0/0
172.16.30.2/32	O_ASE	150	1	D	172.16.20.1	Serial2/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

<AR4>ping -a 10.10.4.1 10.10.5.1

PING 10.10.5.1: 56 data bytes, press CTRL_C to break

Reply from 10.10.5.1: bytes=56 Sequence=1 ttl=253 time=80 ms

Reply from 10.10.5.1: bytes=56 Sequence=2 ttl=253 time=20 ms

Reply from 10.10.5.1: bytes=56 Sequence=3 ttl=253 time=20 ms

Reply from 10.10.5.1: bytes=56 Sequence=4 ttl=253 time=10 ms

Reply from 10.10.5.1: bytes=56 Sequence=5 ttl=253 time=20 ms

--- 10.10.5.1 ping statistics ---

5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 10/30/80 ms

<AR4>ping -a 10.10.4.1 10.10.6.1

PING 10.10.6.1: 56 data bytes, press CTRL_C to break

Reply from 10.10.6.1: bytes=56 Sequence=1 ttl=253 time=40 ms

Reply from 10.10.6.1: bytes=56 Sequence=2 ttl=253 time=30 ms

Reply from 10.10.6.1: bytes=56 Sequence=3 ttl=253 time=20 ms

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<https://t.me/learningnets>

```

Reply from 10.10.6.1: bytes=56 Sequence=4 ttl=253 time=20 ms
Reply from 10.10.6.1: bytes=56 Sequence=5 ttl=253 time=20 ms

```

```

--- 10.10.6.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 20/26/40 ms

```

AR5:**<AR5>display ip routing-table**

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 17 Routes : 17

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.4.0/24	ISIS-L2	15	74	D	172.16.30.1	Serial2/0/0
10.10.5.0/24	Direct	0	0	D	10.10.5.1	LoopBack100
10.10.5.1/32	Direct	0	0	D	127.0.0.1	LoopBack100
10.10.5.255/32	Direct	0	0	D	127.0.0.1	LoopBack100
10.10.6.0/24	ISIS-L2	15	74	D	172.16.30.1	Serial2/0/0
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.10.0/30	ISIS-L2	15	74	D	172.16.30.1	Serial2/0/0
172.16.10.2/32	ISIS-L2	15	74	D	172.16.30.1	Serial2/0/0
172.16.20.0/30	ISIS-L2	15	74	D	172.16.30.1	Serial2/0/0
172.16.20.2/32	ISIS-L2	15	74	D	172.16.30.1	Serial2/0/0
172.16.30.0/30	Direct	0	0	D	172.16.30.2	Serial2/0/0
172.16.30.1/32	Direct	0	0	D	172.16.30.1	Serial2/0/0
172.16.30.2/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
172.16.30.3/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

<AR5>ping -a 10.10.5.1 10.10.4.1

PING 10.10.4.1: 56 data bytes, press CTRL_C to break

```

Reply from 10.10.4.1: bytes=56 Sequence=1 ttl=253 time=30 ms
Reply from 10.10.4.1: bytes=56 Sequence=2 ttl=253 time=30 ms
Reply from 10.10.4.1: bytes=56 Sequence=3 ttl=253 time=20 ms
Reply from 10.10.4.1: bytes=56 Sequence=4 ttl=253 time=20 ms
Reply from 10.10.4.1: bytes=56 Sequence=5 ttl=253 time=30 ms

```

```

--- 10.10.4.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 20/26/30 ms

```

<AR5>ping -a 10.10.5.1 10.10.6.1

PING 10.10.6.1: 56 data bytes, press CTRL_C to break

```

Reply from 10.10.6.1: bytes=56 Sequence=1 ttl=253 time=30 ms
Reply from 10.10.6.1: bytes=56 Sequence=2 ttl=253 time=30 ms
Reply from 10.10.6.1: bytes=56 Sequence=3 ttl=253 time=20 ms
Reply from 10.10.6.1: bytes=56 Sequence=4 ttl=253 time=30 ms
Reply from 10.10.6.1: bytes=56 Sequence=5 ttl=253 time=30 ms

```

```

--- 10.10.6.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 20/28/30 ms

```

AR6:

<AR6>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 17 Routes : 17

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.10.4.0/24	EBGP	255	0	D	172.16.10.1	Serial2/0/0
10.10.5.0/24	EBGP	255	0	D	172.16.10.1	Serial2/0/0
10.10.6.0/24	Direct	0	0	D	10.10.6.1	LoopBack100
10.10.6.1/32	Direct	0	0	D	127.0.0.1	LoopBack100
10.10.6.255/32	Direct	0	0	D	127.0.0.1	LoopBack100
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.10.0/30	Direct	0	0	D	172.16.10.2	Serial2/0/0
172.16.10.1/32	Direct	0	0	D	172.16.10.1	Serial2/0/0
172.16.10.2/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
172.16.10.3/32	Direct	0	0	D	127.0.0.1	Serial2/0/0
172.16.20.0/30	EBGP	255	0	D	172.16.10.1	Serial2/0/0
172.16.20.2/32	EBGP	255	0	D	172.16.10.1	Serial2/0/0
172.16.30.0/30	EBGP	255	0	D	172.16.10.1	Serial2/0/0
172.16.30.2/32	EBGP	255	0	D	172.16.10.1	Serial2/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

<AR6>ping -a 10.10.6.1 10.10.4.1

PING 10.10.4.1: 56 data bytes, press CTRL_C to break

Reply from 10.10.4.1: bytes=56 Sequence=1 ttl=253 time=40 ms

Reply from 10.10.4.1: bytes=56 Sequence=2 ttl=253 time=30 ms

Reply from 10.10.4.1: bytes=56 Sequence=3 ttl=253 time=30 ms

Reply from 10.10.4.1: bytes=56 Sequence=4 ttl=253 time=30 ms

Reply from 10.10.4.1: bytes=56 Sequence=5 ttl=253 time=30 ms

--- 10.10.4.1 ping statistics ---

5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 30/32/40 ms

<AR6>ping -a 10.10.6.1 10.10.5.1

PING 10.10.5.1: 56 data bytes, press CTRL_C to break

Reply from 10.10.5.1: bytes=56 Sequence=1 ttl=253 time=20 ms

Reply from 10.10.5.1: bytes=56 Sequence=2 ttl=253 time=30 ms


```

Reply from 10.10.5.1: bytes=56 Sequence=3 ttl=253 time=30 ms
Reply from 10.10.5.1: bytes=56 Sequence=4 ttl=253 time=20 ms
Reply from 10.10.5.1: bytes=56 Sequence=5 ttl=253 time=30 ms

```

```

--- 10.10.5.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 20/26/30 ms

```

4.3. IPv6 configuration

- You have to provide connectivity between AR9 and AR10. Configure Manual IPv6 over IPv4 tunnel. Use IPv6 subnet 2003:15::/64 for addresses over the tunnel.

AR4:

```

<AR4>system-view
Enter system view, return user view with Ctrl+Z.
[AR4]ipv6

[AR4]interface Tunnel 0/0/0
[AR4-Tunnel0/0/0]ipv6 enable

[AR4-Tunnel0/0/0] ipv6 address 2003:15::2/64

[AR4-Tunnel0/0/0] tunnel-protocol ipv6-ipv4

[AR4-Tunnel0/0/0] source LoopBack100

[AR4-Tunnel0/0/0]destination 10.10.6.1

[AR4-Tunnel0/0/0]quit

[AR4]quit

```

AR6:

```

<AR6>system-view
Enter system view, return user view with Ctrl+Z.

[AR6]ipv6

[AR6]interface Tunnel 0/0/0

[AR6-Tunnel0/0/0]ipv6 enable

[AR6-Tunnel0/0/0]tunnel-protocol ipv6-ipv4

[AR6-Tunnel0/0/0]ipv6 address 2003:15::1/64

[AR6-Tunnel0/0/0]source LoopBack 100

[AR6-Tunnel0/0/0]destination 10.10.4.1

[AR6-Tunnel0/0/0]quit

[AR6]quit

```

Verify the configuration:

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<https://t.me/learningnets>

AR4:

```
<AR4>display ipv6 routing-table
Routing Table : Public
Destinations : 4  Routes : 4

Destination : ::1          PrefixLength : 128
NextHop    : ::1          Preference : 0
Cost       : 0            Protocol   : Direct
RelayNextHop : ::        TunnelID    : 0x0
Interface  : InLoopBack0  Flags      : D

Destination : 2003:15::    PrefixLength : 64
NextHop    : 2003:15::2    Preference : 0
Cost       : 0            Protocol   : Direct
RelayNextHop : ::        TunnelID    : 0x0
Interface  : Tunnel0/0/0   Flags      : D

Destination : 2003:15::2   PrefixLength : 128
NextHop    : ::1          Preference : 0
Cost       : 0            Protocol   : Direct
RelayNextHop : ::        TunnelID    : 0x0
Interface  : Tunnel0/0/0   Flags      : D

Destination : FE80::       PrefixLength : 10
NextHop    : ::           Preference : 0
Cost       : 0            Protocol   : Direct
RelayNextHop : ::        TunnelID    : 0x0
Interface  : NULL0        Flags      : D
```

```
<AR4>ping ipv6 -a 2003:15::2 2003:15::1
PING 2003:15::1 : 56 data bytes, press CTRL_C to break
Reply from 2003:15::1
bytes=56 Sequence=1 hop limit=64 time = 50 ms
Reply from 2003:15::1
bytes=56 Sequence=2 hop limit=64 time = 50 ms
Reply from 2003:15::1
bytes=56 Sequence=3 hop limit=64 time = 40 ms
Reply from 2003:15::1
bytes=56 Sequence=4 hop limit=64 time = 40 ms
Reply from 2003:15::1
bytes=56 Sequence=5 hop limit=64 time = 30 ms

--- 2003:15::1 ping statistics ---
5 packet(s) transmitted
5 packet(s) received
0.00% packet loss
round-trip min/avg/max = 30/42/50 ms
```

AR6:

```
<AR6>display ipv6 routing-table
Routing Table : Public
Destinations : 4  Routes : 4

Destination : ::1          PrefixLength : 128
NextHop    : ::1          Preference : 0
Cost       : 0            Protocol   : Direct
RelayNextHop : ::        TunnelID    : 0x0
Interface  : InLoopBack0  Flags      : D
```

```

Destination : 2003:15::                PrefixLength : 64
NextHop      : 2003:15::1                Preference  : 0
Cost         : 0                         Protocol     : Direct
RelayNextHop : ::                       TunnelID    : 0x0
Interface    : Tunnel0/0/0               Flags       : D

Destination : 2003:15::1                PrefixLength : 128
NextHop      : ::1                      Preference  : 0
Cost         : 0                         Protocol     : Direct
RelayNextHop : ::                       TunnelID    : 0x0
Interface    : Tunnel0/0/0               Flags       : D

Destination : FE80::                    PrefixLength : 10
NextHop      : ::                       Preference  : 0
Cost         : 0                         Protocol     : Direct
RelayNextHop : ::                       TunnelID    : 0x0
Interface    : NULL0                     Flags       : D

<AR6>ping ipv6 -a 2003:15::1 2003:15::2
PING 2003:15::2 : 56 data bytes, press CTRL_C to break
  Reply from 2003:15::2
    bytes=56 Sequence=1 hop limit=64 time = 50 ms
  Reply from 2003:15::2
    bytes=56 Sequence=2 hop limit=64 time = 30 ms
  Reply from 2003:15::2
    bytes=56 Sequence=3 hop limit=64 time = 30 ms
  Reply from 2003:15::2
    bytes=56 Sequence=4 hop limit=64 time = 30 ms
  Reply from 2003:15::2
    bytes=56 Sequence=5 hop limit=64 time = 30 ms

--- 2003:15::2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 30/34/50 ms

```

- Configure OSPFv3 across the tunnel connecting the IPv6 islands.

AR4:

```
<AR4>system-view  
Enter system view, return user view with Ctrl+Z.
```

```
[AR4]ospfv3 1
```

```
[AR4-ospfv3-1]router-id 10.10.4.1
```

```
[AR4-ospfv3-1]quit
```

```
[AR4]interface Tunnel 0/0/0
```

```
[AR4-Tunnel0/0/0]ospfv3 1 area 0
```

```
[AR4-Tunnel0/0/0]quit
```

```
[AR4]quit
```

AR6:

```
<AR6>system-view  
Enter system view, return user view with Ctrl+Z.
```

```
[AR6]ospfv3 1
```

```
[AR6-ospfv3-1]router-id 10.10.6.1
```

```
[AR6-ospfv3-1]quit
```

```
[AR6]interface Tunnel 0/0/0
```

```
[AR6-Tunnel0/0/0]ospfv3 1 area 0
```

```
[AR6-Tunnel0/0/0]quit
```

```
[AR6]quit
```

Verify the configuration:

AR4:

```
<AR4>display ospfv3 peer verbose  
OSPFv3 Process (1)
```

```
Neighbor 10.10.6.1 is Full, interface address FE80::A0A:601
```

```
  In the area 0.0.0.0 via interface Tun0/0/0
```

```
  DR Priority is 1 DR is 0.0.0.0 BDR is 0.0.0.0
```

```
  Options is 0x000013 (-|R|-|E|V6)
```

```
  Dead timer due in 00:00:32
```

```
  Neighbour is up for 00:00:57
```

```
  Database Summary Packets List 0
```

```
  Link State Request List 0
```

```
  Link State Retransmission List 0
```

```
  Neighbour Event: 5
```

```
  Neighbour If Id : 0xd
```

AR6:

```
<AR6>display ospfv3 peer verbose
OSPFv3 Process (1)
```

```
Neighbor 10.10.4.1 is Full, interface address FE80::A0A:401
In the area 0.0.0.0 via interface Tun0/0/0
DR Priority is 1 DR is 0.0.0.0 BDR is 0.0.0.0
Options is 0x000013 (-[R]-[E]V6)
Dead timer due in 00:00:31
Neighbour is up for 00:05:59
Database Summary Packets List 0
Link State Request List 0
Link State Retransmission List 0
Neighbour Event: 5
Neighbour If Id : 0xd
```

- Configure connectivity to the IPv6 only enabled routers AR9 and AR10. Make sure full reachability is available between L0 interfaces on AR1 and AR10.

AR4:

```
<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]interface Serial 1/0/0

[AR4-Serial1/0/0]ipv6 enable

[AR4-Serial1/0/0]ipv6 address 2003:fa:e3:809:ba:9c:68:1/126

[AR4-Serial1/0/0]ospfv3 1 area 0

[AR4-Serial1/0/0]quit

[AR4]quit
```

AR10:

```
<AR10>system-view
Enter system view, return user view with Ctrl+Z.

[AR10]ipv6

[AR10]ospfv3 1

[AR10-ospfv3-1]router-id 10.10.10.10

[AR10-ospfv3-1]quit

[AR10]interface Serial 1/0/0

[AR10-Serial1/0/0]ipv6 enable

[AR10-Serial1/0/0]ipv6 address 2003:fa:e3:809:ba:9c:68:2/126

[AR10-Serial1/0/0]ospfv3 1 area 0

[AR10-Serial1/0/0]quit

[AR10]interface LoopBack 0
```

```
[AR10-LoopBack0]ipv6 enable
[AR10-LoopBack0]ipv6 address 2003:10::1/128
[AR10-LoopBack0]ospfv3 1 area 0
[AR10-LoopBack0]quit
[AR10]quit
```

AR6:

```
<AR6>system-view
Enter system view, return user view with Ctrl+Z.

[AR6]interface Serial 1/0/0
[AR6-Serial1/0/0]ipv6 enable
[AR6-Serial1/0/0]ipv6 address 2003:302:ef:43:ba:58a:17:1/126
[AR6-Serial1/0/0]ospfv3 1 area 0
[AR6-Serial1/0/0]quit
[AR6]quit
```

AR9:

```
<AR9>system-view
Enter system view, return user view with Ctrl+Z.

[AR9]ipv6
[AR9]ospfv3 1
[AR9-ospfv3-1]router-id 9.9.9.9
[AR9-ospfv3-1]quit
[AR9]interface Serial 1/0/0
[AR9-Serial1/0/0]ipv6 enable
[AR9-Serial1/0/0]ipv6 address 2003:302:ef:43:ba:58a:17:2/126
[AR9-Serial1/0/0]ospfv3 1 area 0
[AR9-Serial1/0/0]quit
[AR9]interface LoopBack 0
[AR9-LoopBack0]ipv6 enable
[AR9-LoopBack0]ipv6 address 2003:9::1/128
[AR9-LoopBack0]ospfv3 1 area 0
```

```
[AR9-LoopBack0]quit
```

```
[AR9]quit
```

Verify the configuration:

AR4:

```
<AR4>display ospfv3 peer
```

```
OSPFv3 Process (1)
```

```
OSPFv3 Area (0.0.0.0)
```

Neighbor ID	Pri	State	Dead Time	Interface	Instance ID
10.10.10.10	1	Full/-	00:00:40	S1/0/0	0
10.10.6.1	1	Full/-	00:00:34	Tun0/0/0	0

```
<AR4>display ipv6 routing-table
```

```
Routing Table : Public
```

```
Destinations : 9 Routes : 9
```

```
Destination : ::1 PrefixLength : 128
```

```
NextHop : ::1 Preference : 0
```

```
Cost : 0 Protocol : Direct
```

```
RelayNextHop : :: TunnelID : 0x0
```

```
Interface : InLoopBack0 Flags : D
```

```
Destination : 2003:9::1 PrefixLength : 128
```

```
NextHop : FE80::A0A:601 Preference : 10
```

```
Cost : 1610 Protocol : OSPFv3
```

```
RelayNextHop : :: TunnelID : 0x0
```

```
Interface : Tunnel0/0/0 Flags : D
```

```
Destination : 2003:10::1 PrefixLength : 128
```

```
NextHop : FE80::B479:C92E:8863:1 Preference : 10
```

```
Cost : 48 Protocol : OSPFv3
```

```
RelayNextHop : :: TunnelID : 0x0
```

```
Interface : Serial1/0/0 Flags : D
```

```
Destination : 2003:15:: PrefixLength : 64
```

```
NextHop : 2003:15::2 Preference : 0
```

```
Cost : 0 Protocol : Direct
```

```
RelayNextHop : :: TunnelID : 0x0
```

```
Interface : Tunnel0/0/0 Flags : D
```

```
Destination : 2003:15::2 PrefixLength : 128
```

```
NextHop : ::1 Preference : 0
```

```
Cost : 0 Protocol : Direct
```

```
RelayNextHop : :: TunnelID : 0x0
```

```
Interface : Tunnel0/0/0 Flags : D
```

```
Destination : 2003:FA:E3:809:BA:9C:68:0 PrefixLength : 126
```

```
NextHop : 2003:FA:E3:809:BA:9C:68:1 Preference : 0
```

```
Cost : 0 Protocol : Direct
```

```
RelayNextHop : :: TunnelID : 0x0
```

```
Interface : Serial1/0/0 Flags : D
```

```
Destination : 2003:FA:E3:809:BA:9C:68:1 PrefixLength : 128
```

```
NextHop : ::1 Preference : 0
```

```
Cost : 0 Protocol : Direct
```

```
RelayNextHop : :: TunnelID : 0x0
```

```

Interface : Serial1/0/0          Flags : D

Destination : 2003:302:EF:43:BA:58A:17:0    PrefixLength : 126
NextHop : FE80::A0A:601                    Preference : 10
Cost : 1610                                Protocol : OSPFv3
RelayNextHop : ::                          TunnelID : 0x0
Interface : Tunnel0/0/0              Flags : D

Destination : FE80::                    PrefixLength : 10
NextHop : ::                            Preference : 0
Cost : 0                                Protocol : Direct
RelayNextHop : ::                      TunnelID : 0x0
Interface : NULL0                      Flags : D

```

AR6:

```

<AR6>display ospfv3 peer
OSPFv3 Process (1)
OSPFv3 Area (0.0.0.0)
Neighbor ID Pri State Dead Time Interface Instance ID
9.9.9.9 1 Full/- 00:00:30 S1/0/0 0
10.10.4.1 1 Full/- 00:00:35 Tun0/0/0 0

<AR6>display ipv6 routing-table
Routing Table : Public
Destinations : 9 Routes : 9

Destination ::1 PrefixLength : 128
NextHop ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop :: TunnelID : 0x0
Interface : InLoopBack0 Flags : D

Destination : 2003:9::1 PrefixLength : 128
NextHop : FE80::C93F:D25:AAC:1 Preference : 10
Cost : 48 Protocol : OSPFv3
RelayNextHop :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:10::1 PrefixLength : 128
NextHop : FE80::A0A:401 Preference : 10
Cost : 1610 Protocol : OSPFv3
RelayNextHop :: TunnelID : 0x0
Interface : Tunnel0/0/0 Flags : D

Destination : 2003:15:: PrefixLength : 64
NextHop : 2003:15::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop :: TunnelID : 0x0
Interface : Tunnel0/0/0 Flags : D

Destination : 2003:15::1 PrefixLength : 128
NextHop ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop :: TunnelID : 0x0
Interface : Tunnel0/0/0 Flags : D

Destination : 2003:FA:E3:809:BA:9C:68:0 PrefixLength : 126
NextHop : FE80::A0A:401 Preference : 10
Cost : 1610 Protocol : OSPFv3

```



```

RelayNextHop : :: TunnelID : 0x0
Interface : Tunnel0/0/0 Flags : D

Destination : 2003:302:EF:43:BA:58A:17:0 PrefixLength : 126
NextHop : 2003:302:EF:43:BA:58A:17:1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:302:EF:43:BA:58A:17:1 PrefixLength : 128
NextHop : ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : FE80:: PrefixLength : 10
NextHop : :: Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : NULL0 Flags : D

```

AR9:

```

<AR9>display ospfv3 peer
OSPFv3 Process (1)
OSPFv3 Area (0.0.0.0)
Neighbor ID Pri State Dead Time Interface Instance ID
10.10.6.1 1 Full/- 00:00:38 S1/0/0 0

<AR9>display ipv6 routing-table
Routing Table : Public
Destinations : 8 Routes : 8

Destination : ::1 PrefixLength : 128
NextHop : ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : InLoopBack0 Flags : D

Destination : 2003:9::1 PrefixLength : 128
NextHop : ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : LoopBack0 Flags : D

Destination : 2003:10::1 PrefixLength : 128
NextHop : FE80::E4FB:6401:C249:1 Preference : 10
Cost : 1658 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:15:: PrefixLength : 64
NextHop : FE80::E4FB:6401:C249:1 Preference : 10
Cost : 1610 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:FA:E3:809:BA:9C:68:0 PrefixLength : 126
NextHop : FE80::E4FB:6401:C249:1 Preference : 10
Cost : 1658 Protocol : OSPFv3

```

```

RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:302:EF:43:BA:58A:17:0 PrefixLength : 126
NextHop : 2003:302:EF:43:BA:58A:17:2 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:302:EF:43:BA:58A:17:2 PrefixLength : 128
NextHop : ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : FE80:: PrefixLength : 10
NextHop : :: Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : NULL0 Flags : D

```

AR10:

```

<AR10>display ospfv3 peer
OSPFv3 Process (1)
OSPFv3 Area (0.0.0.0)
Neighbor ID Pri State Dead Time Interface Instance ID
10.10.4.1 1 Full/- 00:00:37 S1/0/0 0

<AR10>display ipv6 routing-table
Routing Table : Public
Destinations : 8 Routes : 8

Destination : ::1 PrefixLength : 128
NextHop : ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : InLoopBack0 Flags : D

Destination : 2003:9::1 PrefixLength : 128
NextHop : FE80::4C58:2759:726C:1 Preference : 10
Cost : 1658 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:10::1 PrefixLength : 128
NextHop : ::1 Preference : 0
Cost : 0 Protocol : Direct
RelayNextHop : :: TunnelID : 0x0
Interface : LoopBack0 Flags : D

Destination : 2003:15:: PrefixLength : 64
NextHop : FE80::4C58:2759:726C:1 Preference : 10
Cost : 1610 Protocol : OSPFv3
RelayNextHop : :: TunnelID : 0x0
Interface : Serial1/0/0 Flags : D

Destination : 2003:FA:E3:809:BA:9C:68:0 PrefixLength : 126
NextHop : 2003:FA:E3:809:BA:9C:68:2 Preference : 0
Cost : 0 Protocol : Direct

```

```

RelayNextHop : ::          TunnelID   : 0x0
Interface   : Serial1/0/0   Flags    : D

Destination : 2003:FA:E3:809:BA:9C:68:2   PrefixLength : 128
NextHop     : ::1                   Preference  : 0
Cost       : 0                     Protocol    : Direct
RelayNextHop : ::          TunnelID   : 0x0
Interface   : Serial1/0/0   Flags    : D

Destination : 2003:302:EF:43:BA:58A:17:0   PrefixLength : 126
NextHop     : FE80::4C58:2759:726C:1       Preference  : 10
Cost       : 1658                       Protocol    : OSPFv3
RelayNextHop : ::          TunnelID   : 0x0
Interface   : Serial1/0/0   Flags    : D

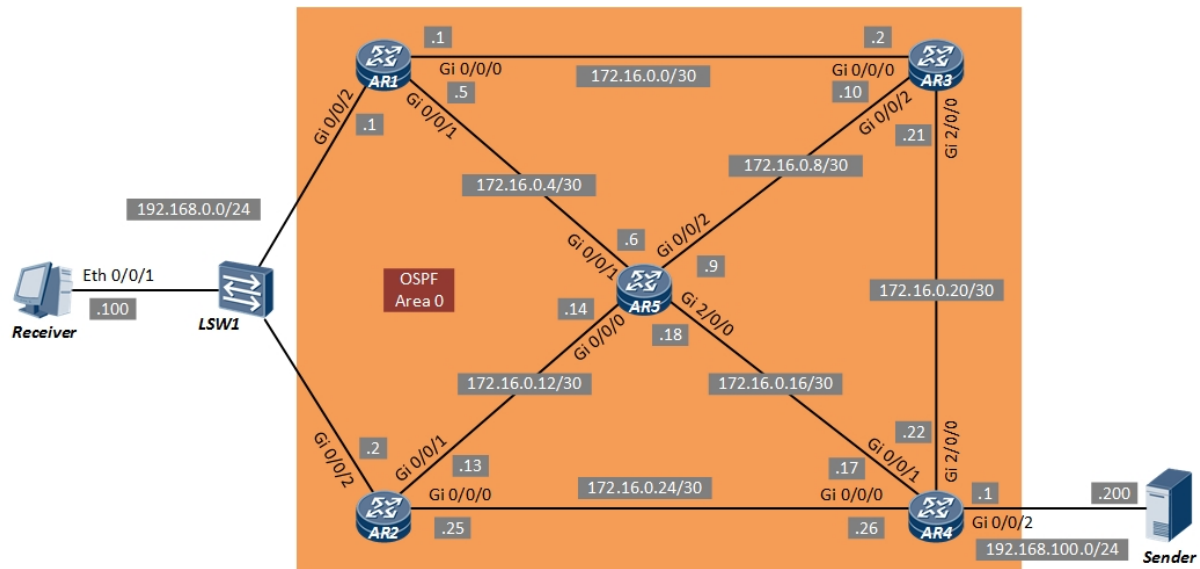
Destination : FE80::          PrefixLength : 10
NextHop     : ::              Preference  : 0
Cost       : 0                Protocol    : Direct
RelayNextHop : ::          TunnelID   : 0x0
Interface   : NULL0          Flags    : D

```

NOTE: For some the reason the ping between the Loopback interfaces of AR9 and AR10 is not successful. Most probably due to the virtual environment, but we can presume the configuration is correct. The routes are correctly advertised and received by OSPFv3.

Chapter 5: Multicast configuration and features - solutions

NOTE: Load topology with name – *Multicast*



5.2. Multicast configuration.

- Configure the interfaces from the diagram with IP addresses shown.

AR1:

```
<AR1>system-view
```

Enter system view, return user view with Ctrl+Z.

```
[AR1]interface GigabitEthernet 0/0/0
```

```
[AR1-GigabitEthernet0/0/0]ip address 172.16.0.1 30
```

Jan 9 2016 23:14:15-08:00 AR1 %%01IFNET/4/LINK_STATE(l)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.

```
[AR1-GigabitEthernet0/0/0]quit
```

```
[AR1]interface GigabitEthernet 0/0/1
```

```
[AR1-GigabitEthernet0/0/1]ip address 172.16.0.5 30
```

Jan 9 2016 23:20:03-08:00 AR1 %%01IFNET/4/LINK_STATE(l)[1]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.

```
[AR1-GigabitEthernet0/0/1]quit
```

```
[AR1]interface GigabitEthernet 0/0/2
```

```
[AR1-GigabitEthernet0/0/2]ip address 192.168.0.1 24
```

Jan 9 2016 23:36:23-08:00 AR1 %%01IFNET/4/LINK_STATE(l)[2]:The line protocol IP on the interface GigabitEthernet0/0/2 has entered the UP state.

```
[AR1-GigabitEthernet0/0/2]quit
```

```
[AR1]quit
```

AR2:

<AR2>system-view

Enter system view, return user view with Ctrl+Z.

[AR2]interface GigabitEthernet 0/0/0

[AR2-GigabitEthernet0/0/0]ip address 172.16.0.25 30

Jan 9 2016 23:46:47-08:00 AR2 %%01IFNET/4/LINK_STATE(l)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.

[AR2-GigabitEthernet0/0/0]quit

[AR2]interface GigabitEthernet 0/0/1

[AR2-GigabitEthernet0/0/1]ip address 172.16.0.13 30

Jan 9 2016 23:47:08-08:00 AR2 %%01IFNET/4/LINK_STATE(l)[1]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.

[AR2-GigabitEthernet0/0/1]quit

[AR2]interface GigabitEthernet 0/0/2

[AR2-GigabitEthernet0/0/2]ip address 192.168.0.2 24

Jan 9 2016 23:47:37-08:00 AR2 %%01IFNET/4/LINK_STATE(l)[2]:The line protocol IP on the interface GigabitEthernet0/0/2 has entered the UP state.

[AR2-GigabitEthernet0/0/2]quit

[AR2]quit

AR3:

<AR3>system-view

Enter system view, return user view with Ctrl+Z.

[AR3]interface GigabitEthernet 0/0/0

[AR3-GigabitEthernet0/0/0]ip address 172.16.0.2 30

Jan 10 2016 02:45:12-08:00 AR3 %%01IFNET/4/LINK_STATE(l)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.

[AR3-GigabitEthernet0/0/0]quit

[AR3]interface GigabitEthernet 0/0/2

[AR3-GigabitEthernet0/0/2]ip address 172.16.0.10 30

Jan 10 2016 02:45:30-08:00 AR3 %%01IFNET/4/LINK_STATE(l)[1]:The line protocol IP on the interface GigabitEthernet0/0/2 has entered the UP state.

[AR3-GigabitEthernet0/0/2]quit

[AR3]interface GigabitEthernet 2/0/0

[AR3-GigabitEthernet2/0/0]ip address 172.16.0.21 30

Jan 10 2016 02:45:59-08:00 AR3 %%01IFNET/4/LINK_STATE(l)[2]:The line protocol IP on the interface GigabitEthernet2/0/0 has entered the UP state.

[AR3-GigabitEthernet2/0/0]quit

[AR3]quit

AR4:

<AR4>system-view

Enter system view, return user view with Ctrl+Z.

[AR4]interface GigabitEthernet 0/0/0

[AR4-GigabitEthernet0/0/0]ip address 172.16.0.26 30

Jan 10 2016 02:48:20-08:00 AR4 %%%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.

[AR4-GigabitEthernet0/0/0]quit

[AR4]interface GigabitEthernet 0/0/1

[AR4-GigabitEthernet0/0/1]ip address 172.16.0.17 30

Jan 10 2016 02:48:52-08:00 AR4 %%%01IFNET/4/LINK_STATE(1)[1]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.

[AR4-GigabitEthernet0/0/1]quit

[AR4]interface GigabitEthernet 0/0/2

[AR4-GigabitEthernet0/0/2]ip address 192.168.10.1 24

Jan 10 2016 02:49:21-08:00 AR4 %%%01IFNET/4/LINK_STATE(1)[2]:The line protocol IP on the interface GigabitEthernet0/0/2 has entered the UP state.

[AR4-GigabitEthernet0/0/2]quit

[AR4]interface GigabitEthernet 2/0/0

[AR4-GigabitEthernet2/0/0]ip address 172.16.0.22 30

Jan 10 2016 03:11:31-08:00 AR4 %%%01IFNET/4/LINK_STATE(1)[3]:The line protocol IP on the interface GigabitEthernet2/0/0 has entered the UP state.

[AR4-GigabitEthernet2/0/0]quit

[AR4]quit

AR5:

<AR5>system-view

Enter system view, return user view with Ctrl+Z.

[AR5]interface GigabitEthernet 0/0/0

[AR5-GigabitEthernet0/0/0]ip address 172.16.0.14 30

Jan 10 2016 03:12:37-08:00 AR5 %%%01IFNET/4/LINK_STATE(1)[0]:The line protocol IP on the interface GigabitEthernet0/0/0 has entered the UP state.

[AR5-GigabitEthernet0/0/0]quit

[AR5]interface GigabitEthernet 0/0/1

[AR5-GigabitEthernet0/0/1]ip address 172.16.0.6 30

Jan 10 2016 03:13:00-08:00 AR5 %%%01IFNET/4/LINK_STATE(1)[1]:The line protocol IP on the interface GigabitEthernet0/0/1 has entered the UP state.

[AR5-GigabitEthernet0/0/1]quit

[AR5]interface GigabitEthernet 0/0/2

```
[AR5-GigabitEthernet0/0/2]ip address 172.16.0.9 30
Jan 10 2016 03:13:27-08:00 AR5 %%%01IFNET/4/LINK_STATE(1)[2]:The line protocol IP
on the interface GigabitEthernet0/0/2 has entered the UP state.

[AR5-GigabitEthernet0/0/2]quit

[AR5]interface GigabitEthernet 2/0/0

[AR5-GigabitEthernet2/0/0]ip address 172.16.0.18 30
Jan 10 2016 03:13:56-08:00 AR5 %%%01IFNET/4/LINK_STATE(1)[3]:The line protocol IP
on the interface GigabitEthernet2/0/0 has entered the UP state.

[AR5-GigabitEthernet2/0/0]quit

[AR5]quit
```

- Configure OSPF routing protocol in Area 0 on all routers.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]ospf 1

[AR1-ospf-1]area 0

[AR1-ospf-1-area-0.0.0.0]network 172.16.0.0 0.0.0.3

[AR1-ospf-1-area-0.0.0.0]network 172.16.0.4 0.0.0.3

[AR1-ospf-1-area-0.0.0.0]network 192.168.0.0 0.0.0.255

[AR1-ospf-1-area-0.0.0.0]quit

[AR1-ospf-1]quit
```

AR2:

```
<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]ospf 1

[AR2-ospf-1]area 0

[AR2-ospf-1-area-0.0.0.0]network 172.16.0.12 0.0.0.3

[AR2-ospf-1-area-0.0.0.0]network 172.16.0.24 0.0.0.3

[AR2-ospf-1-area-0.0.0.0]network 192.168.0.0 0.0.0.255

[AR2-ospf-1-area-0.0.0.0]quit

[AR2-ospf-1]quit

[AR2]quit
```

AR3:**<AR3>system-view**

Enter system view, return user view with Ctrl+Z.

[AR3]ospf 1**[AR3-ospf-1]area 0****[AR3-ospf-1-area-0.0.0.0]network 172.16.0.0 0.0.0.3****[AR3-ospf-1-area-0.0.0.0]network 172.16.0.8 0.0.0.3****[AR3-ospf-1-area-0.0.0.0]network 172.16.0.20 0.0.0.3****[AR3-ospf-1-area-0.0.0.0]quit****[AR3-ospf-1]quit****[AR3]quit****AR4:****<AR4>system-view**

Enter system view, return user view with Ctrl+Z.

[AR4]ospf 1**[AR4-ospf-1]area 0****[AR4-ospf-1-area-0.0.0.0]network 172.16.0.20 0.0.0.3****[AR4-ospf-1-area-0.0.0.0]network 172.16.0.16 0.0.0.3****[AR4-ospf-1-area-0.0.0.0]network 172.16.0.24 0.0.0.3****[AR4-ospf-1-area-0.0.0.0]network 192.168.10.0 0.0.0.255****[AR4-ospf-1-area-0.0.0.0]quit****[AR4-ospf-1]quit****[AR4]quit****AR5:****<AR5>system-view**

Enter system view, return user view with Ctrl+Z.

[AR5-ospf-1]area 0**[AR5-ospf-1-area-0.0.0.0]network 172.16.0.4 0.0.0.3****[AR5-ospf-1-area-0.0.0.0]network 172.16.0.8 0.0.0.3****[AR5-ospf-1-area-0.0.0.0]network 172.16.0.12 0.0.0.3****[AR5-ospf-1-area-0.0.0.0]network 172.16.0.16 0.0.0.3****[AR5-ospf-1-area-0.0.0.0]quit****[AR5-ospf-1]quit**


```
[AR5]quit
```

Verify the configuration:

AR1:

```
<AR1>display ospf peer
```

```
OSPF Process 1 with Router ID 172.16.0.1
Neighbors
```

```
Area 0.0.0.0 interface 172.16.0.1(GigabitEthernet0/0/0)'s neighbors
```

```
Router ID: 172.16.0.2    Address: 172.16.0.2
```

```
State: Full Mode:Nbr is Master Priority: 1
```

```
DR: 172.16.0.1 BDR: 172.16.0.2 MTU: 0
```

```
Dead timer due in 34 sec
```

```
Retrans timer interval: 5
```

```
Neighbor is up for 00:31:21
```

```
Authentication Sequence: [ 0 ]
```

```
Neighbors
```

```
Area 0.0.0.0 interface 172.16.0.5(GigabitEthernet0/0/1)'s neighbors
```

```
Router ID: 172.16.0.14   Address: 172.16.0.6
```

```
State: Full Mode:Nbr is Master Priority: 1
```

```
DR: 172.16.0.5 BDR: 172.16.0.6 MTU: 0
```

```
Dead timer due in 32 sec
```

```
Retrans timer interval: 5
```

```
Neighbor is up for 00:25:35
```

```
Authentication Sequence: [ 0 ]
```

```
Neighbors
```

```
Area 0.0.0.0 interface 192.168.0.1(GigabitEthernet0/0/2)'s neighbors
```

```
Router ID: 172.16.0.13   Address: 192.168.0.2
```

```
State: Full Mode:Nbr is Master Priority: 1
```

```
DR: 192.168.0.1 BDR: 192.168.0.2 MTU: 0
```

```
Dead timer due in 40 sec
```

```
Retrans timer interval: 5
```

```
Neighbor is up for 00:33:53
```

```
Authentication Sequence: [ 0 ]
```

```
<AR1>display ip routing-table
```

```
Route Flags: R - relay, D - download to fib
```

```
-----
Routing Tables: Public
```

```
Destinations : 19    Routes : 23
```

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.0.0/30	Direct	0	0	D	172.16.0.1	GigabitEthernet0/0/0
172.16.0.1/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
172.16.0.3/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
172.16.0.4/30	Direct	0	0	D	172.16.0.5	GigabitEthernet0/0/1
172.16.0.5/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/1

172.16.0.7/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/1
172.16.0.8/30	OSPF	10	2	D	172.16.0.2	GigabitEthernet0/0/0
	OSPF	10	2	D	172.16.0.6	GigabitEthernet0/0/1
172.16.0.12/30	OSPF	10	2	D	192.168.0.2	GigabitEthernet0/0/2
	OSPF	10	2	D	172.16.0.6	GigabitEthernet0/0/1
172.16.0.16/30	OSPF	10	2	D	172.16.0.6	GigabitEthernet0/0/1
172.16.0.20/30	OSPF	10	2	D	172.16.0.2	GigabitEthernet0/0/0
172.16.0.24/30	OSPF	10	2	D	192.168.0.2	GigabitEthernet0/0/2
192.168.0.0/24	Direct	0	0	D	192.168.0.1	GigabitEthernet0/0/2
192.168.0.1/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/2
192.168.0.255/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/2
192.168.10.0/24	OSPF	10	3	D	192.168.0.2	GigabitEthernet0/0/2
	OSPF	10	3	D	172.16.0.2	GigabitEthernet0/0/0
	OSPF	10	3	D	172.16.0.6	GigabitEthernet0/0/1
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

AR2:

<AR2>display ospf peer

OSPF Process 1 with Router ID 172.16.0.13
Neighbors

Area 0.0.0.0 interface 172.16.0.13(GigabitEthernet0/0/1)'s neighbors
Router ID: 172.16.0.14 Address: 172.16.0.14
State: Full Mode:Nbr is Master Priority: 1
DR: 172.16.0.13 BDR: 172.16.0.14 MTU: 0
Dead timer due in 40 sec
Retrans timer interval: 5
Neighbor is up for 00:28:20
Authentication Sequence: [0]

Neighbors

Area 0.0.0.0 interface 172.16.0.25(GigabitEthernet0/0/0)'s neighbors
Router ID: 172.16.0.26 Address: 172.16.0.26
State: Full Mode:Nbr is Master Priority: 1
DR: 172.16.0.25 BDR: 172.16.0.26 MTU: 0
Dead timer due in 40 sec
Retrans timer interval: 5
Neighbor is up for 00:32:43
Authentication Sequence: [0]

Neighbors

Area 0.0.0.0 interface 192.168.0.2(GigabitEthernet0/0/2)'s neighbors
Router ID: 172.16.0.1 Address: 192.168.0.1
State: Full Mode:Nbr is Slave Priority: 1
DR: 192.168.0.1 BDR: 192.168.0.2 MTU: 0
Dead timer due in 29 sec
Retrans timer interval: 5
Neighbor is up for 00:37:12
Authentication Sequence: [0]

AR3:

<AR3>display ospf peer

OSPF Process 1 with Router ID 172.16.0.2
Neighbors

Area 0.0.0.0 interface 172.16.0.2(GigabitEthernet0/0/0)'s neighbors
Router ID: 172.16.0.1 Address: 172.16.0.1
State: Full Mode:Nbr is Slave Priority: 1
DR: 172.16.0.1 BDR: 172.16.0.2 MTU: 0
Dead timer due in 37 sec
Retrans timer interval: 0
Neighbor is up for 00:39:59
Authentication Sequence: [0]

Neighbors

Area 0.0.0.0 interface 172.16.0.10(GigabitEthernet0/0/2)'s neighbors
Router ID: 172.16.0.14 Address: 172.16.0.9
State: Full Mode:Nbr is Master Priority: 1
DR: 172.16.0.10 BDR: 172.16.0.9 MTU: 0
Dead timer due in 30 sec

```
Retrans timer interval: 5
Neighbor is up for 00:33:57
Authentication Sequence: [ 0 ]
```

Neighbors

```
Area 0.0.0.0 interface 172.16.0.21(GigabitEthernet2/0/0)'s neighbors
Router ID: 172.16.0.26   Address: 172.16.0.22
State: Full Mode:Nbr is Master Priority: 1
DR: 172.16.0.21 BDR: 172.16.0.22 MTU: 0
Dead timer due in 35 sec
Retrans timer interval: 5
Neighbor is up for 00:38:25
Authentication Sequence: [ 0 ]
```

AR4:

<AR4>display ospf peer

```
OSPF Process 1 with Router ID 172.16.0.26
Neighbors
```

```
Area 0.0.0.0 interface 172.16.0.26(GigabitEthernet0/0/0)'s neighbors
Router ID: 172.16.0.13   Address: 172.16.0.25
State: Full Mode:Nbr is Slave Priority: 1
DR: 172.16.0.25 BDR: 172.16.0.26 MTU: 0
Dead timer due in 37 sec
Retrans timer interval: 5
Neighbor is up for 00:39:05
Authentication Sequence: [ 0 ]
```

Neighbors

```
Area 0.0.0.0 interface 172.16.0.17(GigabitEthernet0/0/1)'s neighbors
Router ID: 172.16.0.14   Address: 172.16.0.18
State: Full Mode:Nbr is Slave Priority: 1
DR: 172.16.0.17 BDR: 172.16.0.18 MTU: 0
Dead timer due in 33 sec
Retrans timer interval: 5
Neighbor is up for 00:34:42
Authentication Sequence: [ 0 ]
```

Neighbors

```
Area 0.0.0.0 interface 172.16.0.22(GigabitEthernet2/0/0)'s neighbors
Router ID: 172.16.0.2   Address: 172.16.0.21
State: Full Mode:Nbr is Slave Priority: 1
DR: 172.16.0.21 BDR: 172.16.0.22 MTU: 0
Dead timer due in 35 sec
Retrans timer interval: 5
Neighbor is up for 00:39:29
Authentication Sequence: [ 0 ]
```

AR5:

<AR5>display ospf peer

OSPF Process 1 with Router ID 172.16.0.14
Neighbors

Area 0.0.0.0 interface 172.16.0.14(GigabitEthernet0/0/0)'s neighbors
Router ID: 172.16.0.13 Address: 172.16.0.13
State: Full Mode:Nbr is Slave Priority: 1
DR: 172.16.0.13 BDR: 172.16.0.14 MTU: 0
Dead timer due in 34 sec
Retrans timer interval: 0
Neighbor is up for 00:38:05
Authentication Sequence: [0]

Neighbors

Area 0.0.0.0 interface 172.16.0.6(GigabitEthernet0/0/1)'s neighbors
Router ID: 172.16.0.1 Address: 172.16.0.5
State: Full Mode:Nbr is Slave Priority: 1
DR: 172.16.0.5 BDR: 172.16.0.6 MTU: 0
Dead timer due in 40 sec
Retrans timer interval: 5
Neighbor is up for 00:38:40
Authentication Sequence: [0]

Neighbors

Area 0.0.0.0 interface 172.16.0.9(GigabitEthernet0/0/2)'s neighbors
Router ID: 172.16.0.2 Address: 172.16.0.10
State: Full Mode:Nbr is Slave Priority: 1
DR: 172.16.0.10 BDR: 172.16.0.9 MTU: 0
Dead timer due in 31 sec
Retrans timer interval: 0
Neighbor is up for 00:38:24
Authentication Sequence: [0]

Neighbors

Area 0.0.0.0 interface 172.16.0.18(GigabitEthernet2/0/0)'s neighbors
Router ID: 172.16.0.26 Address: 172.16.0.17
State: Full Mode:Nbr is Master Priority: 1
DR: 172.16.0.17 BDR: 172.16.0.18 MTU: 0
Dead timer due in 35 sec
Retrans timer interval: 0
Neighbor is up for 00:38:06
Authentication Sequence: [0]

- Configure PIM sparse mode on all routers.

AR1:

```
<AR1>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR1]mcast routing-enable  
  
[AR1]interface GigabitEthernet 0/0/0  
[AR1-GigabitEthernet0/0/0]pim sm  
[AR1-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1  
[AR1-GigabitEthernet0/0/1]pim sm  
[AR1-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/2  
[AR1-GigabitEthernet0/0/2]pim sm  
[AR1-GigabitEthernet0/0/2]quit  
[AR1]quit
```

AR2:

```
<AR2>system-view  
Enter system view, return user view with Ctrl+Z.  
  
[AR2]mcast routing-enable  
  
[AR2]interface GigabitEthernet 0/0/0  
[AR2-GigabitEthernet0/0/0]pim sm  
[AR2-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1  
[AR2-GigabitEthernet0/0/1]pim sm  
[AR2-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/2  
[AR2-GigabitEthernet0/0/2]pim sm  
[AR2-GigabitEthernet0/0/2]quit  
[AR2]quit
```

AR3:

```
<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]multicast routing-enable

[AR3]interface GigabitEthernet 0/0/0
[AR3-GigabitEthernet0/0/0]pim sm
[AR3-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/2
[AR3-GigabitEthernet0/0/2]pim sm
[AR3-GigabitEthernet0/0/2]interface GigabitEthernet 2/0/0
[AR3-GigabitEthernet2/0/0]pim sm
[AR3-GigabitEthernet2/0/0]quit
[AR3]quit
```

AR4:

```
<AR4>system-view
Enter system view, return user view with Ctrl+Z.

[AR4]multicast routing-enable

[AR4]interface GigabitEthernet 0/0/0
[AR4-GigabitEthernet0/0/0]pim sm
[AR4-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[AR4-GigabitEthernet0/0/1]pim sm
[AR4-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/2
[AR4-GigabitEthernet0/0/2]pim sm
[AR4-GigabitEthernet0/0/2]interface GigabitEthernet 2/0/0
[AR4-GigabitEthernet2/0/0]pim sm
[AR4-GigabitEthernet2/0/0]quit
[AR4]quit
```

AR5:

```

<AR5>system-view
Enter system view, return user view with Ctrl+Z.

[AR5]multicast routing-enable

[AR5]interface GigabitEthernet 0/0/0

[AR5-GigabitEthernet0/0/0]pim sm

[AR5-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1

[AR5-GigabitEthernet0/0/1]pim sm

[AR5-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/2

[AR5-GigabitEthernet0/0/2]pim sm

[AR5-GigabitEthernet0/0/2]interface GigabitEthernet 2/0/0

[AR5-GigabitEthernet2/0/0]pim sm

[AR5-GigabitEthernet2/0/0]quit

[AR5]quit

```

Verify the configuration:

AR1:

```

<AR1>display pim neighbor
VPN-Instance: public net
Total Number of Neighbors = 3

Neighbor    Interface    Uptime    Expires    Dr-Priority    BFD-Session
172.16.0.2  GE0/0/0      01:22:24  00:01:22  1              N
172.16.0.6  GE0/0/1      01:14:13  00:01:30  1              N
192.168.0.2 GE0/0/2      01:23:22  00:01:30  1              N

```

AR2:

```

<AR2>display pim neighbor
VPN-Instance: public net
Total Number of Neighbors = 3

Neighbor    Interface    Uptime    Expires    Dr-Priority    BFD-Session
172.16.0.26 GE0/0/0      01:22:39  00:01:28  1              N
172.16.0.14 GE0/0/1      01:16:58  00:01:38  1              N
192.168.0.1  GE0/0/2      01:24:44  00:01:40  1              N

```

AR3:

```

<AR3>display pim neighbor
VPN-Instance: public net
Total Number of Neighbors = 3

Neighbor    Interface    Uptime    Expires    Dr-Priority    BFD-Session
172.16.0.1  GE0/0/0      01:24:39  00:01:27  1              N
172.16.0.9  GE0/0/2      01:16:18  00:01:23  1              N
172.16.0.22 GE2/0/0      01:23:15  00:01:28  1              N

```


AR4:

<AR4>**display pim neighbor**

VPN-Instance: public net

Total Number of Neighbors = 3

Neighbor	Interface	Uptime	Expires	Dr-Priority	BFD-Session
172.16.0.25	GE0/0/0	01:24:55	00:01:34	1	N
172.16.0.18	GE0/0/1	01:16:46	00:01:26	1	N
172.16.0.21	GE2/0/0	01:24:36	00:01:43	1	N

AR5:

<AR5>**display pim neighbor**

VPN-Instance: public net

Total Number of Neighbors = 4

Neighbor	Interface	Uptime	Expires	Dr-Priority	BFD-Session
172.16.0.13	GE0/0/0	01:25:46	00:01:44	1	N
172.16.0.5	GE0/0/1	01:24:23	00:01:17	1	N
172.16.0.10	GE0/0/2	01:24:11	00:01:20	1	N
172.16.0.17	GE2/0/0	01:23:17	00:01:21	1	N

- Configure the Loopback interfaces from the Table below. Make sure that they are reachable by other routers.

Device	Loopback 0 IP address	Loopback 10 IP address	Loopback 100 IP address
AR3	172.16.16.3/32	10.1.1.3/32	10.10.10.1/32
AR5	172.16.16.5/32	10.1.1.5/32	10.10.10.1/32

AR3:

<AR3>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR3]**interface LoopBack 0**[AR3-LoopBack0]**ip address 172.16.16.3 32**[AR3-LoopBack0]**quit**[AR3]**interface LoopBack 10**[AR3-LoopBack10]**ip address 10.1.1.3 32**[AR3-LoopBack10]**quit**[AR3]**interface LoopBack 100**[AR3-LoopBack100]**ip address 10.10.10.1 32**[AR3-LoopBack100]**quit**[AR3]**ospf 1**[AR3-ospf-1]**area 0**[AR3-ospf-1-area-0.0.0.0]**network 172.16.16.3 0.0.0.0**[AR3-ospf-1-area-0.0.0.0]**network 10.1.1.3 0.0.0.0**

```
[AR3-ospf-1-area-0.0.0.0]network 10.10.10.1 0.0.0.0
```

```
[AR3-ospf-1-area-0.0.0.0]quit
```

```
[AR3-ospf-1]quit
```

```
[AR3]quit
```

AR5:

```
<AR5>system-view
```

Enter system view, return user view with Ctrl+Z.

```
[AR5]interface LoopBack 0
```

```
[AR5-LoopBack0]ip address 172.16.16.5 32
```

```
[AR5-LoopBack0]quit
```

```
[AR5]interface LoopBack 10
```

```
[AR5-LoopBack10]ip address 10.1.1.5 32
```

```
[AR5-LoopBack10]quit
```

```
[AR5]interface LoopBack 100
```

```
[AR5-LoopBack100]ip address 10.10.10.1 32
```

```
[AR5-LoopBack100]quit
```

```
[AR5]ospf 1
```

```
[AR5-ospf-1]area 0
```

```
[AR5-ospf-1-area-0.0.0.0]network 172.16.16.5 0.0.0.0
```

```
[AR5-ospf-1-area-0.0.0.0]network 10.1.1.5 0.0.0.0
```

```
[AR5-ospf-1-area-0.0.0.0]network 10.10.10.1 0.0.0.0
```

```
[AR5-ospf-1-area-0.0.0.0]quit
```

```
[AR5-ospf-1]quit
```

```
[AR5]quit
```

Checking configuration:

AR1:

```
<AR1>display ip routing-table 10.10.10.1
Route Flags: R - relay, D - download to fib
-----
Routing Table : Public
Summary Count : 2
Destination/Mask Proto Pre Cost Flags NextHop Interface
10.10.10.1/32 OSPF 10 1 D 172.16.0.2 GigabitEthernet0/0/0
OSPF 10 1 D 172.16.0.6 GigabitEthernet0/0/1
```

- Configure 10.10.10.1 as Anycast RP for the PIM-SM domain. Use MSDP to accomplish that using the Loopback 10 for peering interface. Other PIM routers should use AR3 and AR5 for BSR for dynamic RP selection.

AR3:

```
<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]interface LoopBack 0
[AR3-LoopBack0]pim sm
[AR3-LoopBack0]interface LoopBack 10
[AR3-LoopBack10]pim sm
[AR3-LoopBack10]interface LoopBack 100
[AR3-LoopBack100]pim sm
[AR3-LoopBack100]quit
[AR3]pim
[AR3-pim]c-bsr LoopBack 0
[AR3-pim]c-rp LoopBack 100
[AR3-pim]quit
[AR3]msdp
[AR3-msdp]originating-rp LoopBack 10
[AR3-msdp]peer 10.1.1.5 connect-interface LoopBack 10
[AR3-msdp]quit
[AR3]quit
```

AR5:

```
<AR5>system-view
```

Enter system view, return user view with Ctrl+Z.

```
[AR5]interface LoopBack 0
```

```
[AR5-LoopBack0]pim sm
```

```
[AR5-LoopBack0]interface LoopBack 10
```

```
[AR5-LoopBack10]pim sm
```

```
[AR5-LoopBack10]interface LoopBack 100
```

```
[AR5-LoopBack100]pim sm
```

```
[AR5-LoopBack100]quit
```

```
[AR5]pim
```

```
[AR5-pim]c-bsr LoopBack 0
```

```
[AR5-pim]c-rp LoopBack 100
```

```
[AR5-pim]quit
```

```
[AR5]msdp
```

```
[AR5-msdp]originating-rp LoopBack 10
```

```
[AR5-msdp]peer 10.1.1.3 connect-interface LoopBack 10
```

```
[AR5-msdp]quit
```

```
[AR5]quit
```

Verify the configuration:

AR3:

```
<AR3>display pim rp-info
VPN-Instance: public net
PIM-SM BSR RP Number: 1
Group/MaskLen: 224.0.0.0/4
  RP: 10.10.10.1 (local)
  Priority: 0
  Uptime: 00:27:31
  Expires: 00:01:45

<AR3>display pim bsr-info
VPN-Instance: public net
Elected AdminScoped BSR Count: 0
Elected BSR Address: 172.16.16.5
  Priority: 0
  Hash mask length: 30
  State: Accept Preferred
  Scope: Not scoped
  Uptime: 00:21:56
  Expires: 00:01:13
  C-RP Count: 1
Candidate AdminScoped BSR Count: 0
Candidate BSR Address: 172.16.16.3
  Priority: 0
  Hash mask length: 30
  State: Candidate
  Scope: Not scoped
  Wait to be BSR: 0

<AR3>display msdp brief
MSDP Peer Brief Information of VPN-Instance: public net
  Configured  Up      Listen   Connect  Shutdown  Down
  1           1       0        0        0         0

  Peer's Address  State  Up/Down time  AS    SA Count  Reset Count
  10.1.1.5       Up     00:21:20     ?     0         0
```

AR5:

```
<AR5>display pim rp-info
VPN-Instance: public net
PIM-SM BSR RP Number: 1
Group/MaskLen: 224.0.0.0/4
  RP: 10.10.10.1 (local)
  Priority: 0
  Uptime: 00:32:00
  Expires: 00:02:10

<AR5>display pim bsr-info
VPN-Instance: public net
Elected AdminScoped BSR Count: 0
Elected BSR Address: 172.16.16.5
  Priority: 0
  Hash mask length: 30
  State: Elected
  Scope: Not scoped
  Uptime: 00:26:28
```

```

Next BSR message scheduled at: 00:00:32
C-RP Count: 1
Candidate AdminScoped BSR Count: 0
Candidate BSR Address: 172.16.16.5
Priority: 0
Hash mask length: 30
State: Elected
Scope: Not scoped
Wait to be BSR: 0

<AR5>display msdp brief
MSDP Peer Brief Information of VPN-Instance: public net
Configured Up Listen Connect Shutdown Down
1 1 0 0 0 0

Peer's Address State Up/Down time AS SA Count Reset Count
10.1.1.3 Up 00:25:45 ? 0 0

```

AR1:

```

<AR1>display pim rp-info
VPN-Instance: public net
PIM-SM BSR RP Number: 1
Group/MaskLen: 224.0.0.0/4
RP: 10.10.10.1
Priority: 0
Uptime: 00:14:54
Expires: 00:02:13

<AR1>display pim bsr-info
VPN-Instance: public net
Elected AdminScoped BSR Count: 0
Elected BSR Address: 172.16.16.5
Priority: 0
Hash mask length: 30
State: Accept Preferred
Scope: Not scoped
Uptime: 00:27:57
Expires: 00:01:12
C-RP Count: 1

```

- Configure IGMP on AR1 and AR2 on the interface towards the Receiver. Make sure that the AR2 is the Designated Router for the segment.

AR1:

```

<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]interface GigabitEthernet 0/0/2

[AR1-GigabitEthernet0/0/2]igmp enable

[AR1-GigabitEthernet0/0/2]quit

[AR1]quit

```

AR2:

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<https://t.me/learningnets>

```

<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]interface GigabitEthernet 0/0/2

[AR2-GigabitEthernet0/0/2]igmp enable

[AR2-GigabitEthernet0/0/2]pim hello-option dr-priority 100

[AR2-GigabitEthernet0/0/2]quit

[AR2]quit

```

Verify the configuration:

AR1:

```

<AR1>display pim interface GigabitEthernet 0/0/2
VPN-Instance: public net
Interface      State NbrCnt HelloInt  DR-Pri  DR-Address
GE0/0/2        up    1    30      1       192.168.0.2

```

AR2:

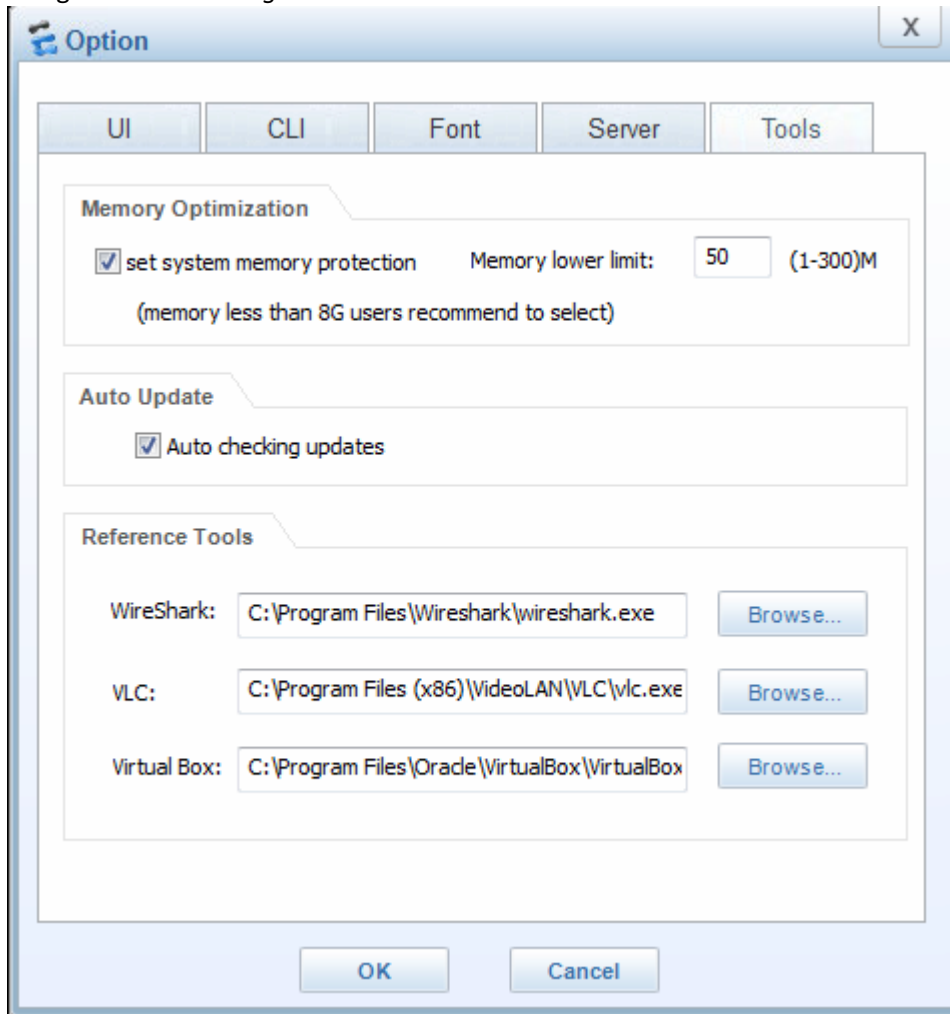
```

<AR2>display pim interface GigabitEthernet 0/0/2
VPN-Instance: public net
Interface      State NbrCnt HelloInt  DR-Pri  DR-Address
GE0/0/2        up    1    30      100     192.168.0.2 (local)

```

- Configure the Receiver to receive multicast traffic from Sender server. Use multicast group address 239.1.1.1

NOTE: eNSP must be configured with correct path of the VLC application beforehand. To do that navigate to the *Settings* window and then click on *Tools* tab.



Multicast Sender:

The screenshot shows the 'Source' configuration window with the 'Basic Config' tab selected. The 'Host Name' is set to 'Source'. The 'Configuration' section contains the following fields:

- IP Address: 192 . 168 . 10 . 200
- Subnet Mask: 255 . 255 . 255 . 0
- Gateway: 192 . 168 . 10 . 1
- MAC Address: 54-89-98-CF-49-44

An 'Apply' button is located at the bottom right of the configuration section.

The screenshot shows the 'Source' configuration window with the 'MCSource' tab selected. The 'Video File Path' is set to 'D:\Downloads\test-mpeg_512kb.mp4'. The 'Configuration' section contains the following fields:

- Multicast Group IP Address: 239 . 1 . 1 . 1
- Multicast Group MAC Address: 01-00-5E-01-00-00
- Source IP Address: 192 . 168 . 10 . 200
- Source MAC Address: 54-89-98-CF-49-44

A 'Play' button is located at the bottom of the configuration section.

Clicking the *Play* button will start the streaming of the video file specified in the path.

Receiver:

The image shows the 'Receiver' application window with the 'Basic Config' tab selected. The window contains the following fields and controls:

- Host Name:** Text box containing 'Reveiver'.
- MAC Address:** Text box containing '54-89-98-31-39-F1'.
- IPv4 Configuration:**
 - Radio buttons for **Static** (selected) and **DHCP**.
 - ☐ Obtain DNS server address automatically.
 - IP Address:** Text box with '192 . 168 . 0 . 100'.
 - Subnet Mask:** Text box with '255 . 255 . 255 . 0'.
 - Gateway:** Text box with '192 . 168 . 0 . 1'.
 - DNS1:** Text box with '0 . 0 . 0 . 0'.
 - DNS2:** Text box with '0 . 0 . 0 . 0'.
- IPv6 Configuration:**
 - Radio buttons for **Static** (selected) and **DHCPv6**.
 - IPv6 Address:** Text box with '::'.
 - Prefix Length:** Text box with '128'.
 - IPv6 Gateway:** Text box with '::'.
- Apply** button at the bottom right.

The image shows the 'Receiver' application window with the 'MCPacket' tab selected. The window contains the following fields and controls:

- Packet Configuration:**
 - Radio buttons for **Version 1**, **Version 2** (selected), and **Version 3**.
 - Source IP:** Text box with '192 . 168 . 0 . 100'.
 - Source MAC:** Text box with '54-89-98-31-39-F1'.
 - Destination IP:** Text box with '239 . 1 . 1 . 1'.
 - Destination MAC:** Text box with '00-00-00-00-00-00'.
- Show VLC** button.
- Join** and **Leave** buttons.

Clicking on the *Join* button will send igmp join message and multicast traffic will be received. Verify the configuration:

AR2:

<AR2>display pim routing-table

VPN-Instance: public net

Total 1 (*, G) entry; 1 (S, G) entry

(*, 239.1.1.1)

RP: 10.10.10.1

Protocol: pim-sm, Flag: WC

UpTime: 00:09:26

Upstream interface: GigabitEthernet0/0/1

Upstream neighbor: 172.16.0.14

RPF prime neighbor: 172.16.0.14

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: igmp, UpTime: 00:09:26, Expires: -

(192.168.10.200, 239.1.1.1)

RP: 10.10.10.1

Protocol: pim-sm, Flag: RPT SPT ACT

UpTime: 00:09:14

Upstream interface: GigabitEthernet0/0/0

Upstream neighbor: 172.16.0.26

RPF prime neighbor: 172.16.0.26

Downstream interface(s) information:

Total number of downstreams: 1

1: GigabitEthernet0/0/2

Protocol: pim-sm, UpTime: 00:09:14, Expires: -

<AR2>display igmp group

Interface group report information of VPN-Instance: public net

GigabitEthernet0/0/2(192.168.0.2):

Total 1 IGMP Group reported

Group Address	Last Reporter	Uptime	Expires
239.1.1.1	192.168.0.100	00:10:13	00:01:57

<AR2>display igmp interface

Interface information of VPN-Instance: public net

GigabitEthernet0/0/2(192.168.0.2):

IGMP is enabled

Current IGMP version is 2

IGMP state: up

IGMP group policy: none

IGMP limit: -

Value of query interval for IGMP (negotiated): -

Value of query interval for IGMP (configured): 60 s

Value of other querier timeout for IGMP: 85 s

Value of maximum query response time for IGMP: 10 s

Querier for IGMP: 192.168.0.1

Total 1 IGMP Group reported

<AR2>display multicast routing-table

Multicast routing table of VPN-Instance: public net

Total 1 entry

00001. (192.168.10.200, 239.1.1.1)

Uptime: 00:11:43

Upstream Interface: GigabitEthernet0/0/0

List of 1 downstream interface

1: GigabitEthernet0/0/2

<AR2>**display multicast forwarding-table**

Multicast Forwarding Table of VPN-Instance: public net

Total 1 entry, 1 matched

00001. (192.168.10.200, 239.1.1.1)

MID: 0, Flags: ACT

Uptime: 00:11:59, Timeout in: 00:03:15

Incoming interface: GigabitEthernet0/0/0

List of 1 outgoing interfaces:

1: GigabitEthernet0/0/2

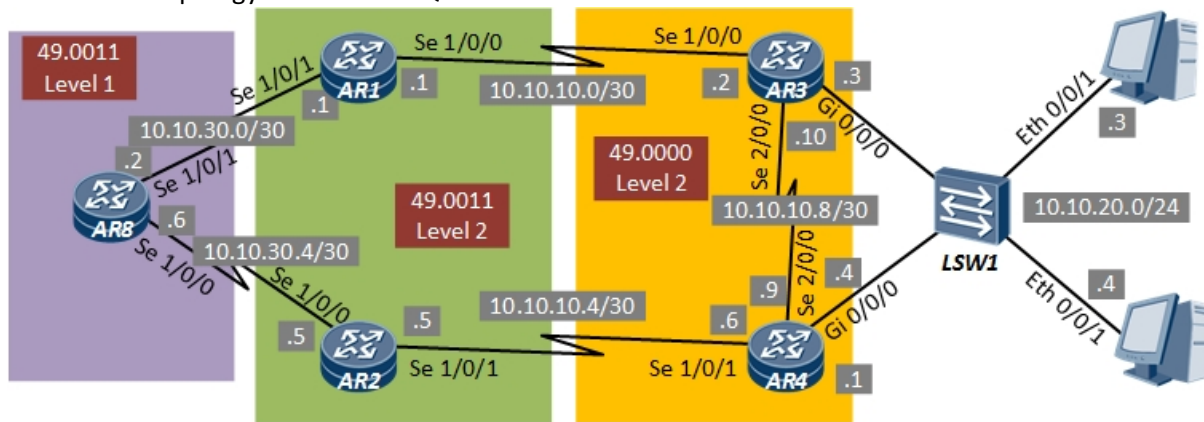
Activetime: 00:11:59

Matched 185482457645723 packets(246440481801489668 bytes), Wrong If 664 packets

Forwarded 182630599360515 packets(242533435950764004 bytes)

Chapter 6: Quality of Service - solutions

NOTE: Load topology with name – QoS



6.1. QoS configuration.

- Make sure that LSW1 is preserving the traffic markings send by Client1 and Client2.

LSW1:

```
[LSW1]interface GigabitEthernet 0/0/3
[LSW1-GigabitEthernet0/0/3]trust dscp
[LSW1-GigabitEthernet0/0/3]quit
[LSW1]interface GigabitEthernet 0/0/4
[LSW1-GigabitEthernet0/0/4]trust dscp
[LSW1-GigabitEthernet0/0/4]quit
[LSW1]quit
```

- Configure the AR3 to remark traffic DCSP priorities on traffic received from interface GE 0/0/0 to 46. You are not allowed to use traffic policy to accomplish that.

AR3:

```
<AR3>system-view
Enter system view, return user view with Ctrl+Z.

[AR3]qos map-table dscp-dscp
[AR3-maptbl-dscp-dscp]input 0 to 63 output 46
[AR3-maptbl-dscp-dscp]quit
[AR3]interface GigabitEthernet 0/0/0
[AR3-GigabitEthernet0/0/0]trust dscp override
[AR3-GigabitEthernet0/0/0]quit
```

[AR3]quit

Checking the configuration:

AR3:

<AR3>display qos map-table dscp-dscp

Input DSCP DSCP

Input DSCP	DSCP
0	46
1	46
2	46
3	46
4	46
5	46
6	46
7	46
8	46
9	46
10	46
11	46
12	46
13	46
14	46
15	46
16	46
17	46
18	46
19	46
20	46
21	46
22	46
23	46
24	46
25	46
26	46
27	46
28	46
29	46
30	46
31	46
32	46
33	46
34	46
35	46
36	46
37	46
38	46
39	46
40	46
41	46
42	46
43	46
44	46
45	46
46	46
47	46
48	46
49	46
50	46

51	46
52	46
53	46
54	46
55	46
56	46
57	46
58	46
59	46
60	46
61	46
62	46
63	46

- Configure AR4 to remark the traffic received from Client1 with DSCP value of 46 whereas traffic received from Client2 with DSCP value 23. Ensure traffic statistics are collected for the packets matching the rules.

AR4:

```
<AR4>system-view
Enter system view, return user view with Ctrl+Z.
```

```
[AR4]acl 2000
```

```
[AR4-acl-basic-2000]rule permit source 10.10.20.3 0
```

```
[AR4-acl-basic-2000]quit
```

```
[AR4]acl 2001
```

```
[AR4-acl-basic-2001]rule permit source 10.10.20.4 0
```

```
[AR4-acl-basic-2001]quit
```

```
[AR4]traffic classifier client1
```

```
[AR4-classifier-client1]if-match acl 2000
```

```
[AR4-classifier-client1]quit
```

```
[AR4]traffic classifier client2
```

```
[AR4-classifier-client2]if-match acl 2001
```

```
[AR4-classifier-client2]quit
```

```
[AR4]traffic behavior client1
```

```
[AR4-behavior-client1]remark dscp 46
```

```
[AR4-behavior-client1]statistic enable
```

```
[AR4-behavior-client1]quit
```

```
[AR4]traffic behavior client2
```

```
[AR4-behavior-client2]remark dscp 23
```

```
[AR4-behavior-client2]statistic enable
```

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```

[AR4-behavior-client2]quit
[AR4]traffic policy policy1
[AR4-trafficpolicy-policy1]classifier client1 behavior client1
[AR4-trafficpolicy-policy1]classifier client2 behavior client2
[AR4-trafficpolicy-policy1]quit
[AR4]interface GigabitEthernet 0/0/0
[AR4-GigabitEthernet0/0/0]traffic-policy policy1 inbound
[AR4-GigabitEthernet0/0/0]quit
[AR4]quit

```

Checking the configuration:

AR4:

```

<AR4>display traffic classifier user-defined
User Defined Classifier Information:
Classifier: client1
Operator: OR
Rule(s) :
  if-match acl 2000
Classifier: client2
Operator: OR
Rule(s) :
  if-match acl 2001

<AR4>display traffic policy user-defined
User Defined Traffic Policy Information:
Policy: policy1
Classifier: client1
Operator: OR
Behavior: client1
Marking:
  Remark DSCP ef

Classifier: client2
Operator: OR
Behavior: client2
Marking:
  Remark DSCP 23

<AR4>display traffic policy statistics interface GigabitEthernet 0/0/0 inbound

Interface: GigabitEthernet0/0/0
Traffic policy inbound: policy1
Rule number: 2
Current status: OK!

```

Item	Sum(Packets/Bytes)	Rate(pps/bps)
Matched	20/	1/
1,960	304	
+--Passed	20/	1/

1,960	304		
+--Dropped		0/	0/
0	0		
+--Filter		0/	0/
0	0		
+--CAR		0/	0/
0	0		
+--Queue Matched		0/	0/
0	0		
+--Enqueued		0/	0/
0	0		
+--Discarded		0/	0/
0	0		
+--Car		0/	0/
0	0		
+--Green packets		0/	0/
0	0		
+--Yellow packets		0/	0/
0	0		
+--Red packets		0/	0/
0	0		

- Configure traffic policer on WAN interface on AR3 limiting the traffic to the rest of the network to 1500kbps.

AR3:

```
<AR3>system-view
Enter system view, return user view with Ctrl+Z.
```

```
[AR3]interface Serial 1/0/0
```

```
[AR3-Serial1/0/0]qos car outbound cir 1500
```

```
[AR3-Serial1/0/0]quit
```

```
[AR3]interface serial 2/0/0
```

```
[AR3-Serial2/0/0]qos car outbound cir 1500
```

```
[AR3-Serial2/0/0]quit
```

```
[AR3]quit
```

Checking the configuration:

AR3:

```
<AR3>display qos car statistics interface Serial 1/0/0 outbound
```

```
Interface : Serial1/0/0
```

```
Direction : Outbound
```

Type	Packets/Bytes	Rate(pps/bps)
Drop	0/0	0/0
Pass	10/720	0/0
Green	10/720	0/0
Yellow	0/0	0/0
Red	0/0	0/0

- Configure drop profiles with WRED parameters based on DSCP. Configure traffic marked with DSCP 46 with low drop probability, whereas traffic with DSCP 23 with higher drop probability. Configure WFQ scheduler for those two queues. Apply the queue profile on WAN interface on router AR4.

AR4:

```
[AR4]drop-profile 46

[AR4-drop-profile-46]wred dscp
Info: Weight type has changed to DSCP.

[AR4-drop-profile-46]dscp 46 low-limit 80 high-limit 95 discard-percentage 15

[AR4-drop-profile-46]quit

[AR4]drop-profile 23

[AR4-drop-profile-23]wred dscp
Info: Weight type has changed to DSCP.

[AR4-drop-profile-23]dscp 23 low-limit 60 high-limit 75 discard-percentage 40

[AR4-drop-profile-23]quit

[AR4]qos queue-profile qp1

[AR4-qos-queue-profile-qp1]schedule wfq 2 to 5

[AR4-qos-queue-profile-qp1]queue 2 drop-profile 23

[AR4-qos-queue-profile-qp1]queue 5 drop-profile 46

[AR4-qos-queue-profile-qp1]quit

[AR4]interface Serial 1/0/1

[AR4-Serial1/0/1]qos queue-profile qp1

[AR4-Serial1/0/1]quit

[AR4]interface Serial 2/0/0

[AR4-Serial2/0/0]qos queue-profile qp1

[AR4-Serial2/0/0]quit

[AR4]quit
```

Checking the configuration:

AR4:

```
<AR4>display qos queue-profile qp1
Queue-profile: qp1
Queue Schedule Weight Length(Bytes/Packets) GTS(CIR/CBS)
-----
2   WFQ      10         -/-         -/-
3   WFQ      10         -/-         -/-
4   WFQ      10         -/-         -/-
```

```

5   WFQ   10      -/-      -/-

<AR4>display drop-profile 23
Drop-profile[2]: 23
DSCP      Low-limit  High-limit  Discard-percentage
-----
0(default)  30      100      10
1          30      100      10
2          30      100      10
3          30      100      10
4          30      100      10
5          30      100      10
6          30      100      10
7          30      100      10
8(cs1)     30      100      10
9          30      100      10
10(af11)   30      100      10
11         30      100      10
12(af12)   30      100      10
13         30      100      10
14(af13)   30      100      10
15         30      100      10
16(cs2)    30      100      10
17         30      100      10
18(af21)   30      100      10
19         30      100      10
20(af22)   30      100      10
21         30      100      10
22(af23)   30      100      10
23         60      75      40
24(cs3)    30      100      10
25         30      100      10
26(af31)   30      100      10
27         30      100      10
28(af32)   30      100      10
29         30      100      10
30(af33)   30      100      10
31         30      100      10
32(cs4)    30      100      10
33         30      100      10
34(af41)   30      100      10
35         30      100      10
36(af42)   30      100      10
37         30      100      10
38(af43)   30      100      10
39         30      100      10
40(cs5)    30      100      10
41         30      100      10
42         30      100      10
43         30      100      10
44         30      100      10
45         30      100      10
46(ef)     30      100      10
47         30      100      10
48(cs6)    30      100      10
49         30      100      10
50         30      100      10
51         30      100      10
52         30      100      10

```

53	30	100	10
54	30	100	10
55	30	100	10
56(cs7)	30	100	10
57	30	100	10
58	30	100	10
59	30	100	10
60	30	100	10
61	30	100	10
62	30	100	10
63	30	100	10

<AR4>display drop-profile 46

Drop-profile[1]: 46

DSCP	Low-limit	High-limit	Discard-percentage

0(default)	30	100	10
1	30	100	10
2	30	100	10
3	30	100	10
4	30	100	10
5	30	100	10
6	30	100	10
7	30	100	10
8(cs1)	30	100	10
9	30	100	10
10(af11)	30	100	10
11	30	100	10
12(af12)	30	100	10
13	30	100	10
14(af13)	30	100	10
15	30	100	10
16(cs2)	30	100	10
17	30	100	10
18(af21)	30	100	10
19	30	100	10
20(af22)	30	100	10
21	30	100	10
22(af23)	30	100	10
23	30	100	10
24(cs3)	30	100	10
25	30	100	10
26(af31)	30	100	10
27	30	100	10
28(af32)	30	100	10
29	30	100	10
30(af33)	30	100	10
31	30	100	10
32(cs4)	30	100	10
33	30	100	10
34(af41)	30	100	10
35	30	100	10
36(af42)	30	100	10
37	30	100	10
38(af43)	30	100	10
39	30	100	10
40(cs5)	30	100	10
41	30	100	10
42	30	100	10

43	30	100	10
44	30	100	10
45	30	100	10
46(ef)	80	95	15
47	30	100	10
48(cs6)	30	100	10
49	30	100	10
50	30	100	10
51	30	100	10
52	30	100	10
53	30	100	10
54	30	100	10
55	30	100	10
56(cs7)	30	100	10
57	30	100	10
58	30	100	10
59	30	100	10
60	30	100	10
61	30	100	10
62	30	100	10
63	30	100	10

<AR4>

- Use a traffic policy on AR1 and AR2 to restrict the traffic received from Client1 and Client2 in such a way that Client 1 should not be able to send more than 2Mbits and Client2 not more than 1Mbits. Make sure that shaped but not policed.

AR1 & AR2:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]traffic classifier client1

[AR1-classifier-client1]if-match dscp 46

[AR1-classifier-client1]quit

[AR1]traffic classifier client2

[AR1-classifier-client2]if-match dscp 23

[AR1-classifier-client2]quit

[AR1]traffic behavior client1

[AR1-behavior-client1]gts cir 2000

[AR1-behavior-client1]quit

[AR1]traffic behavior client2

[AR1-behavior-client2]gts cir 1000

[AR1-behavior-client2]quit

[AR1-trafficpolicy-tp1]classifier client1 behavior client1

[AR1-trafficpolicy-tp1]classifier client2 behavior client2
```

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```

[AR1-trafficpolicy-tp1]quit
[AR1]interface serial 1/0/1
[AR1-Serial1/0/1]traffic-policy tp1 outbound
[AR1-Serial1/0/1]quit
[AR1]quit

<AR2>system-view
Enter system view, return user view with Ctrl+Z.

[AR2]traffic classifier client1
[AR2-classifier-client1]if-match dscp 46
[AR2-classifier-client1]quit
[AR2]traffic classifier client2
[AR2-classifier-client2]if-match dscp 23
[AR2-classifier-client2]quit
[AR2]traffic behavior client1
[AR2-behavior-client1]gts cir 2000
[AR2-behavior-client1]quit
[AR2]traffic behavior client2
[AR2-behavior-client2]gts cir 1000
[AR2-behavior-client2]quit
[AR2]traffic policy tp1
[AR2-trafficpolicy-tp1]classifier client1 behavior client1
[AR2-trafficpolicy-tp1]classifier client2 behavior client2
[AR2-trafficpolicy-tp1]quit
[AR2]interface serial 1/0/0
[AR2-Serial1/0/0]traffic-policy tp1 outbound
[AR2-Serial1/0/0]quit
[AR2]quit

```

Checking the configuration:

AR1:

```

<AR1>display traffic policy user-defined
User Defined Traffic Policy Information:

```

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```

Policy: tp1
Classifier: client1
Operator: OR
Behavior: client1
General Traffic Shape:
  CIR 2000 (Kbps), CBS 50000 (byte)
  Queue length 1 (Packets)

```

```

Classifier: client2
Operator: OR
Behavior: client2
General Traffic Shape:
  CIR 1000 (Kbps), CBS 25000 (byte)
  Queue length 1 (Packets)

```

- To limit the packet discarded over the FR interfaces received from AR5, configure FR shaping to not allow more than 2,5Mbits of traffic send to AR1 and AR2.

AR5:

```

<AR5>system-view
Enter system view, return user view with Ctrl+Z.

[AR5]fr class shape-to-2.5

[AR5-fr-class-shape-to-2.5]cbs outbound 2500

[AR5-fr-class-shape-to-2.5]cir allow outbound 2000

[AR5-fr-class-shape-to-2.5]cir 2000

[AR5-fr-class-shape-to-2.5]quit

[AR5]interface Serial 1/0/0

[AR5-Serial1/0/0]fr traffic-shaping

[AR5-Serial1/0/0]fr-class shape-to-2.5

[AR5-Serial1/0/0]quit

[AR5]interface Serial 1/0/1

[AR5-Serial1/0/1]fr traffic-shaping

[AR5-Serial1/0/1]fr-class shape-to-2.5

[AR5-Serial1/0/1]quit

[AR5]quit

```

Checking the configuration:

AR5:

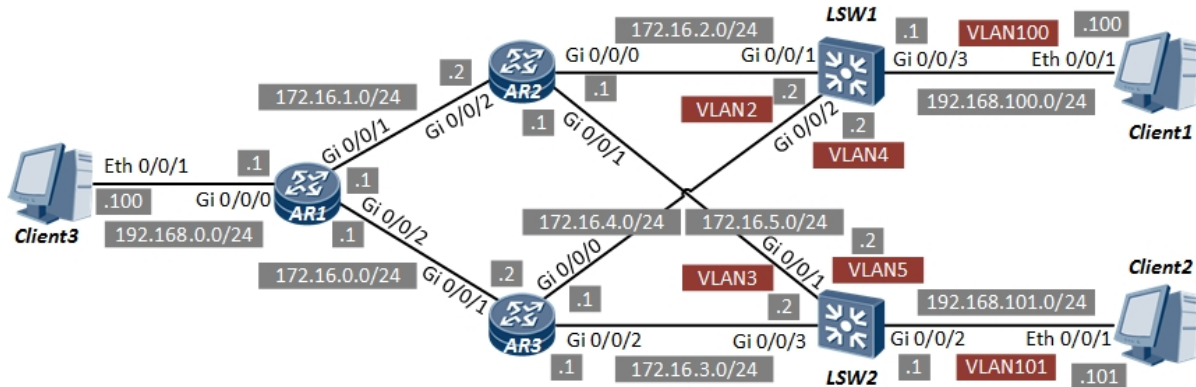
```

<AR5>display fr class shape-to-2.5
fr class shape-to-2.5
General Traffic Shape Info:
  CIR allow outbound 2000(Kbps), CIR 2000(Kbps), CBS outbound 2500(byte)

```

Traffic Shaping Adaptation Info:
traffic-shaping adaptation becn 25(percentage)
PVC-PQ Queue Info:
pvc-pq normal

Chapter 7: Security and IP features - solutions



7.1. IP features

- Configure the interface with the IP addresses as shown on the diagram.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]interface GigabitEthernet 0/0/0
[AR1-GigabitEthernet0/0/0]ip address 192.168.0.1 24
[AR1-GigabitEthernet0/0/0]quit

[AR1]interface GigabitEthernet 0/0/1
[AR1-GigabitEthernet0/0/1]ip address 172.16.1.1 24
[AR1-GigabitEthernet0/0/1]quit

[AR1]interface GigabitEthernet 0/0/2
[AR1-GigabitEthernet0/0/2]ip address 172.16.0.1 24
[AR1-GigabitEthernet0/0/2]quit

[AR1]
```

LSW1:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]vlan batch 2 4 100
Info: This operation may take a few seconds. Please wait for a moment...done.

[LSW1]interface Vlanif 2
[LSW1-Vlanif2]ip address 172.16.2.2 24
[LSW1-Vlanif2]quit
```

```

[LSW1]interface Vlanif 4
[LSW1-Vlanif4]ip address 172.16.4.2 24
[LSW1-Vlanif4]quit
[LSW1]interface Vlanif 100
[LSW1-Vlanif100]ip address 192.168.100.1 24
[LSW1-Vlanif100]quit
[LSW1]interface GigabitEthernet 0/0/1
[LSW1-GigabitEthernet0/0/1]port link-type access
[LSW1-GigabitEthernet0/0/1]port default vlan 2
[LSW1-GigabitEthernet0/0/1]quit
[LSW1]interface GigabitEthernet 0/0/2
[LSW1-GigabitEthernet0/0/2]port link-type access
[LSW1-GigabitEthernet0/0/2]port default vlan 4
[LSW1-GigabitEthernet0/0/2]quit
[LSW1]interface GigabitEthernet 0/0/3
[LSW1-GigabitEthernet0/0/3]port link-type access
[LSW1-GigabitEthernet0/0/3]port default vlan 100
[LSW1-GigabitEthernet0/0/3]quit
[LSW1]

```

- Configure switches LSW1 and LSW2 to allocate IP addresses on respective segments VLAN100 and VLAN101. Use DHCP protocol to accomplish that task. Client1 and Client2 need fixed addresses allocated by DHCP also.

LSW1:

```

<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]dhcp enable
Info: The operation may take a few seconds. Please wait for a moment.done.

[LSW1]ip pool pool100

[LSW1-ip-pool-pool100]network 192.168.100.0 mask 24

[LSW1-ip-pool-pool100]gateway 192.168.100.1

[LSW1-ip-pool-pool100]static-bind ip-address 192.168.100.100 mac-address 5489-981A-595F

[LSW1-ip-pool-pool100]quit

```

```
[LSW1]interface Vlanif 100
[LSW1-Vlanif100]dhcp select global
[LSW1-Vlanif100]quit
[LSW1]
```

LSW2:**<LSW2>system-view**

Enter system view, return user view with Ctrl+Z.

[LSW2]dhcp enable

Info: The operation may take a few seconds. Please wait for a moment.done.

[LSW2]ip pool pool101

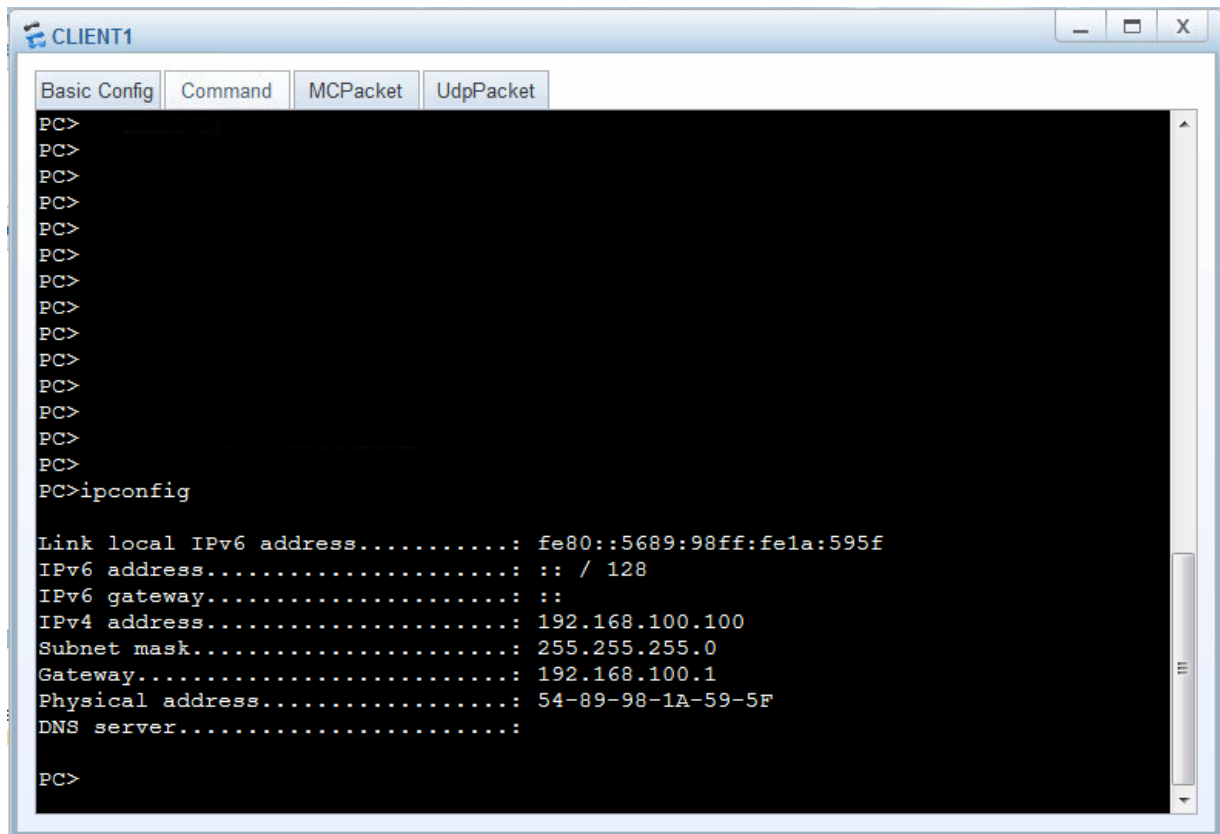
Info:It's successful to create an IP address pool.

[LSW2-ip-pool-pool101]network 192.168.101.0**[LSW2-ip-pool-pool101]gateway-list 192.168.101.1****[LSW2-ip-pool-pool101]static-bind ip-address 192.168.101.101 mac-address 5489-9855-2A9D****[LSW2-ip-pool-pool101]quit****[LSW2]interface Vlanif 101****[LSW2-Vlanif101]dhcp select global****[LSW2-Vlanif101]quit****[LSW2]quit**

Verify the configuration:

Client1:

The screenshot shows the 'CLIENT1' configuration window with the 'Basic Config' tab selected. The 'Host Name' field is empty. The 'MAC Address' field is set to '54-89-98-1A-59-5F'. Under 'IPv4 Configuration', the 'DHCP' radio button is selected, and the checkbox 'Obtain DNS server address automatically' is checked. The 'IP Address', 'Subnet Mask', and 'Gateway' fields are empty. The 'DNS1' and 'DNS2' fields are also empty. Under 'IPv6 Configuration', the 'Static' radio button is selected. The 'IPv6 Address' field is set to '::', the 'Prefix Length' is set to '128', and the 'IPv6 Gateway' field is set to '::'. An 'Apply' button is located at the bottom right of the configuration area.



- Configure static routing to provide full reachability in the network. Use all available links to provide redundancy. Make sure that AR1 use path through AR2 for reaching VLAN100 subnet and AR3 for reaching VLAN101 subnet. For faster detection link faults use NQA on AR1 to switch over the redundancy paths.

AR1:

```

<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]nqa test-instance icmp_test icmp_static_track

[AR1-nqa-icmp_test-icmp_static_track]test-type icmp

[AR1-nqa-icmp_test-icmp_static_track]destination-address ipv4 172.16.2.2

[AR1-nqa-icmp_test-icmp_static_track]frequency 5

[AR1-nqa-icmp_test-icmp_static_track]probe-count 1

[AR1-nqa-icmp_test-icmp_static_track]start now

[AR1-nqa-icmp_test-icmp_static_track]quit

[AR1]nqa test-instance icmp_test_1 icmp_static_track1

[AR1-nqa-icmp_test_1-icmp_static_track]test-type icmp

[AR1-nqa-icmp_test_1-icmp_static_track]destination-address ipv4 172.16.3.2

[AR1-nqa-icmp_test_1-icmp_static_track]frequency 5

```

```
[AR1-nqa-icmp_test_1-icmp_static_track]probe-count 1
[AR1-nqa-icmp_test_1-icmp_static_track]start now
[AR1-nqa-icmp_test_1-icmp_static_track]quit
[AR1]ip route-static 192.168.100.0 24 172.16.0.2 preference 150
[AR1]ip route-static 192.168.100.0 24 172.16.1.2 track nqa icmp_test icmp_static_track
[AR1]ip route-static 192.168.101.0 24 172.16.1.2 preference 150
[AR1]ip route-static 192.168.101.0 24 172.16.0.2 track nqa icmp_test_1 icmp_static_track
[AR1]ip route-static 172.16.2.0 255.255.255.0 172.16.1.2
[AR1]ip route-static 172.16.3.0 255.255.255.0 172.16.0.2
[AR1]ip route-static 172.16.4.0 255.255.255.0 172.16.0.2
[AR1]ip route-static 172.16.5.0 255.255.255.0 172.16.1.2
[AR1]quit
```

AR2:

```
<AR2>system-view
Enter system view, return user view with Ctrl+Z.
[AR2]ip route-static 192.168.0.0 255.255.255.0 172.16.1.1
[AR2]ip route-static 192.168.100.0 255.255.255.0 172.16.2.2
[AR2]ip route-static 192.168.101.0 255.255.255.0 172.16.5.2
[AR2]quit
```

AR3:

```
<AR3>system-view
Enter system view, return user view with Ctrl+Z.
[AR3]ip route-static 192.168.0.0 255.255.255.0 172.16.0.1
[AR3]ip route-static 192.168.100.0 255.255.255.0 172.16.4.2
[AR3]ip route-static 192.168.101.0 255.255.255.0 172.16.2.2
[AR3]quit
```

LSW1:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]ip route-static 172.16.0.0 255.255.255.0 172.16.4.1

[LSW1]ip route-static 172.16.1.0 255.255.255.0 172.16.2.1

[LSW1]ip route-static 192.168.0.0 255.255.255.0 172.16.2.1

[LSW1]ip route-static 192.168.0.0 255.255.255.0 172.16.4.1 preference 150

[LSW1]quit
```

LSW2:

```
<LSW2>system-view
Enter system view, return user view with Ctrl+Z.

[LSW2]ip route-static 172.16.0.0 255.255.255.0 172.16.3.1

[LSW2]ip route-static 172.16.1.0 255.255.255.0 172.16.5.1

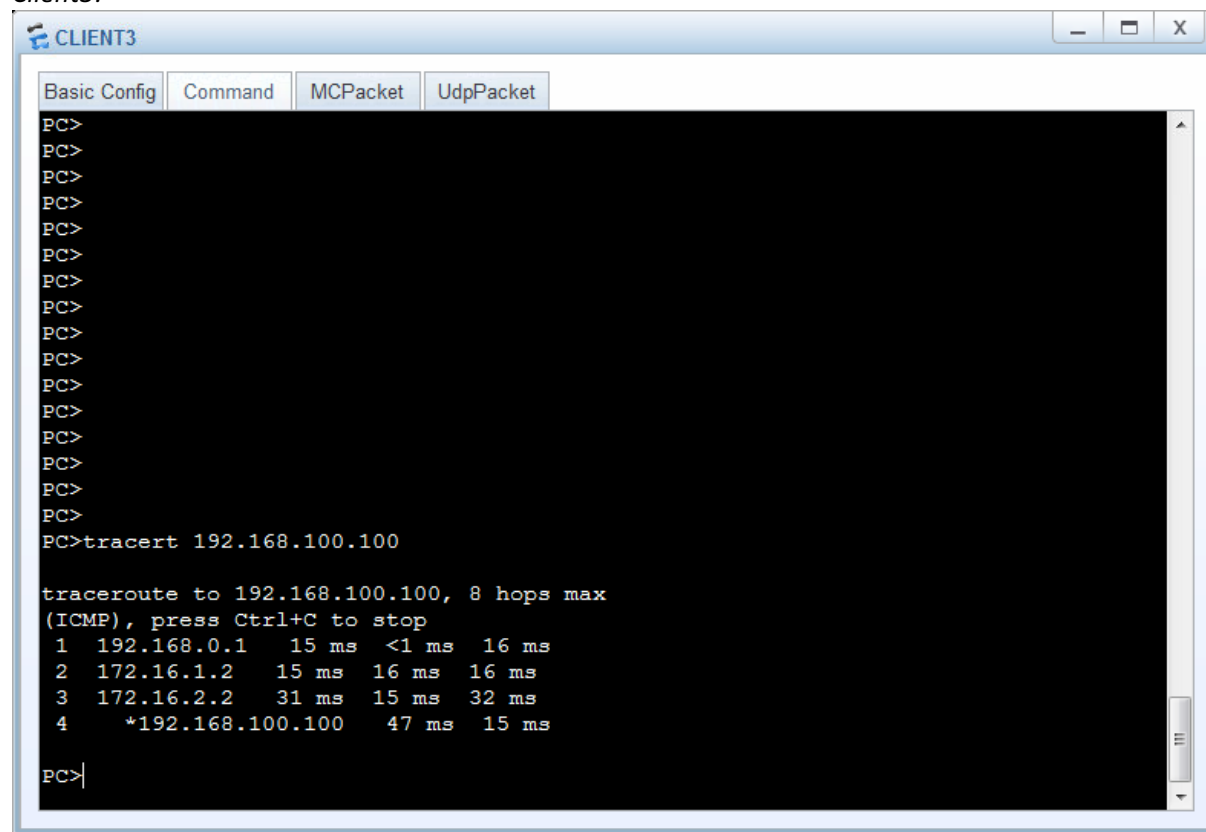
[LSW2]ip route-static 192.168.0.0 255.255.255.0 172.16.3.1

[LSW2]ip route-static 192.168.0.0 255.255.255.0 172.16.5.1 preference 150

[LSW2]quit
```

Verify the configuration:

Client3:



```
CLIENT3
Basic Config Command MCPacket UdpPacket
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>tracert 192.168.100.100

tracert to 192.168.100.100, 8 hops max
(ICMP), press Ctrl+C to stop
 1 192.168.0.1    15 ms  <1 ms  16 ms
 2 172.16.1.2    15 ms  16 ms  16 ms
 3 172.16.2.2    31 ms  15 ms  32 ms
 4 *192.168.100.100 47 ms  15 ms
PC>
```

Shutdown the interface between AR2 and LSW1:

Client3:

```

CLIENT3
Basic Config Command MCPacket UdpPacket
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>
PC>tracert 192.168.100.100

tracert to 192.168.100.100, 8 hops max
(ICMP), press Ctrl+C to stop
 1 192.168.0.1    16 ms  <1 ms  15 ms
 2 172.16.0.2    16 ms  15 ms  16 ms
 3 172.16.4.2    31 ms  16 ms  15 ms
 4 192.168.100.100 32 ms  31 ms  15 ms
PC>

```

- Make sure that subnet 192.168.0.0/24 is masked using NAT, when sending traffic beyond the AR1 gateway. Ensure that failure of any uplink interface on AR1 would not cause disruption in communication.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.
```

```
[AR1]acl 2000
```

```
[AR1-acl-basic-2000]rule 5 permit source 192.168.0.0 0.0.0.255
```

```
[AR1-acl-basic-2000]quit
```

```
[AR1]interface GigabitEthernet 0/0/1
```

```
[AR1-GigabitEthernet0/0/1]nat outbound 2000
```

```
[AR1-GigabitEthernet0/0/1]quit
```

```
[AR1]interface GigabitEthernet 0/0/2
```

```
[AR1-GigabitEthernet0/0/2]nat outbound 2000
```

```
[AR1-GigabitEthernet0/0/2]quit
```

```
[AR1]quit
```

<http://www.inetzero.com> - Copyright 2016 iNET ZERO. All rights reserved
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<https://t.me/learningnets>

Verify the configuration:

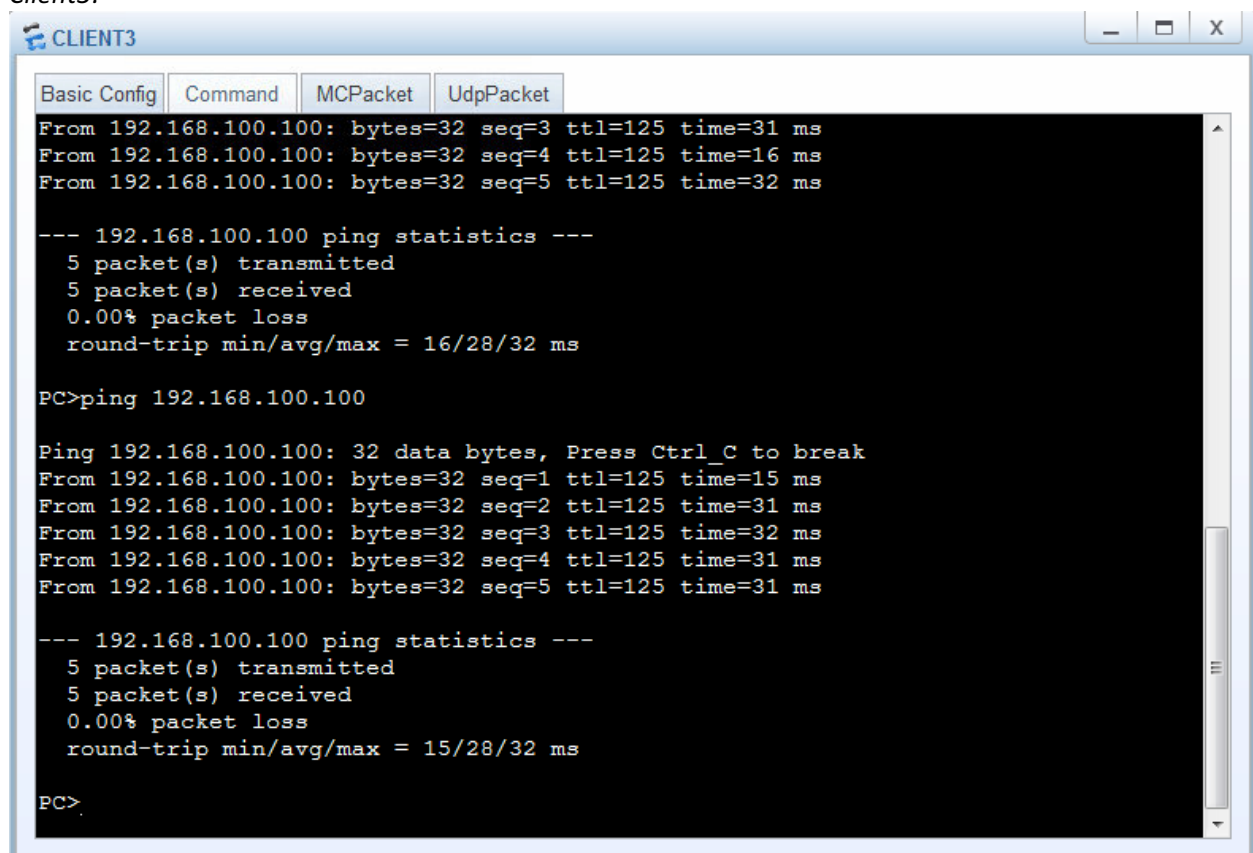
AR1:

<AR1>display nat outbound

NAT Outbound Information:

Interface	Acl	Address-group/IP/Interface	Type
GigabitEthernet0/0/1	2000	172.16.1.1	easyip
GigabitEthernet0/0/2	2000	172.16.0.1	easyip
Total : 2			

Client3:



```

CLIENT3
Basic Config Command MCPacket UdpPacket
From 192.168.100.100: bytes=32 seq=3 ttl=125 time=31 ms
From 192.168.100.100: bytes=32 seq=4 ttl=125 time=16 ms
From 192.168.100.100: bytes=32 seq=5 ttl=125 time=32 ms

--- 192.168.100.100 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 16/28/32 ms

PC>ping 192.168.100.100

Ping 192.168.100.100: 32 data bytes, Press Ctrl_C to break
From 192.168.100.100: bytes=32 seq=1 ttl=125 time=15 ms
From 192.168.100.100: bytes=32 seq=2 ttl=125 time=31 ms
From 192.168.100.100: bytes=32 seq=3 ttl=125 time=32 ms
From 192.168.100.100: bytes=32 seq=4 ttl=125 time=31 ms
From 192.168.100.100: bytes=32 seq=5 ttl=125 time=31 ms

--- 192.168.100.100 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 15/28/32 ms

PC>
  
```

Packet capture on Client1:

*Standard input [Wireshark 1.12.1 (v1.12.1-0-g01b65bf from master-1.12)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
4	6.59900000	HuaweiTe_e8:42:6b	Spanning-tree-(for-STP		119	MST. Root = 32768/0/4c:1f:cc:e8:42:6b Cost = 0
5	8.78300000	HuaweiTe_e8:42:6b	Spanning-tree-(for-STP		119	MST. Root = 32768/0/4c:1f:cc:e8:42:6b Cost = 0
6	10.98200000	172.16.1.1	192.168.100.100	ICMP	74	Echo (ping) request id=0x0f28, seq=1/256, ttl=1
7	10.98200000	192.168.100.100	172.16.1.1	ICMP	74	Echo (ping) reply id=0x0f28, seq=1/256, ttl=1
8	11.02900000	HuaweiTe_e8:42:6b	Spanning-tree-(for-STP		119	MST. Root = 32768/0/4c:1f:cc:e8:42:6b Cost = 0
9	11.99600000	172.16.1.1	192.168.100.100	ICMP	74	Echo (ping) request id=0x1028, seq=2/512, ttl=1
10	11.99600000	192.168.100.100	172.16.1.1	ICMP	74	Echo (ping) reply id=0x1028, seq=2/512, ttl=1
11	13.04200000	172.16.1.1	192.168.100.100	ICMP	74	Echo (ping) request id=0x1128, seq=3/768, ttl=1
12	13.04200000	192.168.100.100	172.16.1.1	ICMP	74	Echo (ping) reply id=0x1128, seq=3/768, ttl=1
13	13.19800000	HuaweiTe_e8:42:6b	Spanning-tree-(for-STP		119	MST. Root = 32768/0/4c:1f:cc:e8:42:6b Cost = 0
14	14.05600000	172.16.1.1	192.168.100.100	ICMP	74	Echo (ping) request id=0x1228, seq=4/1024, ttl=1
15	14.05600000	192.168.100.100	172.16.1.1	ICMP	74	Echo (ping) reply id=0x1228, seq=4/1024, ttl=1
16	15.08500000	172.16.1.1	192.168.100.100	ICMP	74	Echo (ping) request id=0x1328, seq=5/1280, ttl=1
17	15.08500000	192.168.100.100	172.16.1.1	ICMP	74	Echo (ping) reply id=0x1328, seq=5/1280, ttl=1
18	15.36600000	HuaweiTe_e8:42:6b	Spanning-tree-(for-STP		119	MST. Root = 32768/0/4c:1f:cc:e8:42:6b Cost = 0
19	17.51900000	HuaweiTe_e8:42:6b	Spanning-tree-(for-STP		119	MST. Root = 32768/0/4c:1f:cc:e8:42:6b Cost = 0

Frame 1: 119 bytes on wire (952 bits), 119 bytes captured (952 bits) on interface 0

- IEEE 802.3 Ethernet
- Logical-Link Control
- Spanning Tree Protocol

7.3. Security

- Configure on all devices users and privileges shown in the table below.

User	Password	Privileges
super	admin123	System maintenance commands
operator	oper123	Configuration and debugging commands

- Make sure that those user can access the devices via Telnet. Ensure that 15 simultaneous Telnet connection are available.

All devices:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

[AR1]telnet server enable
Error: TELNET server has been enabled

[AR1]user-interface maximum-vty 15

[AR1]user-interface vty 0 14

[AR1-ui-vty0-14]shell

[AR1-ui-vty0-14]authentication-mode aaa

[AR1-ui-vty0-14]quit

[AR1]aaa

[AR1-aaa]local-user super password cipher admin123
Info: Add a new user.

[AR1-aaa]local-user super service-type telnet

[AR1-aaa]local-user super privilege level 3

[AR1-aaa]local-user operator password cipher oper123
Info: Add a new user.

[AR1-aaa]local-user operator service-type telnet

[AR1-aaa]local-user operator privilege level 1

[AR1-aaa]quit

[AR1]quit
```

Verify the configuration:

AR1:

```
<AR1>telnet 172.16.1.2
Press CTRL_] to quit telnet mode
Trying 172.16.1.2 ...
Connected to 172.16.1.2 ...

Login authentication

Username:super
Password:
<AR2>quit

Configuration console exit, please retry to log on

The connection was closed by the remote host
<AR1>
```

- Configure storm control protecting rest of the network from VLAN100 and VLAN101 excessive broadcast traffic. Limit the broadcast traffic not more than 30 percent from the bandwidth of the interface. Block the rest of the broadcast traffic received on the interface and log during storm control event.

LSW1 & LSW2:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]interface GigabitEthernet 0/0/3

[LSW1-GigabitEthernet0/0/3]storm-control broadcast min-rate 30 max-rate 30

[LSW1-GigabitEthernet0/0/3]storm-control action block

[LSW1-GigabitEthernet0/0/3]storm-control enable log

[LSW1-GigabitEthernet0/0/3]quit
[LSW1]
```

Verify the configuration:

LSW1:

```
<LSW1>display storm-control interface GigabitEthernet 0/0/3
```

PortName	Type	Rate (Min/Max)	Mode	Action	Punish- Status	Trap	Log	Int Last- Punish-Time
GE0/0/3	Multicast	0 /0	Pps	Block	Normal	Off	On	5
GE0/0/3	Broadcast	30 /30	Pps	Block	Normal	Off	On	5
GE0/0/3	Unicast	0 /0	Pps	Block	Normal	Off	On	5

- Configure strict ARP learning on LSW1 and LSW2 to protect the switch against ARP flood attacks for VLAN100 and VLAN101. Limit the maximum rate of ARP miss messages to 15 pps.

LSW1 & LSW2:

```
<LSW1>system-view
Enter system view, return user view with Ctrl+Z.

[LSW1]arp learning strict

[LSW1]arp-miss speed-limit source-ip maximum 15

[LSW1]quit

<LSW1>
```

Verify the configuration:

LSW1:

```
<LSW1>display arp-miss speed-limit source-ip
Slot  SuppressType  SuppressValue
-----
0      ARP-miss     15

<LSW1>display arp learning strict
The global configuration:arp learning strict

Interface                LearningStrictState
-----
Total:0
Force-enable:0
Force-disable:0

<LSW1>display arp-miss speed-limit source-ip
Slot  SuppressType  SuppressValue
-----
0      ARP-miss     15
```

- Enable IP address spoofing attacks protection on AR1 which are initiated from subnet 192.168.0.0/24. Enable strict checks.

AR1:

```
<AR1>system-view
Enter system view, return user view with Ctrl+Z.

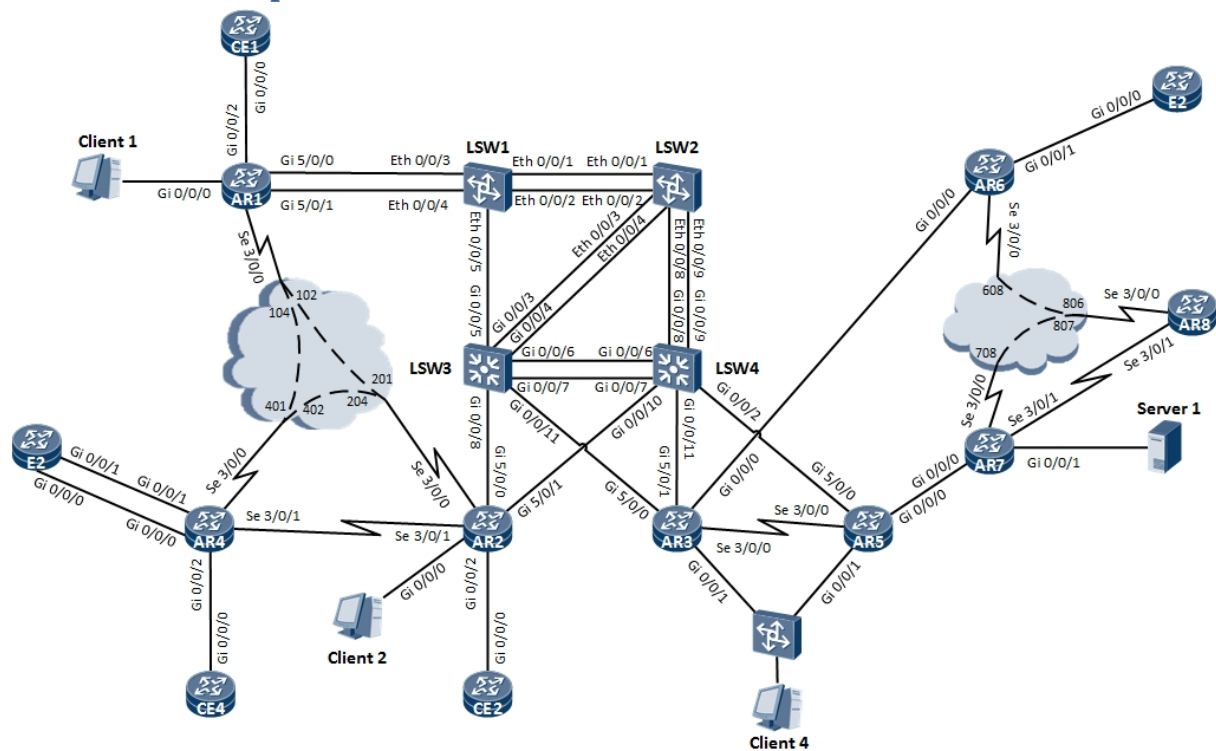
[AR1]interface GigabitEthernet 0/0/0

[AR1-GigabitEthernet0/0/0]urpf strict

[AR1-GigabitEthernet0/0/0]quit

[AR1]quit
```

APPENDIX - Superlab Solutions



Task 1: L2 switching network.

1.1. L2 interface configuration and VLAN assignment.

- Configure link aggregation interface between LSW1 and AR1 using both physical interface between them. Make sure that if additional physical interfaces are added they will function as backup. LACP keepalive messages should be exchanged every second.

AR1:

```
interface GigabitEthernet5/0/0
 eth-trunk 1
#
interface GigabitEthernet5/0/1
 eth-trunk 1
#
interface Eth-Trunk1
 mode lacp-static
 lacp timeout fast
 max active-linknumber 2
 stp disable
#
```

LSW1:

```
interface Ethernet0/0/3
 eth-trunk 1
#
interface Ethernet0/0/4
 eth-trunk 1
```

```
#  
interface Eth-Trunk1  
mode lacp-static  
lacp timeout fast  
max active-linknumber 2  
stp disable  
#
```

Verify the configuration:

AR1:

```
<AR1>display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1          WorkingMode: STATIC
Preempt Delay: Disabled   Hash arithmetic: According to SA-XOR-DA
System Priority: 32768    System ID: 00e0-fc04-6280
Least Active-linknumber: 1 Max Active-linknumber: 2
Operate status: up       Number Of Up Port In Trunk: 2

-----
ActorPortName      Status  PortType PortPri PortNo PortKey PortState Weight
GigabitEthernet5/0/0 Selected 1GE    32768  1   305   11111100 1
GigabitEthernet5/0/1 Selected 1GE    32768  2   305   11111100 1

Partner:
-----
ActorPortName      SysPri SystemID   PortPri PortNo PortKey PortState
GigabitEthernet5/0/0 32768  4c1f-cc53-440c 32768  4   289   11111100
GigabitEthernet5/0/1 32768  4c1f-cc53-440c 32768  5   289   11111100
```

LSW1:

```
<LSW1>display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1          WorkingMode: STATIC
Preempt Delay: Disabled   Hash arithmetic: According to SIP-XOR-DIP
System Priority: 32768    System ID: 4c1f-cc53-440c
Least Active-linknumber: 1 Max Active-linknumber: 2
Operate status: up       Number Of Up Port In Trunk: 2

-----
ActorPortName      Status  PortType PortPri PortNo PortKey PortState Weight
Ethernet0/0/3       Selected 100M    32768  4   289   11111100 1
Ethernet0/0/4       Selected 100M    32768  5   289   11111100 1

Partner:
-----
ActorPortName      SysPri SystemID   PortPri PortNo PortKey PortState
Ethernet0/0/3       32768  00e0-fc04-6280 32768  1   305   11111100
Ethernet0/0/4       32768  00e0-fc04-6280 32768  2   305   11111100
```

- Create the VLAN as follows on Table 1.

LSW1:

```
#
vlan batch 11 to 13 23 to 24 26 32 to 34 42 to 43 45 47 300 500 600
vlan batch 610 620 700 710 900
#
vlan 11
description ar1_lsw1
vlan 12
```



```
description lsw1_lsw2
vlan 13
description lsw1_lsw3
vlan 23
description lsw2_lsw3
vlan 24
description lsw2_lsw4
vlan 26
description ar6_lsw2
vlan 32
description ar2_lsw3
vlan 33
description ar3_lsw3
vlan 34
description lsw3_lsw4
vlan 42
description ar2_lsw4
vlan 43
description ar3_lsw4
vlan 45
description ar5_lsw4
vlan 47
description ar7_lsw4
vlan 300
description redundant
vlan 500
description servers
vlan 600
description engineering
vlan 610
description accounting
vlan 620
description administration
vlan 700
description terminals
vlan 710
description users
vlan 900
description dot1x-vlan
#
```

Verify the configuration:

LSW1:

```
<LSW1>display vlan
```

The total number of vlans is : 22

```
-----
U: Up;      D: Down;      TG: Tagged;    UT: Untagged;
MP: Vlan-mapping;      ST: Vlan-stacking;
#: ProtocolTransparent-vlan; *: Management-vlan;
-----
```

```
VID Type  Ports
-----
```

```
1  common UT:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth0/0/6(D)
    Eth0/0/7(D)  Eth0/0/8(D)  Eth0/0/9(D)  Eth0/0/10(D)
    Eth0/0/11(D) Eth0/0/12(D)  Eth0/0/13(D) Eth0/0/14(D)
    Eth0/0/15(D) Eth0/0/16(D)  Eth0/0/17(D) Eth0/0/18(D)
    Eth0/0/19(D) Eth0/0/20(D)  Eth0/0/21(D) Eth0/0/22(D)
    GE0/0/1(D)   GE0/0/2(D)   Eth-Trunk1(U)
11  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
12  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
13  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
23  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
24  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
26  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
32  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
33  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
34  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
42  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
43  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
45  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
47  common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
300 common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
500 common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
600 common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
610 common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
620 common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
700 common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
710 common TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
900 common UT:Eth0/0/15(D) Eth0/0/16(D) Eth0/0/17(D) Eth0/0/18(D)
    Eth0/0/19(D) Eth0/0/20(D)
    TG:Eth0/0/1(U)  Eth0/0/2(U)  Eth0/0/5(U)  Eth-Trunk1(U)
```

```
VID Status Property  MAC-LRN Statistics Description
-----
```

```
1  enable default  enable disable  VLAN 0001
11 enable default  enable disable  ar1_lsw1
12 enable default  enable disable  lsw1_lsw2
13 enable default  enable disable  lsw1_lsw3
23 enable default  enable disable  lsw2_lsw3
24 enable default  enable disable  lsw2_lsw4
26 enable default  enable disable  ar6_lsw2
32 enable default  enable disable  ar2_lsw3
33 enable default  enable disable  ar3_lsw3
```

34	enable	default	enable	disable	lsw3_lsw4
42	enable	default	enable	disable	ar2_lsw4
43	enable	default	enable	disable	ar3_lsw4
45	enable	default	enable	disable	ar5_lsw4
47	enable	default	enable	disable	ar7_lsw4
300	enable	default	enable	disable	redundant
500	enable	default	enable	disable	servers
600	enable	default	enable	disable	engineering
610	enable	default	enable	disable	accounting
620	enable	default	enable	disable	administration
700	enable	default	enable	disable	terminals
710	enable	default	enable	disable	users
900	enable	default	enable	disable	dot1x-vlan

- Build the L2 network as shown in Figure 1. The interface parameters can be found in Table 2.

LSW1:

```
<LSW1>display current-configuration interface Eth-Trunk 1
#
interface Eth-Trunk1
port link-type trunk
port trunk allow-pass vlan 11
#

<LSW1>display current-configuration interface Ethernet 0/0/1
#
interface Ethernet0/0/1
port link-type trunk
port trunk allow-pass vlan 2 to 4094
#
```

LSW4:

```
<LSW4>display current-configuration interface GigabitEthernet 0/0/1
#
interface GigabitEthernet0/0/1
port link-type access
port default vlan 47
#
```

- Configure Smart Link on LSW4 for interfaces Eth 0/0/7 and Eth 0/0/9. Make sure that only VLAN 300 is protected and Eth 0/0/7 is the master interface. Ensure that the master interface stays at least 5 sec in Down state before a Smart Link switchover will be performed.

LSW4:

```
smart-link group 1
smart-link hold-time 50
smart-link enable
port GigabitEthernet0/0/7 master
port GigabitEthernet0/0/9 slave
#
interface GigabitEthernet0/0/7
port link-type trunk
port trunk allow-pass vlan 300
stp disable
#
interface GigabitEthernet0/0/9
port link-type trunk
port trunk allow-pass vlan 300
stp disable
#
```

LSW3:

```
<LSW3>display current-configuration interface GigabitEthernet 0/0/7
#
interface GigabitEthernet0/0/7
port link-type trunk
port trunk allow-pass vlan 300
stp edged-port enable
#
```

Verify the configuration:

LSW4:

```
<LSW4>display smart-link group 1
Smart Link group 1 information :
Smart Link group was enabled
There is no Load-Balance
There is no protected-vlan reference-instance
DeviceID: 4c1f-cc61-7413
Member          Role  State  Flush Count Last-Flush-Time
-----
GigabitEthernet0/0/7  Master Inactive 0      0000/00/00 00:00:00 UTC+00:00
GigabitEthernet0/0/9  Slave Active 0      0000/00/00 00:00:00 UTC+00:00

<LSW4>display smart-link protocol-parameter group 1
SMART-LINK Group 1:
*****
*Master Port Info:
IfIndex:      17(GigabitEthernet0/0/7)
PortStatus:   3(inactive)
LinkStatus:   1(up)
IFNET_S
SMLK Group ID: 1
MTLK Group ID: 0
Role:         1(master)
Ctrl Vlan:    0
Password:
*Slave Port Info:
IfIndex:      19(GigabitEthernet0/0/9)
PortStatus:   2(active)
LinkStatus:   1(up)
IFNET_S
SMLK Group ID: 1
MTLK Group ID: 0
Role:         2(slave)
CTRL Vlan:    0
Password:
*FSM Info:
CurrentState: 3(Slave)
TransEvent:   3(SMLK_EVT_MASTERLINKUP)
TransIfIndex: 17(GigabitEthernet0/0/7)
*Other Config:
LockForce:    0(unknown)
```

```
WtrTime:      60 sec.
RevertEnable: 0(disable)
GroupActive:   1(active)
MTLK Uplink:   0
RvtTimeCounter: 0 sec.
*Flush Send Info:
CTRL Vlan:     0
Password:
*1AG Event Info:
Event Type:    0
```

1.2. Spanning Tree configuration.

- Configure LSW1, LSW2 and LSW3 in MSTP region *primary* with two instances. The Following VLANs are mapped to each of the instances.

LSW1:

```
#
stp region-configuration
region-name primary
revision-level 1
instance 1 vlan 11 to 13 23 to 24 26 600 620 700
instance 2 vlan 32 to 34 42 to 43 45 47 500 610 710
active region-configuration
#
```

LSW2:

```
#
stp region-configuration
region-name primary
revision-level 1
instance 1 vlan 11 to 13 23 to 24 26 600 620 700
instance 2 vlan 32 to 34 42 to 43 45 47 500 610 710
active region-configuration
#
```

LSW3:

```
#
stp region-configuration
region-name primary
revision-level 1
instance 1 vlan 11 to 13 23 to 24 26 600 620 700
instance 2 vlan 32 to 34 42 to 43 45 47 500 610 710
active region-configuration
#
```

Verify the configuration:

LSW1:

```
<LSW1>display stp region-configuration
Oper configuration
Format selector :0
Region name :primary
Revision level :1

Instance VLANs Mapped
0 1 to 10, 14 to 22, 25, 27 to 31, 35 to 41, 44, 46, 48 to 499,
501 to 599, 601 to 609, 611 to 619, 621 to 699, 701 to 709, 711
to 4094
1 11 to 13, 23 to 24, 26, 600, 620, 700
2 32 to 34, 42 to 43, 45, 47, 500, 610, 710

<LSW1>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge :32768.4c1f-cc53-440c
Config Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 19
CIST Root/ERPC :4096.4c1f-ccb9-db98 / 0
CIST RegRoot/IRPC :4096.4c1f-ccb9-db98 / 1
CIST RootPortId :16.3
BPDU-Protection :Disabled
TC or TCN received :55
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 14h:36m:36s
Number of TC :15
Last TC occurred :Ethernet0/0/2
```

LSW2:

```
<LSW2>display stp region-configuration
Oper configuration
Format selector :0
Region name :primary
Revision level :1

Instance VLANs Mapped
0 1 to 10, 14 to 22, 25, 27 to 31, 35 to 41, 44, 46, 48 to 499,
501 to 599, 601 to 609, 611 to 619, 621 to 699, 701 to 709, 711
to 4094
1 11 to 13, 23 to 24, 26, 600, 620, 700
2 32 to 34, 42 to 43, 45, 47, 500, 610, 710

<LSW2>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge :4096.4c1f-ccb9-db98
Config Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC :4096.4c1f-ccb9-db98 / 0
CIST RegRoot/IRPC :4096.4c1f-ccb9-db98 / 0
```

```

CIST RootPortId   :0.0
BPDU-Protection   :Disabled
TC or TCN received :15
TC count per hello :0
STP Converge Mode  :Normal
Time since last TC :0 days 14h:42m:36s
Number of TC       :18
Last TC occurred   :Ethernet0/0/8

```

LSW3:

```

<LSW3>display stp region-configuration
Oper configuration
Format selector   :0
Region name       :primary
Revision level    :1

Instance  VLANs Mapped
0          1 to 10, 14 to 22, 25, 27 to 31, 35 to 41, 44, 46, 48 to 499,
          501 to 599, 601 to 609, 611 to 619, 621 to 699, 701 to 709, 711
          to 4094
1          11 to 13, 23 to 24, 26, 600, 620, 700
2          32 to 34, 42 to 43, 45, 47, 500, 610, 710

<LSW3>display stp
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge       :32768.4c1f-ccb9-5713
Config Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times      :Hello 2s MaxAge 20s FwDly 15s MaxHop 19
CIST Root/ERPC    :4096.4c1f-ccb9-db98 / 0
CIST RegRoot/IRPC :4096.4c1f-ccb9-db98 / 1
CIST RootPortId   :128.4
BPDU-Protection   :Disabled
TC or TCN received :65
TC count per hello :0
STP Converge Mode  :Normal
Time since last TC :0 days 14h:43m:46s
Number of TC       :17
Last TC occurred   :GigabitEthernet0/0/4

```

- Make sure that the root bridge for Instance 1 is LSW1, whereas for Instance 2 the root bridge is LSW2. LSW2 must be also nominated for CIST root bridge.

LSW1:

```

#
stp instance 1 priority 4096
#

```


LSW2:

```
#
stp instance 0 priority 4096
stp instance 2 priority 4096
#
```

Verify the configuration:

LSW1:

```
<LSW1>display stp instance 0
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge      :32768.4c1f-cc53-440c
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 19
CIST Root/ERPC   :4096.4c1f-ccb9-db98 / 0
CIST RegRoot/IRPC :4096.4c1f-ccb9-db98 / 1
CIST RootPortId  :16.3
BPDU-Protection  :Disabled
TC or TCN received :55
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 15h:1m:38s
Number of TC      :15
Last TC occurred  :Ethernet0/0/2

<LSW1>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID   :4096.4c1f-cc53-440c
MSTI RegRoot/IRPC :4096.4c1f-cc53-440c / 0
MSTI RootPortId  :0.0
Master Bridge    :4096.4c1f-ccb9-db98
Cost to Master    :1
TC received      :40
TC count per hello :0
Time since last TC :0 days 15h:1m:55s
Number of TC      :14
Last TC occurred  :Ethernet0/0/5

<LSW1>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID   :32768.4c1f-cc53-440c
MSTI RegRoot/IRPC :4096.4c1f-ccb9-db98 / 1
MSTI RootPortId  :16.3
Master Bridge    :4096.4c1f-ccb9-db98
Cost to Master    :1
TC received      :59
TC count per hello :0
Time since last TC :0 days 0h:0m:10s
Number of TC      :15
Last TC occurred  :Ethernet0/0/2
```

LSW2:

```
<LSW2>display stp instance 0
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge      :4096.4c1f-ccb9-db98
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :4096.4c1f-ccb9-db98 / 0
CIST RegRoot/IRPC :4096.4c1f-ccb9-db98 / 0
CIST RootPortId  :0.0
BPDU-Protection  :Disabled
TC or TCN received :15
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:16m:59s
Number of TC      :19
Last TC occurred  :Ethernet0/0/8
```

```
<LSW2>display stp instance 1
-----[MSTI 1 Global Info]-----
MSTI Bridge ID   :32768.4c1f-ccb9-db98
MSTI RegRoot/IRPC :4096.4c1f-cc53-440c / 22000
MSTI RootPortId  :128.3
Master Bridge    :4096.4c1f-ccb9-db98
Cost to Master    :0
TC received      :127
TC count per hello :0
Time since last TC :0 days 0h:19m:15s
Number of TC      :22
Last TC occurred  :Ethernet0/0/8
```

```
<LSW2>display stp instance 2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID   :4096.4c1f-ccb9-db98
MSTI RegRoot/IRPC :4096.4c1f-ccb9-db98 / 0
MSTI RootPortId  :0.0
Master Bridge    :4096.4c1f-ccb9-db98
Cost to Master    :0
TC received      :15
TC count per hello :0
Time since last TC :0 days 0h:19m:32s
Number of TC      :20
Last TC occurred  :Ethernet0/0/8
```

- On LSW1 interface GE 0/0/2 must be set to root for Instance 0 and Instance 2.

LSW1:

```
#
interface Ethernet0/0/2
 stp instance 0 port priority 16
 stp instance 2 port priority 16
#
```

Verify the configuration:

LSW1:

```
<LSW1>display stp instance 0 interface Ethernet0/0/2
-----[CIST Global Info][Mode MSTP]-----
CIST Bridge      :32768.4c1f-cc53-440c
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 19
CIST Root/ERPC   :4096.4c1f-ccb9-db98 / 0
CIST RegRoot/IRPC :4096.4c1f-ccb9-db98 / 1
CIST RootPortId  :16.3
BPDU-Protection  :Disabled
TC or TCN received :57
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 0h:29m:55s
Number of TC      :16
Last TC occurred  :Ethernet0/0/2
---[Port3(Ethernet0/0/2)][FORWARDING]----
Port Protocol     :Enabled
Port Role         :Root Port
Port Priority      :16
Port Cost(Dot1T ) :Config=auto / Active=1
Designated Bridge/Port :4096.4c1f-ccb9-db98 / 16.2
Port Edged        :Config=default / Active=disabled
Point-to-point    :Config=auto / Active=true
Transit Limit     :147 packets/hello-time
Protection Type   :Loop
Port STP Mode     :MSTP
Port Protocol Type :Config=auto / Active=dot1s
BPDU Encapsulation :Config=stp / Active=stp
PortTimes         :Hello 2s MaxAge 20s FwDly 15s RemHop 20
TC or TCN send    :4
TC or TCN received :27
BPDU Sent         :307496
                  TCN: 0, Config: 0, RST: 0, MST: 307496
BPDU Received     :307960
                  TCN: 0, Config: 0, RST: 0, MST: 307960

<LSW1>display stp instance 2 interface Ethernet0/0/2
-----[MSTI 2 Global Info]-----
MSTI Bridge ID    :32768.4c1f-cc53-440c
MSTI RegRoot/IRPC :4096.4c1f-ccb9-db98 / 1
MSTI RootPortId   :16.3
Master Bridge     :4096.4c1f-ccb9-db98
Cost to Master     :1
```

```

TC received      :59
TC count per hello :0
Time since last TC :0 days 0h:30m:8s
Number of TC      :15
Last TC occurred  :Ethernet0/0/2
----[Port3(Ethernet0/0/2)][FORWARDING]----
Port Role        :Root Port
Port Priority     :16
Port Cost(Dot1T) :Config=auto / Active=1
Designated Bridge/Port :4096.4c1f-ccb9-db98 / 16.2
Port Times       :RemHops 20
TC or TCN send   :4
TC or TCN received :27

```

- On LSW2 interface GE 0/0/3 and GE 0/0/4 must be blocked for Instance 1.

LSW2:

```

#
interface Ethernet0/0/3
 stp instance 1 cost 1000000
#
interface Ethernet0/0/4
 stp instance 1 cost 1000000
#

```

Verify the configuration:

LSW2:

```

<LSW2>display stp instance 1 interface Ethernet 0/0/3
-----[MSTI 1 Global Info]-----
MSTI Bridge ID      :32768.4c1f-ccb9-db98
MSTI RegRoot/IRPC   :4096.4c1f-cc53-440c / 200000
MSTI RootPortId     :128.1
Master Bridge       :4096.4c1f-ccb9-db98
Cost to Master      :0
TC received         :153
TC count per hello  :0
Time since last TC  :0 days 0h:0m:29s
Number of TC        :28
Last TC occurred    :Ethernet0/0/1
----[Port3(Ethernet0/0/3)][DISCARDING]----
Port Role           :Alternate Port
Port Priority        :128
Port Cost(Dot1T)    :Config=1000000 / Active=1000000
Designated Bridge/Port :32768.4c1f-ccbf-5713 / 128.3
Port Times          :RemHops 19
TC or TCN send      :1
TC or TCN received  :6

<LSW2>display stp instance 1 interface Ethernet 0/0/4
-----[MSTI 1 Global Info]-----
MSTI Bridge ID      :32768.4c1f-ccb9-db98

```

```

MSTI RegRoot/IRPC :4096.4c1f-cc53-440c / 200000
MSTI RootPortId :128.1
Master Bridge :4096.4c1f-ccb9-db98
Cost to Master :0
TC received :153
TC count per hello :0
Time since last TC :0 days 0h:0m:33s
Number of TC :28
Last TC occurred :Ethernet0/0/1
---[Port4(Ethernet0/0/4)][DISCARDING]---
Port Role :Alternate Port
Port Priority :128
Port Cost(Dot1T) :Config=1000000 / Active=1000000
Designated Bridge/Port :32768.4c1f-ccbf-5713 / 128.4
Port Times :RemHops 19
TC or TCN send :2
TC or TCN received :4

```

- On LSW3 interface Gi 0/0/4 must be the root for Instance 2.

LSW3:

```

#
interface GigabitEthernet0/0/4
 stp instance 2 port priority 16
#

```

Verify the configuration:

LSW3:

```

<LSW3>display stp instance 2 interface GigabitEthernet 0/0/4
-----[MSTI 2 Global Info]-----
MSTI Bridge ID :32768.4c1f-ccbf-5713
MSTI RegRoot/IRPC :4096.4c1f-ccb9-db98 / 1
MSTI RootPortId :16.4
Master Bridge :4096.4c1f-ccb9-db98
Cost to Master :1
TC received :83
TC count per hello :0
Time since last TC :0 days 5h:35m:48s
Number of TC :26
Last TC occurred :GigabitEthernet0/0/4
---[Port4(GigabitEthernet0/0/4)][FORWARDING]---
Port Role :Root Port
Port Priority :16
Port Cost(Dot1T) :Config=auto / Active=1
Designated Bridge/Port :4096.4c1f-ccb9-db98 / 16.4
Port Times :RemHops 20
TC or TCN send :1
TC or TCN received :2

```

- Configure Rapid STP on LSW4. Ensure that LSW4 does not become the CIST root bridge.

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LSW4:

```
#
stp mode rstp
#
```

Verify the configuration:

LSW4:

```
<LSW4>display stp
-----[CIST Global Info][Mode RSTP]-----
CIST Bridge      :32768.4c1f-cc61-7413
Config Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
Active Times     :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC   :4096.4c1f-ccb9-db98 / 1
CIST RegRoot/IRPC :32768.4c1f-cc61-7413 / 0
CIST RootPortId  :128.6
BPDU-Protection  :Disabled
TC or TCN received :71
TC count per hello :0
STP Converge Mode :Normal
Time since last TC :0 days 5h:54m:28s
Number of TC      :20
Last TC occurred  :GigabitEthernet0/0/6
```

- Make sure that if a superior BPDU message is received from LSW4 will not result in a root bridge change for the MST region.

LSW2:

```
<LSW2>display current-configuration interface Ethernet 0/0/8
#
interface Ethernet0/0/8
 stp root-protection
#
```

LSW3:

```
<LSW3>display current-configuration interface GigabitEthernet 0/0/6
#
interface GigabitEthernet0/0/6
 stp root-protection
#
```

Verify the configuration:

LSW3:

```
<LSW3>display stp brief
MSTID Port          Role STP State  Protection
0   GigabitEthernet0/0/6    DESI FORWARDING  ROOT
```

- Ensure that all switching ports connected to routers transition immediately to the STP forwarding state.

LSW1:

```
#
interface Eth-Trunk1
 stp edged-port enable
#
```

- Protect the interfaces which participate in a MST region from loops in case of lost BPDUs on the interface.

LSW1:

```
#
interface Ethernet0/0/2
 stp loop-protection
#
```

Verify the configuration:

LSW1:

```
<LSW1>display stp brief
```

MSTID	Port	Role	STP State	Protection
0	Ethernet0/0/1	ALTE	DISCARDING	<u>LOOP</u>
0	Ethernet0/0/2	ROOT	FORWARDING	<u>LOOP</u>
0	Ethernet0/0/5	DESI	FORWARDING	<u>LOOP</u>
0	Eth-Trunk1	DESI	FORWARDING	NONE
1	Ethernet0/0/1	DESI	FORWARDING	<u>LOOP</u>
1	Ethernet0/0/2	DESI	FORWARDING	<u>LOOP</u>
1	Ethernet0/0/5	DESI	FORWARDING	<u>LOOP</u>
1	Eth-Trunk1	DESI	FORWARDING	NONE
2	Ethernet0/0/1	ALTE	DISCARDING	<u>LOOP</u>
2	Ethernet0/0/2	ROOT	FORWARDING	<u>LOOP</u>
2	Ethernet0/0/5	DESI	FORWARDING	<u>LOOP</u>

1.3. L3 interface configuration

1.3.1. L3 address assignment.

- Configure the IP addresses from Table 3.

AR1:

```
<AR1>display current-configuration interface v111
[V200R003C00]
#
interface Vlanif11
 ip address 10.0.30.2 255.255.255.0
#
<AR1>display current-configuration interface lo0
[V200R003C00]
#
interface LoopBack0
 ip address 10.0.110.1 255.255.255.255
#
```


LSW1:

```
<LSW1>display current-configuration interface vl11
```

```
#
interface Vlanif11
ip address 10.0.30.1 255.255.255.0
#
```

```
<LSW1>display current-configuration interface lo0
```

```
#
interface LoopBack0
ip address 10.0.210.1 255.255.255.0
#
```

Verify the configuration:

AR1:

```
<AR1>display interface vl11
```

```
Vlanif11 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-10-28 06:09:34 UTC-08:00
Description:HUAWEI, AR Series, Vlanif11 Interface
Route Port,The Maximum Transmit Unit is 1500
Internet Address is 10.0.30.2/24
IP Sending Frames' Format is PKTFMT_ETHNT_2, Hardware address is 00e0-fc04-6280
Current system time: 2015-10-30 02:02:30-08:00
  Input bandwidth utilization : --
  Output bandwidth utilization : --
```

```
<AR1>display interface lo0
```

```
LoopBack0 current state : UP
Line protocol current state : UP (spoofing)
Description:HUAWEI, AR Series, LoopBack0 Interface
Route Port,The Maximum Transmit Unit is 1500
Internet Address is 10.0.110.1/32
Physical is Loopback
Current system time: 2015-10-30 02:02:45-08:00
  Last 300 seconds input rate 0 bits/sec, 0 packets/sec
  Last 300 seconds output rate 0 bits/sec, 0 packets/sec
  Realtime 0 seconds input rate 0 bits/sec, 0 packets/sec
  Realtime 0 seconds output rate 0 bits/sec, 0 packets/sec
  Input: 0 bytes
  Output:0 bytes
  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%
```

1.4. Frame Relay

1.4.1. Frame Relay between AR1, AR2 and AR4.

- Configure a full meshed Frame Relay network between AR1, AR2 and AR4 on the physical interfaces.
- Do not configure static mappings over these Frame Relay connections.

AR1:

```
<AR1>display current-configuration interface se3/0/0
[V200R003C00]
#
interface Serial3/0/0
 link-protocol fr
 ip address 10.0.10.1 255.255.255.128
#
```

AR2:

```
<AR2>display current-configuration interface se3/0/0
[V200R003C00]
#
interface Serial3/0/0
 link-protocol fr
 ip address 10.0.10.2 255.255.255.128
#
```

AR4:

```
<AR4>display current-configuration interface se3/0/0
[V200R003C00]
#
interface Serial3/0/0
 link-protocol fr
 ip address 10.0.10.4 255.255.255.128
#
```

Verify the configuration:

AR1:

```
<AR1>display fr map-info
Map Statistics for interface Serial3/0/0 (DTE)
 DLCI = 102, IP INARP 10.0.10.2, Serial3/0/0
   create time = 2015/10/21 05:26:20, status = ACTIVE
   encapsulation = ietf, vlink = 2, broadcast
 DLCI = 104, IP INARP 10.0.10.4, Serial3/0/0
   create time = 2015/10/21 05:26:15, status = ACTIVE
   encapsulation = ietf, vlink = 1, broadcast

<AR1>ping 10.0.10.2
PING 10.0.10.2: 56 data bytes, press CTRL_C to break
Reply from 10.0.10.2: bytes=56 Sequence=1 ttl=255 time=10 ms
```

```

Reply from 10.0.10.2: bytes=56 Sequence=2 ttl=255 time=20 ms
Reply from 10.0.10.2: bytes=56 Sequence=3 ttl=255 time=1 ms
Reply from 10.0.10.2: bytes=56 Sequence=4 ttl=255 time=10 ms

```

```

--- 10.0.10.2 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 1/10/20 ms

```

<AR1>ping 10.0.10.4

```

PING 10.0.10.4: 56 data bytes, press CTRL_C to break
Reply from 10.0.10.4: bytes=56 Sequence=1 ttl=255 time=20 ms
Reply from 10.0.10.4: bytes=56 Sequence=2 ttl=255 time=10 ms
Reply from 10.0.10.4: bytes=56 Sequence=3 ttl=255 time=20 ms
Reply from 10.0.10.4: bytes=56 Sequence=4 ttl=255 time=10 ms
Reply from 10.0.10.4: bytes=56 Sequence=5 ttl=255 time=20 ms

```

```

--- 10.0.10.4 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/16/20 ms

```

1.4.2. Frame Relay between AR6, AR7 and AR8.

- Configure Point-to-Point connections between AR6 and AR8, and between AR7 and AR8.
- You are not allowed to use Inverse ARP for Layer 3 to Layer 2 mappings.

AR6:

```

interface Serial3/0/0
 link-protocol fr
 undo fr inarp
#
interface Serial3/0/0.1
 fr dlci 608
 fr map ip 172.20.3.2 608 broadcast
 ip address 172.20.3.1 255.255.255.0
#

```

AR7:

```

#
interface Serial3/0/0
 link-protocol fr
 undo fr inarp
#
interface Serial3/0/0.1
 fr dlci 708
 fr map ip 172.20.4.2 708 broadcast
 ip address 172.20.4.1 255.255.255.0
#

```

AR8:

```
#
interface Serial3/0/0
 link-protocol fr
 undo fr inarp
#
interface Serial3/0/0.1
 fr dlci 806
 fr map ip 172.20.3.1 806 broadcast
 ip address 172.20.3.2 255.255.255.0
#
```

Verify the configuration:

AR6:

```
<AR6>display fr map-info
Map Statistics for interface Serial3/0/0 (DTE)
 DLCI = 608, IP 172.20.3.2, Serial3/0/0.1
  create time = 2015/10/21 05:25:25, status = ACTIVE
  encapsulation = ietf, vlink = 1, broadcast

<AR6>ping 172.20.3.2
PING 172.20.3.2: 56 data bytes, press CTRL_C to break
 Reply from 172.20.3.2: bytes=56 Sequence=1 ttl=255 time=10 ms
 Reply from 172.20.3.2: bytes=56 Sequence=2 ttl=255 time=10 ms
 Reply from 172.20.3.2: bytes=56 Sequence=3 ttl=255 time=20 ms
 Reply from 172.20.3.2: bytes=56 Sequence=4 ttl=255 time=10 ms
 Reply from 172.20.3.2: bytes=56 Sequence=5 ttl=255 time=10 ms

--- 172.20.3.2 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/12/20 ms
```

AR8:

```
<AR8>display fr map-info
Map Statistics for interface Serial3/0/0 (DTE)
 DLCI = 806, IP 172.20.3.1, Serial3/0/0.1
  create time = 2015/10/21 05:25:54, status = ACTIVE
  encapsulation = ietf, vlink = 1, broadcast
 DLCI = 807, IP 172.20.4.1, Serial3/0/0.2
  create time = 2015/10/21 05:25:55, status = ACTIVE
  encapsulation = ietf, vlink = 2, broadcast

<AR8>ping 172.20.3.1
PING 172.20.3.1: 56 data bytes, press CTRL_C to break
 Reply from 172.20.3.1: bytes=56 Sequence=1 ttl=255 time=20 ms
 Reply from 172.20.3.1: bytes=56 Sequence=2 ttl=255 time=20 ms
 Reply from 172.20.3.1: bytes=56 Sequence=3 ttl=255 time=20 ms
 Reply from 172.20.3.1: bytes=56 Sequence=4 ttl=255 time=10 ms
```

```

--- 172.20.3.1 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/17/20 ms

<AR8>ping 172.20.4.1
PING 172.20.4.1: 56 data bytes, press CTRL_C to break
 Reply from 172.20.4.1: bytes=56 Sequence=1 ttl=255 time=10 ms
 Reply from 172.20.4.1: bytes=56 Sequence=2 ttl=255 time=10 ms
 Reply from 172.20.4.1: bytes=56 Sequence=3 ttl=255 time=10 ms
 Reply from 172.20.4.1: bytes=56 Sequence=4 ttl=255 time=10 ms
 Reply from 172.20.4.1: bytes=56 Sequence=5 ttl=255 time=10 ms

--- 172.20.4.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/10/10 ms

```

1.5. PPP and HDLC configuration

1.5.1. PPP connection between AR2 and AR4.

- Configure PPP connection between AR2 and AR4.
- For increased security configure AR4 to issue three-way handshake unidirectional authentication for authenticating AR2 using username *Huawei* and password *workbook*.

AR2:

```

#
interface Serial3/0/1
 link-protocol ppp
 ppp chap user Huawei
 ppp chap password cipher %$%$Kxr94=5g@&5-*4$;S^[M,*Fg%$%$
 ip address 10.0.11.1 255.255.255.252 #

```

AR4:

```

#
aaa
 local-user huawei password cipher %$%$XK.XvFBz'5bkiQ{0VC8"+8w%$%$
 local-user huawei service-type ppp
#
#
interface Serial3/0/1
 link-protocol ppp
 ppp authentication-mode chap
 ip address 10.0.11.2 255.255.255.252
#

```

Verify the configuration:

AR2:

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<https://t.me/learningnets>

```

<AR2>display interface Serial 3/0/1
Serial3/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-10-21 05:26:24 UTC-08:00
Description:HUAWEI, AR Series, Serial3/0/1 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.0.11.1/30
Link layer protocol is PPP
LCP opened, IPCP opened
Last physical up time : 2015-10-21 05:26:21 UTC-08:00
Last physical down time : 2015-10-21 05:26:10 UTC-08:00
Current system time: 2015-10-30 23:02:31-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 6 bytes/sec 48 bits/sec 0 packets/sec
Last 300 seconds output rate 4 bytes/sec 32 bits/sec 0 packets/sec

Input: 168144 packets, 5380650 bytes
  Broadcast:      0, Multicast:      0
  Errors:         0, Runts:          0
  Giants:        0, CRC:            0

  Alignments:     0, Overruns:       0
  Dribbles:       0, Aborts:         0
  No Buffers:     0, Frame Error:    0

Output: 196176 packets, 3755758 bytes
  Total Error:    0, Overruns:       0
  Collisions:     0, Deferred:       0
  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%

<AR2>ping 10.0.11.2
PING 10.0.11.2: 56 data bytes, press CTRL_C to break
  Reply from 10.0.11.2: bytes=56 Sequence=1 ttl=255 time=10 ms
  Reply from 10.0.11.2: bytes=56 Sequence=2 ttl=255 time=10 ms
  Reply from 10.0.11.2: bytes=56 Sequence=3 ttl=255 time=10 ms
  Reply from 10.0.11.2: bytes=56 Sequence=4 ttl=255 time=20 ms

--- 10.0.11.2 ping statistics ---
  4 packet(s) transmitted
  4 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 10/12/20 ms

```

AR4:

```

<AR4>display interface Serial 3/0/1
Serial3/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-10-21 05:26:24 UTC-08:00
Description:HUAWEI, AR Series, Serial3/0/1 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.0.11.2/30
Link layer protocol is PPP
LCP opened, IPCP opened
Last physical up time : 2015-10-21 05:26:21 UTC-08:00
Last physical down time : 2015-10-21 05:25:04 UTC-08:00
Current system time: 2015-10-30 23:03:12-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 9 bytes/sec 72 bits/sec 0 packets/sec
Last 300 seconds output rate 2 bytes/sec 16 bits/sec 0 packets/sec

Input: 196305 packets, 7684604 bytes
  Broadcast:      0, Multicast:      0
  Errors:         0, Runts:          0
  Giants:        0, CRC:             0

  Alignments:     0, Overruns:       0
  Dribbles:       0, Aborts:         0
  No Buffers:     0, Frame Error:    0

Output: 168256 packets, 2019418 bytes
  Total Error:    0, Overruns:       0
  Collisions:     0, Deferred:       0
  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%

<AR4>ping 10.0.11.1
PING 10.0.11.1: 56 data bytes, press CTRL_C to break
  Reply from 10.0.11.1: bytes=56 Sequence=1 ttl=255 time=10 ms
  Reply from 10.0.11.1: bytes=56 Sequence=2 ttl=255 time=10 ms
  Reply from 10.0.11.1: bytes=56 Sequence=3 ttl=255 time=10 ms
  Reply from 10.0.11.1: bytes=56 Sequence=4 ttl=255 time=10 ms

--- 10.0.11.1 ping statistics ---
  4 packet(s) transmitted
  4 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 10/10/10 ms

```

1.5.2.HDLC connection between AR3 and AR5.

- Configure HDLC connection between AR3 and AR5.

AR3:

```
#
interface Serial3/0/0
link-protocol hdlc
ip address 10.10.10.1 255.255.255.252
```

AR5:

```
#
interface Serial3/0/0
link-protocol hdlc
ip address 10.10.10.2 255.255.255.252
#
```

Verify the configuration:

AR3:

```
<AR3>display interface Serial 3/0/0
Serial3/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-10-21 05:25:43 UTC-08:00
Description:HUAWEI, AR Series, Serial3/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.10.10.1/30
Link layer protocol is nonstandard HDLC
Last physical up time : 2015-10-21 05:25:43 UTC-08:00
Last physical down time : 2015-10-21 05:25:30 UTC-08:00
Current system time: 2015-10-30 23:13:12-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 13 bytes/sec 104 bits/sec 0 packets/sec
Last 300 seconds output rate 9 bytes/sec 72 bits/sec 0 packets/sec

Input: 178648 packets, 11965558 bytes
  Broadcast:      0, Multicast:      0
  Errors:         0, Runt:           0
  Giants:         0, CRC:            0

  Alignments:     0, Overruns:       0
  Dribbles:       0, Aborts:         0
  No Buffers:     0, Frame Error:    0

Output: 178229 packets, 8359459 bytes
  Total Error:    0, Overruns:       0
  Collisions:     0, Deferred:       0
  Input bandwidth utilization : 0%
  Output bandwidth utilization : 0%

<AR3>ping 10.10.10.2
PING 10.10.10.2: 56 data bytes, press CTRL_C to break
  Reply from 10.10.10.2: bytes=56 Sequence=1 ttl=255 time=20 ms
  Reply from 10.10.10.2: bytes=56 Sequence=2 ttl=255 time=20 ms
  Reply from 10.10.10.2: bytes=56 Sequence=3 ttl=255 time=20 ms
```

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```
Reply from 10.10.10.2: bytes=56 Sequence=4 ttl=255 time=10 ms
```

```
--- 10.10.10.2 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/17/20 ms
```

AR5:

```
<AR5>display interface se3/0/0
Serial3/0/0 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-10-21 05:25:43 UTC-08:00
Description:HUAWEI, AR Series, Serial3/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 10.10.10.2/30
Link layer protocol is nonstandard HDLC
Last physical up time : 2015-10-21 05:25:43 UTC-08:00
Last physical down time : 2015-10-21 05:25:00 UTC-08:00
Current system time: 2015-10-30 23:09:11-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 15 bytes/sec 120 bits/sec 0 packets/sec
Last 300 seconds output rate 10 bytes/sec 80 bits/sec 0 packets/sec
```

```
Input: 178254 packets, 11925837 bytes
```

```
Broadcast:      0, Multicast:      0
Errors:         0, Runts:          0
Giants:         0, CRC:            0
```

```
Alignments:     0, Overruns:       0
Dribbles:       0, Aborts:         0
No Buffers:     0, Frame Error:    0
```

```
Output: 178672 packets, 8393830 bytes
```

```
Total Error:    0, Overruns:       0
Collisions:     0, Deferred:       0
Input bandwidth utilization : 0%
Output bandwidth utilization : 0%
```

```
<AR5>ping 10.10.10.1
```

```
PING 10.10.10.1: 56 data bytes, press CTRL_C to break
```

```
Reply from 10.10.10.1: bytes=56 Sequence=1 ttl=255 time=10 ms
Reply from 10.10.10.1: bytes=56 Sequence=2 ttl=255 time=10 ms
Reply from 10.10.10.1: bytes=56 Sequence=3 ttl=255 time=10 ms
Reply from 10.10.10.1: bytes=56 Sequence=4 ttl=255 time=10 ms
```

```
--- 10.10.10.1 ping statistics ---
 4 packet(s) transmitted
 4 packet(s) received
 0.00% packet loss
 round-trip min/avg/max = 10/10/10 ms
```

1.5.3. PPP connection between AR7 and AR8.

- Configure PPP connection between AR7 and AR8.
- Configure bidirectional PAP authentication using router's usernames and password *security*.

AR7:

```
#
interface Serial3/0/1
 link-protocol ppp
 ppp authentication-mode pap
 ppp pap local-user AR7 password cipher %$%$<9hv(j;Y)WIK*4Jy^@BE,0xA%$%$
 ip address 172.20.5.1 255.255.255.0
#
```

AR8:

```
#
interface Serial3/0/1
 link-protocol ppp
 ppp authentication-mode pap
 ppp pap local-user AR8 password cipher %$%$8R+;5w&}^T^GqDY6lb+Q,0@L%$%$
 ip address 172.20.5.2 255.255.255.0
#
```

Verify the configuration:

AR7:

```
<AR7>display interface Serial 3/0/1
Serial3/0/1 current state : UP
Line protocol current state : UP
Last line protocol up time : 2015-10-21 05:26:01 UTC-08:00
Description:HUAWEI, AR Series, Serial3/0/1 Interface
Route Port,The Maximum Transmit Unit is 1500, Hold timer is 10(sec)
Internet Address is 172.20.5.1/24
Link layer protocol is PPP
LCP opened, IPCP opened
Last physical up time : 2015-10-21 05:25:58 UTC-08:00
Last physical down time : 2015-10-21 05:25:10 UTC-08:00
Current system time: 2015-10-30 23:41:19-08:00
Physical layer is synchronous, Virtualbaudrate is 64000 bps
Interface is DTE, Cable type is V11, Clock mode is TC
Last 300 seconds input rate 16 bytes/sec 128 bits/sec 0 packets/sec
Last 300 seconds output rate 12 bytes/sec 96 bits/sec 0 packets/sec

Input: 196736 packets, 14270623 bytes
Broadcast:      0, Multicast:      0
Errors:         0, Runts:         0
Giants:         0, CRC:          0

Alignments:     0, Overruns:      0
Dribbles:       0, Aborts:        0
No Buffers:     0, Frame Error:   0
```

Output: 196795 packets, 10353421 bytes

Total Error: 0, Overruns: 0

Collisions: 0, Deferred: 0

Input bandwidth utilization : 0%

Output bandwidth utilization : 0%

<AR7>**ping 172.20.5.2**

PING 172.20.5.2: 56 data bytes, press CTRL_C to break

Reply from 172.20.5.2: bytes=56 Sequence=1 ttl=255 time=10 ms

Reply from 172.20.5.2: bytes=56 Sequence=2 ttl=255 time=10 ms

Reply from 172.20.5.2: bytes=56 Sequence=3 ttl=255 time=10 ms

Reply from 172.20.5.2: bytes=56 Sequence=4 ttl=255 time=10 ms

--- 172.20.5.2 ping statistics ---

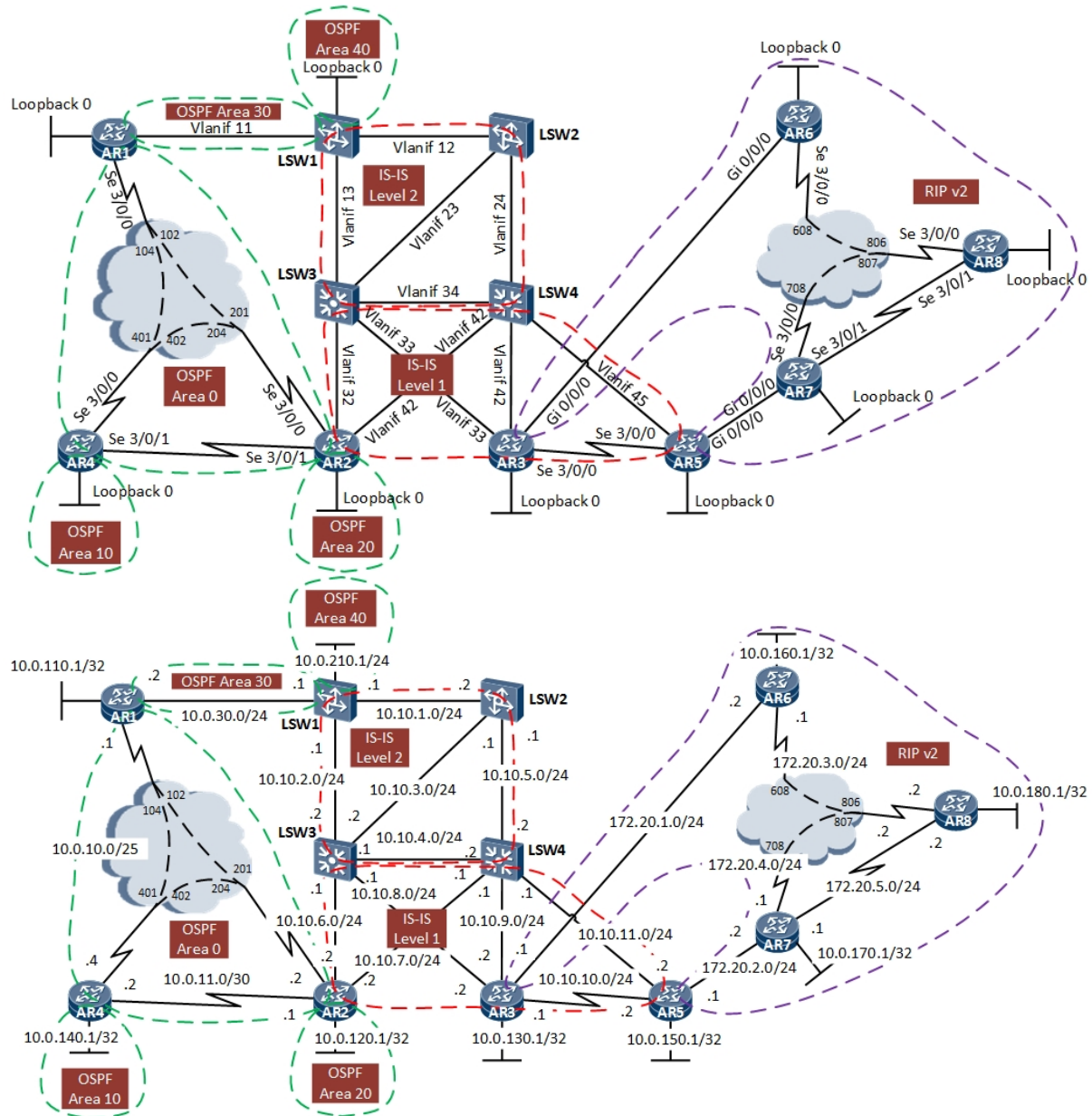
4 packet(s) transmitted

4 packet(s) received

0.00% packet loss

round-trip min/avg/max = 10/10/10 ms

2. IGP Network Configuration.



2.1. OSPF Area 0

- Configure Area 0 on the Frame Relay connection between AR1, AR2 and AR4.
- No DR and BDR election should be performed.
- You are not allowed to use the **peer** command.
- Configure area authentication using md5 encryption with password *workbook*.
- Make sure that Frame-relay subnet is seen on all routers with its correct mask.

AR1:

```

<AR1>display current-configuration section ospf
[V200R003C00]
#
ospf 1 router-id 10.0.110.1
asbr-summary 10.0.10.0 255.255.255.128
area 0.0.0.0
authentication-mode md5 1 cipher %$%$KZPeR$41pN`Zge*g4"|0']mI%$%$
network 10.0.10.0 0.0.0.127
network 10.0.100.0 0.0.0.255
#

<AR1>display current-configuration interface se3/0/0
[V200R003C00]
#
interface Serial3/0/0
ospf network-type p2mp
#

```

AR2:

```

<AR2>display current-configuration section ospf
[V200R003C00]
#
ospf 1 router-id 10.0.120.1
asbr-summary 10.0.10.0 255.255.255.128
area 0.0.0.0
authentication-mode md5 1 cipher %$%$[]L6I^\<;kfrP*Bd|~+'[CQ%$%$
network 1.1.1.1 0.0.0.0
network 10.0.10.0 0.0.0.127
network 10.0.200.0 0.0.0.255
#

#
interface Serial3/0/0
ip address 10.0.10.2 255.255.255.128
ospf network-type p2mp
#

```

AR4:

```

<AR4>display current-configuration section ospf
[V200R003C00]
#
ospf 1 router-id 10.0.140.1
asbr-summary 10.0.10.0 255.255.255.128
area 0.0.0.0
authentication-mode md5 1 cipher %$%$^Z7SV;q/0"vb-J3cObiN'dF8%$%$
network 10.0.10.0 0.0.0.127
#

#
interface Serial3/0/0
ip address 10.0.10.4 255.255.255.128

```

```
ospf network-type p2mp
#
```

Verify the configuration:

AR1:

```
<AR1>display ospf peer
```

```
      OSPF Process 1 with Router ID 10.0.110.1
      Neighbors
```

```
Area 0.0.0.0 interface 10.0.10.1(Serial3/0/0)'s neighbors
```

```
Router ID: 10.0.120.1    Address: 10.0.10.2
```

```
State: Full Mode:Nbr is Master Priority: 1
```

```
DR: None BDR: None MTU: 0
```

```
Dead timer due in 106 sec
```

```
Retrans timer interval: 0
```

```
Neighbor is up for 43:08:21
```

```
Authentication Sequence: [ 1268715]
```

```
Router ID: 10.0.140.1    Address: 10.0.10.4
```

```
State: Full Mode:Nbr is Master Priority: 1
```

```
DR: None BDR: None MTU: 0
```

```
Dead timer due in 91 sec
```

```
Retrans timer interval: 0
```

```
Neighbor is up for 43:08:09
```

```
Authentication Sequence: [ 1268030]
```

```
<AR1>display ospf lsdb
```

```
      OSPF Process 1 with Router ID 10.0.110.1
      Link State Database
```

```
      Area: 0.0.0.0
```

Type	LinkState ID	AdvRouter	Age	Len	Sequence	Metric
Router	10.0.110.1	10.0.110.1	695	72	800002DF	1
Router	10.0.120.1	10.0.120.1	654	84	800002D6	1
Router	10.0.140.1	10.0.140.1	548	60	800002CD	0
Sum-Net	10.0.120.1	10.0.120.1	457	28	800002C2	0
Sum-Net	10.0.30.0	10.0.110.1	901	28	80000057	1
Sum-Net	10.0.140.1	10.0.140.1	919	28	800002C1	0

AR2:

<AR2>display ospf peer

OSPF Process 1 with Router ID 10.0.120.1
Neighbors

Area 0.0.0.0 interface 10.0.10.2(Serial3/0/0)'s neighbors

Router ID: 10.0.110.1 Address: 10.0.10.1

State: Full Mode:Nbr is Slave Priority: 1

DR: None BDR: None MTU: 0

Dead timer due in 112 sec

Retrans timer interval: 5

Neighbor is up for 43:35:28

Authentication Sequence: [157071]

Router ID: 10.0.140.1 Address: 10.0.10.4

State: Full Mode:Nbr is Master Priority: 1

DR: None BDR: None MTU: 0

Dead timer due in 109 sec

Retrans timer interval: 5

Neighbor is up for 44:11:27

Authentication Sequence: [1269830]

AR4:

<AR4>display ospf peer

OSPF Process 1 with Router ID 10.0.140.1
Neighbors

Area 0.0.0.0 interface 10.0.10.4(Serial3/0/0)'s neighbors

Router ID: 10.0.110.1 Address: 10.0.10.1

State: Full Mode:Nbr is Slave Priority: 1

DR: None BDR: None MTU: 0

Dead timer due in 111 sec

Retrans timer interval: 0

Neighbor is up for 43:34:46

Authentication Sequence: [157070]

Router ID: 10.0.120.1 Address: 10.0.10.2

State: Full Mode:Nbr is Slave Priority: 1

DR: None BDR: None MTU: 0

Dead timer due in 118 sec

Retrans timer interval: 5

Neighbor is up for 44:10:56

Authentication Sequence: [1270515]

LSW1:

```
<LSW1>display ip routing-table 10.0.10.0
```

Route Flags: R - relay, D - download to fib

Routing Table : Public

Summary Count : 1

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.10.0/25	ISIS-L2	15	2	D	10.10.2.2	Vlanif13

2.2. OSPF Area 30 and Area 40

- Configure Area 30 between AR1 and LSW1. Make sure that no LSA4 and LSA5 are present in the OSPF database for Area 30.
- Configure Area 40 on interface Loopback 0 on LSW1. Make sure that Area 40 has reachability with other OSPF areas.
- Advertise Loopback 0 interface of AR1 in such a way that if any AR1 physical interface is down, the Loopback 0 is seen as NSSA route.
- Use IP address of the Loopback interface for an OSPF router-id where applicable.

AR1:

```
<AR1>display current-configuration section ospf
```

```
[V200R003C00]
```

```
#
```

```
ospf 1 router-id 10.0.110.1
```

```
filter-policy ip-prefix DIRECT export direct
```

```
import-route direct
```

```
area 0.0.0.30
```

```
network 10.0.30.0 0.0.0.255
```

```
nssa
```

```
#
```

```
<AR1>display current-configuration | include ip-prefix DIRECT
```

```
ip ip-prefix DIRECT index 10 permit 10.0.110.0 24 greater-equal 24 less-equal 32
```

LSW1:

```
ospf 1 router-id 10.0.210.1
```

```
import-route ospf 2
```

```
import-route isis 1 tag 200 route-policy I2O
```

```
area 0.0.0.30
```

```
network 10.0.30.0 0.0.0.255
```

```
nssa
```

```
#
```

```
ospf 2 router-id 10.0.210.1
```

```
area 0.0.0.40
```

```
network 10.0.210.0 0.0.0.255
```

```
#
```


Verify the configuration:

AR1:

<AR1>**display ospf peer vl11**

OSPF Process 1 with Router ID 10.0.110.1
Neighbors

Area 0.0.0.30 interface 10.0.30.2(Vlanif11)'s neighbors

Router ID: 10.0.210.1 Address: 10.0.30.1

State: Full Mode:Nbr is Master Priority: 1

DR: 10.0.30.1 BDR: 10.0.30.2 MTU: 0

Dead timer due in 36 sec

Retrans timer interval: 5

Neighbor is up for 92:01:45

Authentication Sequence: [0]

<AR1>**display ospf interface vl11**

OSPF Process 1 with Router ID 10.0.110.1
Interfaces

Interface: 10.0.30.2 (Vlanif11)

Cost: 1 State: BDR Type: Broadcast MTU: 1500

Priority: 1

Designated Router: 10.0.30.1

Backup Designated Router: 10.0.30.2

Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1

<AR1>**display ospf lsdb ase self-originate**

OSPF Process 1 with Router ID 10.0.110.1
Link State Database

Type : External

Ls id : 10.0.110.1

Adv rtr : 10.0.110.1

Ls age : 827

Len : 36

Options : E

seq# : 800000b9

chk ---- More ---- Net mask : 255.255.255.255

TOS 0 Metric: 1

E type : 2

Forwarding Address : 0.0.0.0

Tag : 1

Priority : Low

LSW1:

<LSW1>display ospf peer

OSPF Process 1 with Router ID 10.0.210.1
Neighbors

Area 0.0.0.30 interface 10.0.30.1(Vlanif11)'s neighbors

Router ID: 10.0.110.1 Address: 10.0.30.2

State: Full Mode:Nbr is Slave Priority: 1

DR: 10.0.30.1 BDR: 10.0.30.2 MTU: 0

Dead timer due in 35 sec

Retrans timer interval: 5

Neighbor is up for 92:24:43

Authentication Sequence: [0]

OSPF Process 2 with Router ID 10.0.210.1

<LSW1>display ospf lsdb

OSPF Process 1 with Router ID 10.0.210.1
Link State Database

Area: 0.0.0.30

Type	LinkState ID	AdvRouter	Age	Len	Sequence	Metric
Router	10.0.110.1	10.0.110.1	1224	36	80000330	1
Router	10.0.210.1	10.0.210.1	1171	36	8000033A	1
Network	10.0.30.1	10.0.210.1	1171	32	800000BB	0
Sum-Net	10.0.120.1	10.0.110.1	1036	28	800000BA	48
Sum-Net	10.0.100.0	10.0.110.1	1226	28	80000326	1
Sum-Net	1.1.1.1	10.0.110.1	1036	28	800000BA	48
Sum-Net	10.0.140.1	10.0.110.1	1023	28	800000BB	48
Sum-Net	10.0.200.0	10.0.110.1	1036	28	800000BA	49
Sum-Net	10.0.10.4	10.0.110.1	1023	28	800000BB	48
Sum-Net	10.0.10.1	10.0.110.1	1043	28	800000BA	0
Sum-Net	10.0.10.2	10.0.110.1	1036	28	800000BA	48
NSSA	10.10.5.0	10.0.210.1	1079	36	80000325	1
NSSA	172.20.5.0	10.0.210.1	1079	36	80000326	1
NSSA	10.10.2.0	10.0.210.1	1079	36	80000325	1
NSSA	172.20.2.0	10.0.210.1	1079	36	80000326	1
NSSA	10.10.3.0	10.0.210.1	1079	36	80000325	1
NSSA	172.20.3.0	10.0.210.1	1079	36	80000326	1
NSSA	10.10.1.0	10.0.210.1	1079	36	80000325	1
NSSA	172.20.1.0	10.0.210.1	1079	36	80000326	1
NSSA	10.0.230.0	10.0.210.1	1079	36	80000325	1
NSSA	10.10.10.0	10.0.210.1	1079	36	80000326	1
NSSA	10.10.11.0	10.0.210.1	1079	36	80000325	1
NSSA	10.10.8.0	10.0.210.1	1079	36	80000325	1
NSSA	10.10.9.0	10.0.210.1	1079	36	80000325	1
NSSA	10.0.10.0	10.0.210.1	1079	36	80000325	1
NSSA	10.0.11.0	10.0.210.1	1082	36	80000325	1
NSSA	10.0.11.2	10.0.210.1	1082	36	80000325	1
NSSA	10.0.130.0	10.0.210.1	1082	36	80000326	1
NSSA	10.0.210.0	10.0.210.1	1082	36	80000328	1

```

NSSA 172.20.160.0 10.0.210.1 1082 36 80000326 1
NSSA 10.0.220.0 10.0.210.1 1082 36 80000325 1
NSSA 3.3.3.0 10.0.210.1 1082 36 80000325 1
NSSA 172.20.170.0 10.0.210.1 1082 36 80000326 1
NSSA 10.0.240.0 10.0.210.1 1082 36 80000325 1
NSSA 10.0.150.0 10.0.210.1 1082 36 80000325 1
NSSA 172.20.180.0 10.0.210.1 1082 36 80000326 1
NSSA 10.10.6.0 10.0.210.1 1082 36 80000325 1
NSSA 10.10.7.0 10.0.210.1 1082 36 80000325 1
NSSA 10.10.4.0 10.0.210.1 1082 36 80000325 1
NSSA 172.20.4.0 10.0.210.1 1082 36 80000326 1
NSSA 0.0.0.0 10.0.110.1 1039 36 800000BA 1
NSSA 10.0.110.1 10.0.110.1 1039 36 800000C1 1

```

OSPF Process 2 with Router ID 10.0.210.1
Link State Database

Area: 0.0.0.40

Type	LinkState ID	AdvRouter	Age	Len	Sequence	Metric
Router	10.0.210.1	10.0.210.1	338	36	800000BD	0

<LSW1>display ip routing-table 10.0.110.1

Route Flags: R - relay, D - download to fib

Routing Table : Public

Summary Count : 1

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.110.1/32	O_NSSA	150	1	D	10.0.30.2	Vlanif11

2.3. OSPF Area 10 and Area 20

- Configure Area 10 and Area 20 for the Loopback 0 interfaces on AR4 and AR2 respectively. Those prefixes must appear as Inter Area routes in the OSPF database.
- For security reasons configure OSPF to not send Hello messages on those interfaces.

AR2:

```

<AR2>display current-configuration section ospf
[V200R003C00]
#
ospf 1 router-id 10.0.120.1
silent-interface LoopBack0
area 0.0.0.20
network 10.0.120.1 0.0.0.0
#

```

AR4:

```

<AR4>display current-configuration section ospf
[V200R003C00]
#
ospf 1 router-id 10.0.140.1

```

```
silent-interface LoopBack0
area 0.0.0.10
network 10.0.140.1 0.0.0.0
#
```

Verify the configuration:

AR2:

```
<AR2>display ospf interface lo0
```

```
OSPF Process 1 with Router ID 10.0.120.1
Interfaces
```

```
Interface: 10.0.120.1 (LoopBack0)
Cost: 0   State: P-2-P   Type: P2P   MTU: 1500
Timers: Hello 10 , Dead 40 , Poll 120 , Retransmit 5 , Transmit Delay 1
Silent interface, No hellos
```

AR1:

```
<AR1>display ip routing-table 10.0.120.1
```

```
Route Flags: R - relay, D - download to fib
```

```
-----
Routing Table : Public
```

```
Summary Count : 1
```

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface

10.0.120.1/32	OSPF	10	48	D	10.0.10.2	Serial3/0/0

```
<AR1>display ip routing-table 10.0.10.14
```

```
Route Flags: R - relay, D - download to fib
```

```
-----
Routing Table : Public
```

```
Summary Count : 1
```

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface

10.0.140.1/32	OSPF	10	48	D	10.0.10.4	Serial3/0/0

2.4. IS-IS Level 2

- Configure IS-IS Level 2 adjacencies using Area ID 49.0002 on LSW1, LSW2, LSW3 and LSW4.
- LSW1 and LSW2 must have only Level 2 IS-IS adjacencies.
- The Loopback0 subnets of LSW2, LSW3 and LSW4 should appear as internal IS-IS routes in the routing table.
- The interface cost must be based on the interface bandwidth.
- Configure IS-IS interface MD5 authentication using password *workbook*.

LSW1:

```
#
isis 1
 is-level level-2
 auto-cost enable
 network-entity 49.0002.1002.0010.0001.00
 is-name LSW1
#
interface Vlanif12
 ip address 10.10.1.1 255.255.255.0
 isis enable 1
 isis authentication-mode md5 EEidVzPI;YEBi%T]n/.I9P"#
#
interface Vlanif13
 ip address 10.10.2.1 255.255.255.0
 isis enable 1
 isis authentication-mode md5 gR`h+FB8+Su:|l#3M^#3p]L#
#
interface LoopBack0
 ip address 10.0.210.1 255.255.255.0
 isis enable 1
#
```

LSW2:

```
#
isis 1
 is-level level-2
 auto-cost enable
 network-entity 49.0002.1002.0020.0001.00
 is-name LSW2
#
interface Vlanif12
 ip address 10.10.1.2 255.255.255.0
 isis enable 1
 isis authentication-mode md5 czHs-^H04u:|l#3M^#36Su#
#
interface Vlanif23
 ip address 10.10.3.1 255.255.255.0
 isis enable 1
 isis authentication-mode md5 R2Ix0RYms!'eKRQqbl+O[RW#
#
interface Vlanif24
 ip address 10.10.5.1 255.255.255.0
 isis enable 1
 isis authentication-mode md5 M*poAx#HgCy~t+Byca8Y$+h#
#
interface LoopBack0
 ip address 10.0.220.1 255.255.255.0
 isis enable 1
#
```

LSW3:

```
#
isis 1
 auto-cost enable
 network-entity 49.0001.1002.0023.0001.00
 is-name LSW3
#
interface Vlanif13
 ip address 10.10.2.2 255.255.255.0
 isis enable 1
 isis authentication-mode md5 djKcXeOwEE:.`&R&e7S({]A#
#
interface Vlanif23
 ip address 10.10.3.2 255.255.255.0
 isis enable 1
 isis authentication-mode md5 ~83-5>o93Z^QW:LZJi;=2U*#
#
interface LoopBack0
 ip address 10.0.230.1 255.255.255.0
 isis enable 1
#
```

LSW4:

```
#
isis 1
 cost-style wide
 auto-cost enable
 network-entity 49.0001.1002.0024.0001.00
 is-name LSW4
 import-route isis level-2 into level-1
#
interface Vlanif1
#
interface Vlanif24
 ip address 10.10.5.2 255.255.255.0
 isis enable 1
 isis authentication-mode md5 \\ONMP{eT"EBi%T]n/.ILuG#
#
interface Vlanif34
 ip address 10.10.4.2 255.255.255.0
 isis enable 1
 isis authentication-mode md5 &haM:T<5]1o\lT0$,T(BVlH#
#
interface LoopBack0
 ip address 10.0.240.1 255.255.255.0
 isis enable 1
#
```

Verify the configuration:

LSW1:

<LSW1>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
LSW2	Vlanif12	LSW2.01	Up	8s	L2	64
LSW3	Vlanif13	LSW3.01	Up	8s	L2	64

Total Peer(s): 2

LSW2:

<LSW2>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
LSW1	Vlanif12	LSW2.01	Up	22s	L2	64
LSW3	Vlanif23	LSW3.02	Up	7s	L2	64
LSW4	Vlanif24	LSW2.03	Up	25s	L2	64

Total Peer(s): 3

LSW3:

<LSW3>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
LSW1	Vlanif13	LSW3.01	Up	22s	L2	64
LSW2	Vlanif23	LSW3.02	Up	24s	L2	64
AR2	Vlanif32	LSW3.03	Up	29s	L1	64
AR3	Vlanif33	LSW3.04	Up	28s	L1	64
LSW4	Vlanif34	LSW3.05	Up	22s	L1(L1L2)	64
LSW4	Vlanif34	LSW3.05	Up	22s	L2(L1L2)	64

Total Peer(s): 6

LSW4:

<LSW4>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
LSW2	Vlanif24	LSW2.03	Up	7s	L2	64
LSW3	Vlanif34	LSW3.05	Up	9s	L1(L1L2)	64
LSW3	Vlanif34	LSW3.05	Up	7s	L2(L1L2)	64
AR2	Vlanif42	LSW4.03	Up	25s	L1	64
AR3	Vlanif43	LSW4.04	Up	21s	L1	64
AR5	Vlanif45	LSW4.05	Up	20s	L1	64

Total Peer(s): 6

2.5. IS-IS Level 1

- Configure IS-IS Level 1 adjacencies using Area ID 49.001 on LSW3, LSW4, AR2, AR3 and AR5.
- AR2, AR3 and AR5 must have only Level 1 IS-IS adjacencies.
- The interface cost must be based on the interface bandwidth.
- Advertise the Loopback 0 interfaces of AR3 and AR5 as external routes. Make sure that the /24 subnet is only advertised.

AR2:

<AR2>display current-configuration section isis

[V200R003C00]

#

isis 1

is-level level-1

auto-cost enable

network-entity 49.0001.1000.1200.0001.00

is-name AR2

import-route direct level-1 tag 100

attached-bit avoid-learning

#

<AR2>display current-configuration interface

[V200R003C00]

#

interface Vlanif32

ip address 10.10.6.2 255.255.255.0

isis enable 1

#

interface Vlanif42

ip address 10.10.7.2 255.255.255.0

isis enable 1

#

AR3:

<AR3>display current-configuration section isis

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```

[V200R003C00]
#
isis 1
 is-level level-1
 auto-cost enable
 network-entity 49.0001.1000.0013.0001.00
 is-name AR3
 import-route direct level-1 route-policy LOOPBACK-ONLY
 attached-bit avoid-learning
#

<AR3>display current-configuration interface
[V200R003C00]
#
interface Vlanif33
 ip address 10.10.8.2 255.255.255.0
 isis enable 1
#
interface Vlanif43
 ip address 10.10.9.2 255.255.255.0
 isis enable 1
#
interface Serial3/0/0
 link-protocol hdlc
 ip address 10.10.10.1 255.255.255.252
 isis enable 1
#

<AR3>display current-configuration section route-policy
[V200R003C00]
#
route-policy LOOPBACK-ONLY permit node 1
 if-match ip-prefix LOOPBACK
#
ip ip-prefix LOOPBACK index 10 permit 10.0.130.0 24 greater-equal 24 less-equal 24
#

```

AR5:

```

<AR5>display current-configuration section isis
[V200R003C00]
#
isis 1
 is-level level-1
 auto-cost enable
 network-entity 49.0001.1000.1500.0001.00
 is-name AR5
 import-route direct level-1 route-policy LOOPBACK-ONLY
 attached-bit avoid-learning
#

<AR5>display current-configuration interface
[V200R003C00]
#

```

```

interface Vlanif45
ip address 10.10.11.2 255.255.255.0
isis enable 1
#
interface Serial3/0/0
link-protocol hdlc
ip address 10.10.10.2 255.255.255.252
isis enable 1
#

<AR5>display current-configuration section route-policy
[V200R003C00]
#
route-policy LOOPBACK-ONLY permit node 1
if-match ip-prefix LOOPBACK
#
ip ip-prefix LOOPBACK index 10 permit 10.0.130.0 24 greater-equal 24 less-equal 24
#

```

Verify the configuration:

AR2:

<AR2>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
LSW3	Vlanif32	LSW3.03	Up	8s	L1	64
LSW4	Vlanif42	LSW4.03	Up	8s	L1	64

Total Peer(s): 2

<AR2>display isis lsdb

Database information for ISIS(1)

Level-1 Link State Database

LSPID	Seq Num	Checksum	Holdtime	Length	ATT/P/OL
AR3.00-00	0x00000733	0x339a	682	117	0/0/0
AR3.00-01	0x0000072c	0x14c6	682	117	0/0/0
AR2.00-00*	0x00000742	0x74c3	1068	93	0/0/0
AR2.00-01*	0x00000751	0x3ab5	1068	202	0/0/0
AR5.00-00	0x0000073f	0xf965	552	94	0/0/0
AR5.00-01	0x0000073d	0xb2a	552	101	0/0/0
LSW3.00-00	0x00000721	0x3653	648	153	1/0/0
LSW3.03-00	0x0000071a	0xebf	648	54	0/0/0
LSW3.04-00	0x0000071a	0x2e9d	648	54	0/0/0
LSW3.05-00	0x0000071a	0xb304	648	54	0/0/0
LSW4.00-00	0x0000075a	0xcbc3	1164	220	1/0/0

```
LSW4.03-00      0x0000071f 0x4c2    1164    54    0/0/0
LSW4.04-00      0x0000071f 0x24a0    1164    54    0/0/0
LSW4.05-00      0x0000071f 0x328f    1164    54    0/0/0
```

Total LSP(s): 14

*(In TLV)-Leaking Route, *(By LSPID)-Self LSP, +-Self LSP(Extended),
ATT-Attached, P-Partition, OL-Overload

<AR2>**display ip routing-table protocol isis | include 0.0.0.0**

Route Flags: R - relay, D - download to fib

Public routing table : ISIS

Destinations : 27 Routes : 40

ISIS routing table status : <Active>

Destinations : 24 Routes : 35

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface

ISIS routing table status : <Inactive>

Destinations : 3 Routes : 5

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface

<AR2>**display ip routing-table 10.0.230.1**

Route Flags: R - relay, D - download to fib

Routing Table : Public

Summary Count : 1

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface

10.0.230.0/24	ISIS-L1	15	1	D	10.10.6.1	Vlanif32

AR3:

<AR3>**display isis peer**

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
LSW3	Vlanif33	LSW3.04	Up	7s	L1	64
LSW4	Vlanif43	LSW4.04	Up	8s	L1	64
AR5	S3/0/0	0000000001	Up	28s	L1	--

Total Peer(s): 3

AR5:

<AR5>display isis peer

Peer information for ISIS(1)

System Id	Interface	Circuit Id	State	HoldTime	Type	PRI
LSW4	Vlanif45	LSW4.05	Up	8s	L1	64
AR3	S3/0/0	0000000001	Up	25s	L1	--

Total Peer(s): 2

2.6. RIPv2 domain.

- Configure the RIPv2 protocol on AR3, AR5, AR6, AR7 and AR8.
- Make sure that AR3 and AR5 send RIPv2 updates only on the Gi0/0/0 interfaces.
- The PPP interface between AR7 and AR8 should function as the backup link in case of a Frame Relay interface failure.

AR3:

```
<AR3>display current-configuration section rip
[V200R003C00]
#
rip 1
undo summary
version 2
peer 172.20.1.2
network 172.20.0.0
silent-interface all
#
```

AR5:

```
<AR5>display current-configuration section rip
[V200R003C00]
#
rip 1
undo summary
version 2
peer 172.20.2.2
network 172.20.0.0
network 2.0.0.0
silent-interface all
#
```

AR6:

```
<AR6>display current-configuration section rip
[V200R003C00]
#
rip 1
undo summary
version 2
peer 172.20.1.1
network 172.20.0.0
silent-interface GigabitEthernet0/0/0
#
#
interface Serial3/0/0.1
fr dlci 608
fr map ip 172.20.3.2 608 broadcast
ip address 172.20.3.1 255.255.255.0
rip version 2 broadcast
```

AR7:

```

<AR7>display current-configuration section rip
[V200R003C00]
#
rip 1
undo summary
version 2
peer 172.20.2.1
network 172.20.0.0
silent-interface GigabitEthernet0/0/0
#
#
interface Serial3/0/0.1
fr dlci 708
fr map ip 172.20.4.2 708 broadcast
ip address 172.20.4.1 255.255.255.0
rip version 2 broadcast
#
interface Serial3/0/1
link-protocol ppp
ppp authentication-mode pap
ppp pap local-user AR7 password cipher %$%$<9hv(j;Y)WIK*4Jy^@BE,0xA%$%$
ip address 172.20.5.1 255.255.255.0
rip metricin 5
rip metricout 5
rip version 2 broadcast
#

```

AR8:

```

<AR8>display current-configuration section rip
[V200R003C00]
#
rip 1
undo summary
version 2
network 172.20.0.0
#
#
interface Serial3/0/0.1
fr dlci 806
fr map ip 172.20.3.1 806 broadcast
ip address 172.20.3.2 255.255.255.0
rip version 2 broadcast
#
interface Serial3/0/0.2
fr dlci 807
fr map ip 172.20.4.1 807 broadcast
ip address 172.20.4.2 255.255.255.0
rip version 2 broadcast
#

```

```

interface Serial3/0/1
link-protocol ppp
ppp authentication-mode pap
ppp pap local-user AR8 password cipher %$%$8R+;5w&}^T^GqDY6lb+Q,0@L%$%$
ip address 172.20.5.2 255.255.255.0
rip metricin 5
rip metricout 5
rip version 2 broadcast
#

```

Verify the configuration:

AR3:

<AR3>display rip 1 neighbor

IP Address	Interface	Type	Last-Heard-Time
172.20.1.2	GigabitEthernet0/0/0	RIP	0:0:3

Number of RIP routes : 11

AR5:

<AR5>display rip 1 neighbor

IP Address	Interface	Type	Last-Heard-Time
172.20.2.2	GigabitEthernet0/0/0	RIP	0:0:10

Number of RIP routes : 8

AR6:

<AR6>display rip 1 neighbor

IP Address	Interface	Type	Last-Heard-Time
172.20.1.1	GigabitEthernet0/0/0	RIP	0:0:32
Number of RIP routes : 1			
172.20.3.2	Serial3/0/0.1	RIP	0:0:2
Number of RIP routes : 9			

AR7:

<AR7>display rip 1 neighbor

IP Address	Interface	Type	Last-Heard-Time
172.20.2.1	GigabitEthernet0/0/0	RIP	0:0:14
Number of RIP routes : 4			
172.20.4.2	Serial3/0/0.1	RIP	0:0:17
Number of RIP routes : 4			

AR8:

<AR8>display rip 1 neighbor

```

-----
IP Address    Interface          Type  Last-Heard-Time
-----
172.20.3.1    Serial3/0/0.1      RIP   0:0:18
Number of RIP routes : 3
172.20.4.1    Serial3/0/0.2      RIP   0:0:6
Number of RIP routes : 7

```

<AR8>display ip routing-table protocol rip

Route Flags: R - relay, D - download to fib

Public routing table : RIP

Destinations : 9 Routes : 10

RIP routing table status : <Active>

Destinations : 9 Routes : 10

```

Destination/Mask  Proto  Pre Cost  Flags NextHop    Interface
-----
0.0.0.0/0         RIP    100 7      D 172.20.3.1      Serial3/0/0.1
                  RIP    100 7      D 172.20.4.1      Serial3/0/0.2
2.2.2.2/32        RIP    100 2      D 172.20.4.1      Serial3/0/0.2
10.0.100.0/24     RIP    100 2      D 172.20.4.1      Serial3/0/0.2
10.0.200.0/24     RIP    100 2      D 172.20.4.1      Serial3/0/0.2
172.20.1.0/24     RIP    100 1      D 172.20.3.1      Serial3/0/0.1
172.20.2.0/24     RIP    100 1      D 172.20.4.1      Serial3/0/0.2
172.20.100.0/24   RIP    100 1      D 172.20.4.1      Serial3/0/0.2
172.20.160.0/24   RIP    100 1      D 172.20.3.1      Serial3/0/0.1
172.20.170.0/24   RIP    100 1      D 172.20.4.1      Serial3/0/0.2

```

RIP routing table status : <Inactive>

Destinations : 0 Routes : 0

<AR8>system-view

Enter system view, return user view with Ctrl+Z.

[AR8]interface Serial 3/0/0

[AR8-Serial3/0/0]shutdown

Nov 11 2015 01:44:57-08:00 AR8 %%01IFPDT/4/IF_STATE(1)[0]:Interface Serial3/0/0 has turned into DOWN state.

<AR8>display ip routing-table protocol rip

Route Flags: R - relay, D - download to fib

Public routing table : RIP

Destinations : 10 Routes : 10

RIP routing table status : <Active>

Destinations : 10 Routes : 10

```

Destination/Mask  Proto  Pre Cost  Flags NextHop    Interface
-----
2.2.2.2/32        RIP    100 11     D 172.20.5.1      Serial3/0/1

```



```

10.0.100.0/24 RIP 100 11 D 172.20.5.1 Serial3/0/1
10.0.200.0/24 RIP 100 11 D 172.20.5.1 Serial3/0/1
172.20.1.0/24 RIP 100 12 D 172.20.5.1 Serial3/0/1
172.20.2.0/24 RIP 100 10 D 172.20.5.1 Serial3/0/1
172.20.3.0/24 RIP 100 11 D 172.20.5.1 Serial3/0/1
172.20.4.0/24 RIP 100 10 D 172.20.5.1 Serial3/0/1
172.20.100.0/24 RIP 100 10 D 172.20.5.1 Serial3/0/1
172.20.160.0/24 RIP 100 12 D 172.20.5.1 Serial3/0/1
172.20.170.0/24 RIP 100 10 D 172.20.5.1 Serial3/0/1

```

RIP routing table status : <Inactive>
Destinations : 0 Routes : 0

<AR8>**system-view**

Enter system view, return user view with Ctrl+Z.

[AR8]**interface Serial 3/0/0**

[AR8-Serial3/0/0]**undo shutdown**

2.7. Redistribution between OSPF and IS-IS

- Make sure that the OSPF domain has full reachability with the rest of the network. Configure mutual redistribution between OSPF and IS-IS routing protocols. Make sure that all routes are redistributed.
- Use route tags to resolve suboptimal routing issues.
- A failure of AR2 should not limit the reachability to OSPF domain.
- Ensure that devices in the IS-IS Level 1 domain can make optimal routing decisions for the destinations in the OSPF domain. No default routes must be learned from IS-IS Level-1-2 routers.

AR2:

```

<AR2>display current-configuration section isis
[V200R003C00]
#
isis 1
 is-level level-1
 cost-style wide
 auto-cost enable
 network-entity 49.0001.1000.1200.0001.00
 is-name AR2
 import-route direct level-1 tag 100
 import-route ospf 1 level-1 tag 100 route-policy O2I
 attached-bit avoid-learning
#
#
route-policy O2I deny node 1
 if-match tag 200
#
route-policy O2I permit node 3
#
#
ospf 1 router-id 10.0.120.1

```

```

asbr-summary 10.0.10.0 255.255.255.128
import-route isis 1 tag 200 route-policy I2O
silent-interface LoopBack0
area 0.0.0.0
authentication-mode md5 1 cipher %$%$[]L6I'\<;kfrP*Bd|~+'[CQ%$%$
network 1.1.1.1 0.0.0.0
network 10.0.10.0 0.0.0.127
network 10.0.200.0 0.0.0.255
area 0.0.0.20
network 10.0.120.1 0.0.0.0
#
#
route-policy I2O deny node 1
if-match tag 100
#
route-policy I2O permit node 2
#

```

LSW1:

```

#
isis 1
is-level level-2
cost-style wide
auto-cost enable
network-entity 49.0002.1002.0010.0001.00
is-name LSW1
import-route direct tag 100
import-route ospf 2 tag 100
import-route ospf 1 inherit-cost tag 100 route-policy O2I
#
#
ospf 1 router-id 10.0.210.1
import-route ospf 2
import-route isis 1 tag 200 route-policy I2O
area 0.0.0.30
network 10.0.30.0 0.0.0.255
nssa
#
#
route-policy O2I deny node 1
if-match tag 200
#
route-policy O2I permit node 3
#
route-policy I2O deny node 1
if-match tag 100
#
route-policy I2O permit node 2
#

```

Verify the configuration:

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<https://t.me/learningnets>

AR1:

<AR1>display ospf routing

OSPF Process 1 with Router ID 10.0.110.1
Routing Tables

Routing for Network

Destination	Cost	Type	NextHop	AdvRouter	Area
10.0.10.1/32	0	Stub	10.0.10.1	10.0.110.1	0.0.0.0
10.0.30.0/24	1	Transit	10.0.30.2	10.0.110.1	0.0.0.30
10.0.100.0/24	1	Stub	10.0.100.1	10.0.110.1	0.0.0.0
1.1.1.1/32	48	Stub	10.0.10.2	10.0.120.1	0.0.0.0
10.0.10.2/32	48	Stub	10.0.10.2	10.0.120.1	0.0.0.0
10.0.10.4/32	48	Stub	10.0.10.4	10.0.140.1	0.0.0.0
10.0.120.1/32	48	Inter-area	10.0.10.2	10.0.120.1	0.0.0.0
10.0.140.1/32	48	Inter-area	10.0.10.4	10.0.140.1	0.0.0.0
10.0.200.0/24	49	Stub	10.0.10.2	10.0.120.1	0.0.0.0

Routing for ASEs

Destination	Cost	Type	Tag	NextHop	AdvRouter
172.20.100.0/24	1	Type2	1	10.0.10.2	10.0.120.1

Routing for NSSAs

Destination	Cost	Type	Tag	NextHop	AdvRouter
10.0.130.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.0.150.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.0.210.0/24	1	Type2	1	10.0.30.1	10.0.210.1
10.0.220.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.0.230.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.0.240.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.1.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.2.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.3.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.4.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.5.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.6.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.7.0/24	1	Type2	200	10.0.30.1	10.0.210.1
10.10.8.0/24	1	Type2	200	10.0.30.1	10.0.210.1

LSW3:

<LSW3>display ip routing-table 10.0.10.0 25 verbose

Route Flags: R - relay, D - download to fib

Routing Table : Public

Summary Count : 1

Destination: 10.0.10.0/25

Protocol: ISIS-L1 Process ID: 1

Preference: 15 Cost: 1

NextHop: 10.10.6.2 Neighbour: 0.0.0.0

State: Active Adv Age: 21d02h02m53s

Tag: 100 Priority: low

Label: NULL QoSInfo: 0x0

IndirectID: 0x0	
RelayNextHop: 0.0.0.0	Interface: Vlanif32
TunnelID: 0x0	Flags: D

2.8. Redistribution between IS-IS and RIPv2

- Redistribute only a single default route from the IS-IS domain towards the RIPv2 domain. You may configure a single static route to accomplish this task.
- IS-IS routers should have every RIPv2 route .
- Be sure that no routing loops/ suboptimal routing is/are present in the IS-IS domain. You are not allowed to use route tags. Any changes should only affect the 172.20/16 subnets.
- AR3 must reach the RIPv2 domain using the lowest hop count possible.

AR3:

```
<AR3>display current-configuration section isis
[V200R003C00]
#
isis 1
 is-level level-1
 cost-style wide
 auto-cost enable
 network-entity 49.0001.1000.0013.0001.00
 is-name AR3
 import-route direct level-1 route-policy LOOPBACK-ONLY
 import-route rip 1 level-1
 attached-bit avoid-learning
 preference 110 route-policy RIP_PREFERENCE
#
<AR3>display current-configuration section rip
[V200R003C00]
#
rip 1
 undo summary
 default-route originate cost 5
 version 2
 peer 172.20.1.2
 network 172.20.0.0
 silent-interface all
#
<AR3>display current-configuration section route-policy
[V200R003C00]
#
route-policy RIP_PREFERENCE permit node 1
 if-match ip-prefix RIP_ROUTES
#
route-policy LOOPBACK-ONLY permit node 1
 if-match ip-prefix LOOPBACK
#
ip ip-prefix RIP_ROUTES index 10 permit 172.20.0.0 16 greater-equal 16 less-equal 32
ip ip-prefix LOOPBACK index 10 permit 10.0.130.0 24 greater-equal 24 less-equal 24
```

AR5:

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```
<AR5>display current-configuration section isis
[V200R003C00]
#
isis 1
 is-level level-1
 cost-style wide
 auto-cost enable
 network-entity 49.0001.1000.1500.0001.00
 is-name AR5
 import-route direct level-1 route-policy LOOPBACK-ONLY
 import-route rip 1 level-1
 attached-bit avoid-learning
 preference 110 route-policy RIP_PREFERENCE
#
return
<AR5>display current-configuration section rip
[V200R003C00]
#
rip 1
 undo summary
 default-route originate cost 5
 version 2
 peer 172.20.2.2
 network 172.20.0.0
 silent-interface all
#

<AR5>display current-configuration interface vl45
[V200R003C00]
#
interface Vlanif45
 ip address 10.10.11.2 255.255.255.0
 isis enable 1
 isis cost 1000
#

<AR5>display current-configuration section route-policy
[V200R003C00]
#
route-policy RIP_PREFERENCE permit node 1
 if-match ip-prefix RIP_ROUTES
#
route-policy LOOPBACK-ONLY permit node 1
 if-match ip-prefix LOOPBACK
#
ip ip-prefix RIP_ROUTES index 10 permit 172.20.0.0 16 greater-equal 16 less-equal 32
ip ip-prefix LOOPBACK index 10 permit 10.0.150.0 24 greater-equal 24 less-equal 24
```

LSW4:

```
#
interface Vlanif45
ip address 10.10.11.1 255.255.255.0
isis enable 1
#
```

Verify the configuration:

AR8:

<AR8>**display ip routing-table protocol rip**

Route Flags: R - relay, D - download to fib

Public routing table : RIP

Destinations : 9 Routes : 10

RIP routing table status : <Active>

Destinations : 9 Routes : 10

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
0.0.0.0/0	RIP	100	7	D	172.20.3.1	Serial3/0/0.1
	RIP	100	7	D	172.20.4.1	Serial3/0/0.2
2.2.2.2/32	RIP	100	2	D	172.20.4.1	Serial3/0/0.2
10.0.100.0/24	RIP	100	2	D	172.20.4.1	Serial3/0/0.2
10.0.200.0/24	RIP	100	2	D	172.20.4.1	Serial3/0/0.2
172.20.1.0/24	RIP	100	1	D	172.20.3.1	Serial3/0/0.1
172.20.2.0/24	RIP	100	1	D	172.20.4.1	Serial3/0/0.2
172.20.100.0/24	RIP	100	1	D	172.20.4.1	Serial3/0/0.2
172.20.160.0/24	RIP	100	1	D	172.20.3.1	Serial3/0/0.1
172.20.170.0/24	RIP	100	1	D	172.20.4.1	Serial3/0/0.2

RIP routing table status : <Inactive>

Destinations : 0 Routes : 0

LSW4:

<LSW4>display ip routing-table protocol isis

Route Flags: R - relay, D - download to fib

Public routing table : ISIS

Destinations : 33 Routes : 48

ISIS routing table status : <Active>

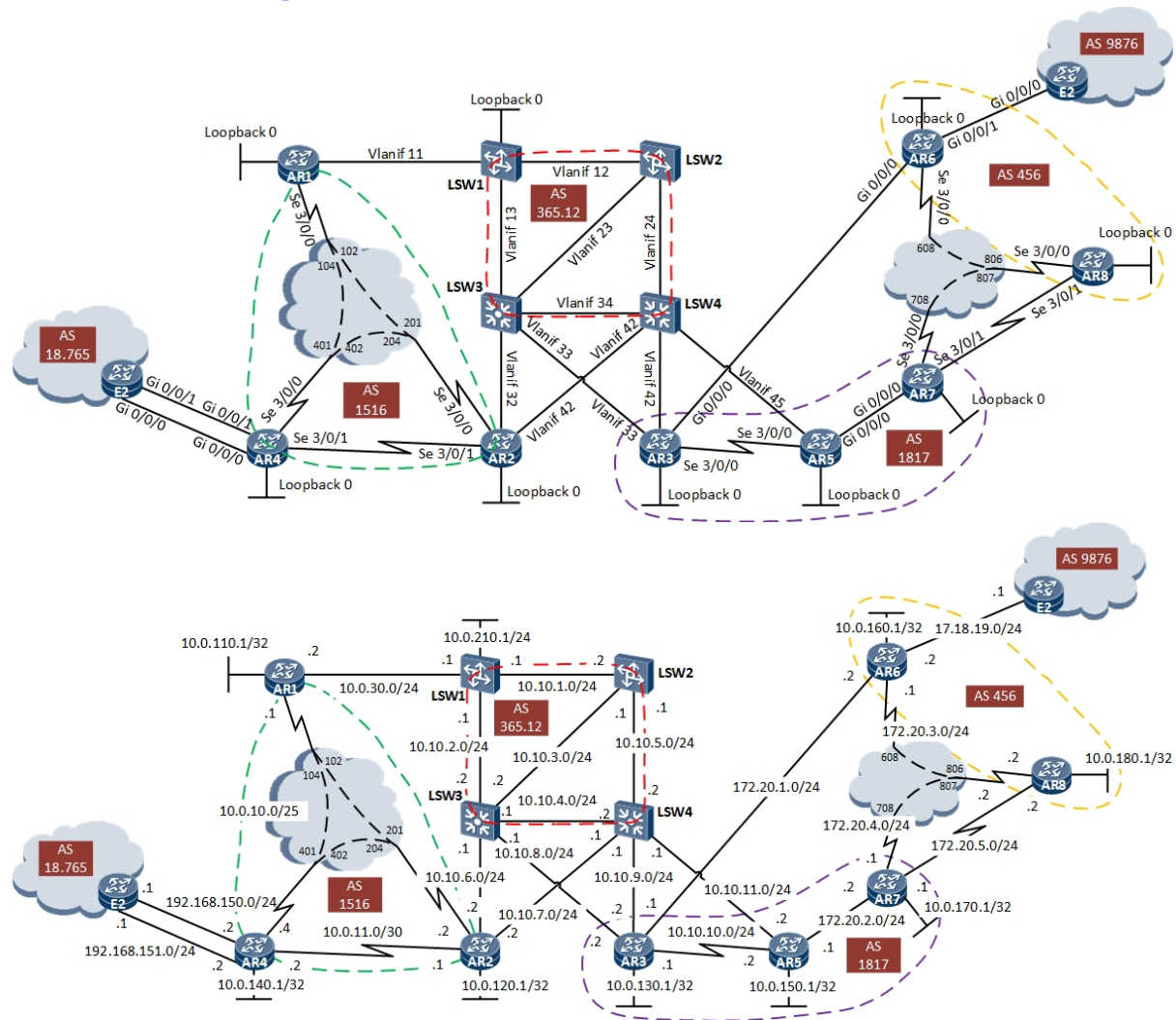
Destinations : 33 Routes : 48

```
172.20.1.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
172.20.2.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
172.20.3.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
172.20.4.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
172.20.5.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
172.20.160.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
172.20.170.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
172.20.180.0/24 ISIS-L1 15 1 D 10.10.11.2 Vlanif45
      ISIS-L1 15 1 D 10.10.9.2 Vlanif43
```

ISIS routing table status : <Inactive>

Destinations : 0 Routes : 0

Task 3: BGP configuration



3.1. Configure the following AS numbers on the devices in following table.

Device	AS number
AR1	1516
AR2	1516
AR3	1817
AR4	1516
AR5	1817
AR6	456
AR7	1817
AR8	456
LSW1	365.12
LSW2	365.12
LSW3	365.12
LSW4	365.12

3.2. Configure the BGP peering sessions as shown in the following table.

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Peer 1	Peer 2	Peering interface
AR1	LSW1	Loopback0
AR1	AR4	Loopback0
AR1	AR2	Loopback0
AR2	AR4	Loopback0
AR2	LSW3	Loopback0
AR2	LSW4	Loopback0
AR2	AR3	Loopback0
AR3	LSW3	Direct
AR3	LSW4	Direct
AR3	AR5	Loopback0
AR3	AR7	Loopback0
AR3	AR6	Direct
AR4	E1	Loopback0
AR5	AR7	Loopback0
AR6	AR7	Loopback0
AR6	AR8	Loopback0
AR6	E2	Direct
LSW1	LSW2	Loopback0
LSW1	LSW3	Loopback0
LSW1	LSW4	Loopback0

- Configure LSW1 as Route Reflector for LSW2, LSW3 and LSW4 BGP routers. Make sure that the BGP sessions are authenticated with md5 password *workbook*.
- All iBGP routes in any AS should have local address for next-hop attribute.
- Configure additional interfaces on AR4 and AR6 for the peering sessions with E1 (AS18.765) and E2(9876). Following table contents the additional interface information.

Device	Interface	IP address
AR4	Gi 0/0/0	192.168.150.2/24
	Gi 0/0/1	192.168.151.2/24
AR6	Gi 0/0/1	17.18.19.2/24
E1	Gi 0/0/0	192.168.150.2/24
	Gi 0/0/1	192.168.151.2/24
	Loopback 0	15.15.15.15/32

- You are allowed to use a static routes for the peering session between E1 and AR4.

AR1:

```
<AR1>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
peer 10.0.120.1 as-number 1516
peer 10.0.120.1 connect-interface LoopBack0
peer 10.0.140.1 as-number 1516
peer 10.0.140.1 connect-interface LoopBack0
peer 10.0.210.1 as-number 365.12
peer 10.0.210.1 ebgp-max-hop 2
```

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```

peer 10.0.210.1 connect-interface LoopBack0
#
ipv4-family unicast
undo synchronization
peer 10.0.120.1 enable
peer 10.0.120.1 next-hop-local
peer 10.0.120.1 advertise-community
peer 10.0.140.1 enable
peer 10.0.140.1 next-hop-local
peer 10.0.140.1 advertise-community
peer 10.0.210.1 enable
peer 10.0.210.1 advertise-community
peer 10.0.210.1 advertise-ext-community
#

```

AR2:

```

<AR2>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
peer 10.0.110.1 as-number 1516
peer 10.0.110.1 connect-interface LoopBack0
peer 10.0.130.1 as-number 1817
peer 10.0.130.1 ebgp-max-hop 3
peer 10.0.130.1 connect-interface LoopBack0
peer 10.0.140.1 as-number 1516
peer 10.0.140.1 connect-interface LoopBack0
peer 10.0.230.1 as-number 365.12
peer 10.0.230.1 ebgp-max-hop 255
peer 10.0.230.1 connect-interface LoopBack0
peer 10.0.240.1 as-number 365.12
peer 10.0.240.1 ebgp-max-hop 255
peer 10.0.240.1 connect-interface LoopBack0
#
ipv4-family unicast
undo synchronization
peer 10.0.110.1 enable
peer 10.0.110.1 next-hop-local
peer 10.0.110.1 advertise-community
peer 10.0.130.1 enable
peer 10.0.130.1 advertise-community
peer 10.0.140.1 enable
peer 10.0.140.1 next-hop-local
peer 10.0.140.1 advertise-community
peer 10.0.230.1 enable
peer 10.0.230.1 advertise-community
peer 10.0.240.1 enable
peer 10.0.240.1 advertise-community
#

```

AR3:

```

<AR3>display current-configuration section bgp
[V200R003C00]
#
bgp 1817
peer 10.0.120.1 as-number 1516
peer 10.0.120.1 ebgp-max-hop 3
peer 10.0.120.1 connect-interface LoopBack0
peer 10.0.150.1 as-number 1817
peer 10.0.150.1 connect-interface LoopBack0
peer 10.10.8.1 as-number 365.12
peer 10.10.9.1 as-number 365.12
peer 172.20.1.2 as-number 456
peer 172.20.170.1 as-number 1817
peer 172.20.170.1 connect-interface LoopBack0
peer ::172.20.180.1 as-number 456
#
ipv4-family unicast
undo synchronization
peer 10.0.120.1 enable
peer 10.0.120.1 advertise-community
peer 10.0.150.1 enable
peer 10.0.150.1 next-hop-local
peer 10.0.150.1 advertise-community
peer 10.10.8.1 enable
peer 10.10.8.1 advertise-community
peer 10.10.9.1 enable
peer 10.10.9.1 advertise-community
peer 172.20.1.2 enable
peer 172.20.170.1 enable
peer 172.20.170.1 next-hop-local
peer 172.20.170.1 advertise-community
#

```

AR4:

```

<AR4>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
peer 10.0.110.1 as-number 1516
peer 10.0.110.1 connect-interface LoopBack0
peer 10.0.120.1 as-number 1516
peer 10.0.120.1 connect-interface LoopBack0
peer 15.15.15.15 as-number 18.765
peer 15.15.15.15 ebgp-max-hop 2
peer 15.15.15.15 connect-interface LoopBack0
#
ipv4-family unicast
undo synchronization
peer 10.0.110.1 enable
peer 10.0.110.1 next-hop-local
peer 10.0.110.1 advertise-community
peer 10.0.120.1 enable
peer 10.0.120.1 next-hop-local

```

```
peer 10.0.120.1 advertise-community
peer 15.15.15.15 enable
peer 15.15.15.15 advertise-community
#

<AR4>display current-configuration | include static
ip route-static 15.15.15.15 255.255.255.255 192.168.150.1
ip route-static 15.15.15.15 255.255.255.255 192.168.151.1
#
```

AR5:

```
<AR5>display current-configuration section bgp
[V200R003C00]
#
bgp 1817
peer 10.0.130.1 as-number 1817
peer 10.0.130.1 connect-interface LoopBack0
peer 172.20.170.1 as-number 1817
peer 172.20.170.1 connect-interface LoopBack0
#
ipv4-family unicast
undo synchronization
network 10.0.0.0 255.255.0.0
peer 10.0.130.1 enable
peer 10.0.130.1 advertise-community
peer 172.20.170.1 enable
peer 172.20.170.1 advertise-community
#
```

AR6:

```
<AR6>display current-configuration section bgp
[V200R003C00]
#
bgp 456
peer 17.18.19.1 as-number 9876
peer 17.18.19.1 fake-as 654
peer 172.20.1.1 as-number 1817
peer 172.20.170.1 as-number 1817
peer 172.20.170.1 ebgp-max-hop 3
peer 172.20.170.1 connect-interface LoopBack0
peer 172.20.180.1 as-number 456
peer 172.20.180.1 connect-interface LoopBack0
#
ipv4-family unicast
undo synchronization
peer 17.18.19.1 enable
```

```

peer 17.18.19.1 advertise-community
peer 172.20.1.1 enable
peer 172.20.170.1 enable
peer 172.20.170.1 advertise-community
peer 172.20.180.1 enable
peer 172.20.180.1 next-hop-local
peer 172.20.180.1 advertise-community
#

```

AR7:

```

<AR7>display current-configuration section bgp
[V200R003C00]
#
bgp 1817
peer 10.0.130.1 as-number 1817
peer 10.0.130.1 connect-interface LoopBack0
peer 10.0.150.1 as-number 1817
peer 10.0.150.1 connect-interface LoopBack0
peer 172.20.160.1 as-number 456
peer 172.20.160.1 ebgp-max-hop 3
peer 172.20.160.1 connect-interface LoopBack0
#
ipv4-family unicast
undo synchronization
peer 10.0.130.1 enable
peer 10.0.130.1 next-hop-local
peer 10.0.130.1 advertise-community
peer 10.0.150.1 enable
peer 10.0.150.1 next-hop-local
peer 10.0.150.1 advertise-community
peer 172.20.160.1 enable
peer 172.20.160.1 advertise-community
#

```

AR8:

```

<AR8>display current-configuration section bgp
[V200R003C00]
#
bgp 456
peer 172.20.160.1 as-number 456
peer 172.20.160.1 connect-interface LoopBack0
peer ::10.0.130.1 as-number 1817
#
ipv4-family unicast
undo synchronization
peer 172.20.160.1 enable
peer 172.20.160.1 advertise-community

```

#

LSW1:

```
#
bgp 365.12
peer 10.0.110.1 as-number 1516
peer 10.0.110.1 ebgp-max-hop 2
peer 10.0.110.1 connect-interface LoopBack0
peer 10.0.220.1 as-number 365.12
peer 10.0.220.1 connect-interface LoopBack0
peer 10.0.220.1 password simple workbook
peer 10.0.230.1 as-number 365.12
peer 10.0.230.1 connect-interface LoopBack0
peer 10.0.230.1 password simple workbook
peer 10.0.240.1 as-number 365.12
peer 10.0.240.1 connect-interface LoopBack0
peer 10.0.240.1 password simple workbook
#
ipv4-family unicast
undo synchronization
peer 10.0.110.1 enable
peer 10.0.110.1 advertise-community
peer 10.0.220.1 enable
peer 10.0.220.1 reflect-client
peer 10.0.220.1 next-hop-local
peer 10.0.220.1 advertise-community
peer 10.0.230.1 enable
peer 10.0.230.1 reflect-client
peer 10.0.230.1 next-hop-local
peer 10.0.230.1 advertise-community
peer 10.0.240.1 enable
peer 10.0.240.1 reflect-client
peer 10.0.240.1 next-hop-local
peer 10.0.240.1 advertise-community
#
```

LSW2:

```
#
bgp 365.12
peer 10.0.210.1 as-number 365.12
peer 10.0.210.1 connect-interface LoopBack0
peer 10.0.210.1 password simple workbook
#
ipv4-family unicast
undo synchronization
peer 10.0.210.1 enable
peer 10.0.210.1 advertise-community
#
```

LSW3:

```
#
bgp 365.12
peer 10.0.120.1 as-number 1516
peer 10.0.120.1 ebgp-max-hop 2
peer 10.0.120.1 connect-interface LoopBack0
peer 10.0.210.1 as-number 365.12
peer 10.0.210.1 connect-interface LoopBack0
peer 10.0.210.1 password simple workbook
peer 10.10.8.2 as-number 1817
#
ipv4-family unicast
undo synchronization
peer 10.0.120.1 enable
peer 10.0.120.1 advertise-community
peer 10.0.210.1 enable
peer 10.0.210.1 next-hop-local
peer 10.0.210.1 advertise-community
peer 10.10.8.2 enable
peer 10.10.8.2 advertise-community
#
```

LSW4:

```
#
bgp 365.12
peer 10.0.120.1 as-number 1516
peer 10.0.120.1 ebgp-max-hop 255
peer 10.0.120.1 connect-interface LoopBack0
peer 10.0.210.1 as-number 365.12
peer 10.0.210.1 connect-interface LoopBack0
peer 10.0.210.1 password simple workbook
peer 10.10.9.2 as-number 1817
#
ipv4-family unicast
undo synchronization
peer 10.0.120.1 enable
peer 10.0.120.1 advertise-community
peer 10.0.210.1 enable
peer 10.0.210.1 next-hop-local
```

```
peer 10.0.210.1 advertise-community
peer 10.10.9.2 enable
peer 10.10.9.2 advertise-community
#
```

Verify the configuration:

AR1:

```
<AR1>display bgp peer
```

BGP local router ID : 10.0.30.2

Local AS number : 1516

Total number of peers : 3

Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.120.1	4	1516	1855	1851	0	0030h43m	Established	11	
10.0.140.1	4	1516	1849	1852	0	0030h43m	Established	16	
10.0.210.1	4	365.12	1850	1847	0	0030h43m	Established	11	

AR2:

```
<AR2>display bgp peer
```

BGP local router ID : 10.10.6.2

Local AS number : 1516

Total number of peers : 5

Peers in established state : 5

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.110.1	4	1516	1860	1865	0	0030h57m	Established	1	
10.0.130.1	4	1817	1858	1864	0	0030h57m	Established	11	
10.0.140.1	4	1516	1858	1865	0	0030h57m	Established	16	
10.0.230.1	4	365.12	1860	1863	0	0030h58m	Established	11	
10.0.240.1	4	365.12	1858	1864	0	0030h58m	Established	11	

AR3:

<AR3>display bgp peer

BGP local router ID : 10.10.8.2

Local AS number : 1817

Total number of peers : 6

Peers in established state : 6

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.120.1	4	1516	2108	2101	0	0034h56m	Established	17	
10.0.150.1	4	1817	2099	2104	0	0034h56m	Established	1	
10.10.8.1	4	365.12	2105	2104	0	0034h56m	Established	16	
10.10.9.1	4	365.12	2102	2104	0	0034h56m	Established	16	
172.20.1.2	4	456	2103	2103	0	0034h56m	Established	9	
172.20.170.1	4	1817	2103	2102	0	0034h56m	Established	9	

AR4:

<AR4>display bgp peer

BGP local router ID : 192.168.150.2

Local AS number : 1516

Total number of peers : 3

Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.110.1	4	1516	2854	2852	0	0047h26m	Established	1	
10.0.120.1	4	1516	2861	2852	0	0047h27m	Established	11	
15.15.15.15	4	18.765	2850	2854	0	0047h28m	Established	16	

AR5:

<AR5>display bgp peer

BGP local router ID : 10.10.11.2

Local AS number : 1817

Total number of peers : 2

Peers in established state : 2

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.130.1	4	1817	2858	2854	0	0047h30m	Established	17	
172.20.170.1	4	1817	2860	2855	0	0047h31m	Established	9	

AR6:

<AR6>display bgp peer

BGP local router ID : 172.20.1.2

Local AS number : 456

Total number of peers : 4

Peers in established state : 4

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
17.18.19.1	4	9876	2852	2860	0	0047h33m	Established	9	

172.20.1.1	4	1817	2860	2860	0 0047h33m	Established	18
172.20.170.1	4	1817	2864	2860	0 0047h33m	Established	18
172.20.180.1	4	456	2856	2862	0 0047h33m	Established	0

AR7:

<AR7>display bgp peer

BGP local router ID : 172.20.2.2

Local AS number : 1817

Total number of peers : 3

Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.130.1	4	1817	2954	2958	0	0049h14m	Established	17	
10.0.150.1	4	1817	2952	2958	0	0049h15m	Established	1	
172.20.160.1	4	456	2956	2960	0	0049h15m	Established	9	

AR8:

<AR8>display bgp peer

BGP local router ID : 172.20.180.1

Local AS number : 456

Total number of peers : 1

Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
172.20.160.1	4	456	2958	2953	0	0049h11m	Established	27	

LSW1:

<LSW1>display bgp peer

BGP local router ID : 10.0.30.1

Local AS number : 365.12

Total number of peers : 4

Peers in established state : 4

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.110.1	4	1516	2963	2967	0	0049h19m	Established	25	
10.0.220.1	4	365.12	2962	2970	0	0049h21m	Established	0	
10.0.230.1	4	365.12	2971	2970	0	0049h20m	Established	0	
10.0.240.1	4	365.12	2968	2970	0	0049h20m	Established	27	

LSW2:

<LSW2>display bgp peer

BGP local router ID : 10.10.1.2

Local AS number : 365.12

Total number of peers : 1

Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv

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<https://t.me/learningnets>

10.0.210.1	4	365.12	2973	2965	0 0049h23m	Established	27

LSW3:

<LSW3>display bgp peer

BGP local router ID : 10.10.2.2

Local AS number : 365.12

Total number of peers : 3

Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.120.1	4	1516	2975	2969	0	0049h22m	Established	26	
10.0.210.1	4	365.12	2973	2975	0	0049h23m	Established	27	
10.10.8.2	4	1817	2971	2972	0	0049h23m	Established	27	

LSW4:

<LSW4>display bgp peer

BGP local router ID : 10.10.5.2

Local AS number : 365.12

Total number of peers : 3

Peers in established state : 3

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref	Rcv
10.0.120.1	4	1516	2978	2969	0	0049h23m	Established	26	
10.0.210.1	4	365.12	2974	2973	0	0049h24m	Established	0	
10.10.9.2	4	1817	2972	2970	0	0049h24m	Established	27	

3.3. BGP route manipulation

- Configure AR4 and AR6 to set different communities on the routes received from E1 (1516:1) and E2(456:1).

AR4:

<AR4>display current-configuration section bgp

[V200R003C00]

#

bgp 1516

#

ipv4-family unicast

undo synchronization

peer 15.15.15.15 enable

peer 15.15.15.15 route-policy FROM-E1 import

#

#

route-policy FROM-E1 permit node 1

apply community 1516:1

#

AR6:

```
<AR6>display current-configuration section bgp
[V200R003C00]
#
bgp 456
#
ipv4-family unicast
 undo synchronization
 peer 17.18.19.1 enable
 peer 17.18.19.1 route-policy FROM-E2 import
#
#
route-policy FROM-E2 permit node 1
 apply community 456:1
#
```

Verify the configuration:

AR4:

```
<AR4>display bgp routing-table peer 10.0.110.1 advertised-routes 87.1.0.0 24

BGP local router ID : 192.168.150.2
Local AS number : 1516
BGP routing table entry information of 87.1.0.0/24:
From: 15.15.15.15 (192.168.150.1)
Route Duration: 2d03h18m28s
Relay IP Nexthop: 192.168.150.1
Relay IP Out-Interface: GigabitEthernet0/0/0
Original nexthop: 15.15.15.15
Advertised nexthop: 10.0.140.1
Qos information : 0x0
Community:<1516:1>
AS-path 18.765, origin incomplete, MED 0, localpref 100
```

- Advertise a summary route 10.0.0.0/16 from AR2 and AR5. Make sure that the summary route is advertised to E2 by AR6 even if the link to AR3 is down.

AR2:

```

<AR2>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family unicast
undo synchronization
network 10.0.0.0 255.255.0.0
#
<AR2>display current-configuration | include static
ip route-static 10.0.0.0 255.255.0.0 NULL0
#

```

AR5:

```

<AR5>display current-configuration section bgp
[V200R003C00]
#
bgp 1817
peer 10.0.130.1 as-number 1817
peer 10.0.130.1 connect-interface LoopBack0
peer 172.20.170.1 as-number 1817
peer 172.20.170.1 connect-interface LoopBack0
#
ipv4-family unicast
undo synchronization
network 10.0.0.0 255.255.0.0
#

```

AR7:

```

<AR7>display current-configuration section bgp
[V200R003C00]
#
bgp 1817
#
ipv4-family unicast
undo synchronization
peer 10.0.130.1 enable
peer 10.0.130.1 route-policy FROM-AR3 import
peer 10.0.130.1 next-hop-local
peer 10.0.130.1 advertise-community

<AR7>display current-configuration section route-policy
[V200R003C00]
#
route-policy FROM-AR3 permit node 1
if-match ip-prefix AR3-LOOPBACK
apply ip-address next-hop 172.20.2.1
#
route-policy FROM-AR3 permit node 5
#
<AR7>display current-configuration | include ip-prefix

```

```
ip ip-prefix AR3-LOOPBACK index 10 permit 10.0.130.0 24
```

Verify the configuration:

AR5:

```
<AR5>display bgp routing-table peer 172.20.170.1 advertised-routes
```

BGP Local router ID is 10.10.11.2

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 1

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 10.0.0.0/16	172.20.2.1	0	100	0	i

AR7:

```
<AR7>display ip routing-table 10.0.0.0 16
```

Route Flags: R - relay, D - download to fib

Routing Table : Public

Summary Count : 1

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
10.0.0.0/16	IBGP	255	0	RD	<u>172.20.2.1</u>	GigabitEthernet0/0/0

- Ensure that LSW1 is not receiving the summary route from AR1. This configuration should be done only on AR2.

AR2:

```
<AR2>display current-configuration section bgp
```

```
[V200R003C00]
```

```
#
```

```
bgp 1516
```

```
#
```

```
ipv4-family unicast
```

```
undo synchronization
```

```
peer 10.0.110.1 enable
```

```
peer 10.0.110.1 route-policy TO-AR1 export
```

```
peer 10.0.110.1 next-hop-local
```

```
peer 10.0.110.1 advertise-community
```

```
#
```

```
<AR2>display current-configuration section route-policy
```

```

route-policy TO-AR1 permit node 1
  if-match ip-prefix LOCAL-SUMM
  apply community no-export 456:1
#
route-policy TO-AR1 permit node 2
#

```

Verify the configuration:

AR2:

```
<AR2>display bgp routing-table peer 10.0.110.1 advertised-routes 10.0.0.0 16
```

```

BGP local router ID : 10.10.6.2
Local AS number : 1516
BGP routing table entry information of 10.0.0.0/16:
Network route.
From: 0.0.0.0 (0.0.0.0)
Route Duration: 3d00h18m37s
Direct Out-interface: NULL0
Original nexthop: 0.0.0.0
Advertised nexthop: 10.0.120.1
Qos information : 0x0
Community: no-export, <456:1>
AS-path Nil, origin igp, MED 0, localpref 100

```

LSW1:

```
<LSW1>display bgp routing-table peer 10.0.110.1 received-routes | include 10.0.0.0
```

```

BGP Local router ID is 10.0.30.1
Status codes: * - valid, > - best, d - damped,
              h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

```

Total Number of Routes: 25

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn

- Advertise to E1 only routes marked with community 456:1. Make sure that the summary route 10.0.0.0/16 match this requirement and is sent to E1.

AR2:

```
#
route-policy TO-LSW4 permit node 1
  if-match ip-prefix LOCAL-SUMM
  apply community 456:1
#
```

AR5:

```
#
route-policy TO-AR3 permit node 1
  if-match ip-prefix LOCAL-SUMM
  apply community 456:1
#
```

AR4:

```
#
bgp 1516
#
ipv4-family unicast
  undo synchronization
  peer 15.15.15.15 enable
  peer 15.15.15.15 route-policy FROM-E1 import
  peer 15.15.15.15 route-policy TO-E1 export
  peer 15.15.15.15 advertise-community
#
#
route-policy TO-E1 permit node 1
  if-match as-path-filter 1
#
route-policy TO-E1 permit node 2
  if-match community-filter 1
#
#
ip community-filter 1 permit 456:1
#
```

Verify the configuration:

AR4:

```
<AR4>display bgp routing-table peer 15.15.15.15 advertised-routes 10.0.0.0 16

BGP local router ID : 192.168.150.2
Local AS number : 1516
BGP routing table entry information of 10.0.0.0/16:
From: 10.0.120.1 (10.10.6.2)
Route Duration: 3d06h50m11s
Relay IP Nexthop: 10.0.10.2
Relay IP Out-Interface: Serial3/0/0
Original nexthop: 10.0.120.1
```



```

Advertised nexthop: 10.0.140.1
Qos information : 0x0
Community:<456:1>
AS-path 1516, origin igp

```

- Route 75.75.0.0/24 must be excluded from the routes sent to E1. This configuration should not be done on AR4.

AR1:

```

<AR1>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family unicast
undo synchronization
peer 10.0.120.1 advertise-community
peer 10.0.140.1 enable
peer 10.0.140.1 route-policy TO-AR4 export
peer 10.0.140.1 next-hop-local
peer 10.0.140.1 advertise-community
#

<AR1>display current-configuration section route-policy
[V200R003C00]
#
route-policy TO-AR4 permit node 1
if-match ip-prefix 75.75.0.0
apply community none
#
route-policy TO-AR4 permit node 2
#

```

AR2:

```
<AR2>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family unicast
undo synchronization
peer 10.0.140.1 enable
peer 10.0.140.1 route-policy TO-AR4 export
peer 10.0.140.1 next-hop-local
peer 10.0.140.1 advertise-community
#
#
route-policy TO-AR4 permit node 1
if-match ip-prefix 75.75.0.0
apply local-preference 200
apply community none
#
route-policy TO-AR4 permit node 2
apply local-preference 200
apply community 456:1
#
```

AR4:

```

<AR4>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family unicast
undo synchronization
peer 15.15.15.15 enable
peer 15.15.15.15 route-policy FROM-E1 import
peer 15.15.15.15 route-policy TO-E1 export
peer 15.15.15.15 advertise-community
#
#
route-policy TO-E1 permit node 1
if-match community-filter 1
if-match as-path-filter 1
#

```

Verify the configuration:

AR4:

```

[AR4]display bgp routing-table peer 15.15.15.15 advertised-routes

```

BGP Local router ID is 192.168.150.2

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 9

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*>i 10.0.0.0/16	10.0.140.1		0	1516i	
*>i 143.25.64.0/24	10.0.140.1		0	1516 1817 456 9876i	
*>i 143.25.65.0/24	10.0.140.1		0	1516 1817 456 9876i	
*>i 143.25.66.0/24	10.0.140.1		0	1516 1817 456 9876i	
*>i 143.25.67.0/24	10.0.140.1		0	1516 1817 456 9876i	
*>i 143.25.68.0/24	10.0.140.1		0	1516 1817 456 9876i	
*>i 143.25.69.0/24	10.0.140.1		0	1516 1817 456 9876i	
*>i 143.25.70.0/24	10.0.140.1		0	1516 1817 456 9876i	
*>i 143.25.71.0/24	10.0.140.1		0	1516 1817 456 9876i	

- Make sure that AR2 is the preferred exit point from AS1615. Traffic coming to E1 through the AS1615 should prefer AR2. This configuration should be done on AR4.

AR2:

```
#
route-policy TO-AR4 permit node 1
  if-match ip-prefix 75.75.0.0
  apply local-preference 200
  apply community none
#
route-policy TO-AR4 permit node 2
  apply local-preference 200
  apply community 456:1
#
```

AR4:

```
<AR4>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family unicast
  undo synchronization
  peer 10.0.110.1 enable
  peer 10.0.110.1 route-policy TO-AR1 export
  peer 10.0.110.1 next-hop-local
  peer 10.0.110.1 advertise-community
#
#
route-policy TO-AR1 permit node 1
  apply origin incomplete
#
```

- Ensure that if the peering session between AR2 and AR3 is not established when interfaces of AR2 to AS365.12 are down. In such cases E2 routes should not be advertised to E1.

AR4:

```
#
route-policy TO-E1 permit node 1
  if-match community-filter 1
  if-match as-path-filter 1
#
#
ip as-path-filter 1 deny 365\12
ip as-path-filter 1 permit .*
#
```

- AS365.12 should send traffic to AR2 over the link from LSW4. Use the BGP attribute with highest priority. This configuration should be done on AR2.

AR2:

```
<AR2>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family unicast
undo synchronization
peer 10.0.230.1 enable
peer 10.0.230.1 route-policy TO-LSW3 export
peer 10.0.230.1 advertise-community
peer 10.0.240.1 enable
peer 10.0.240.1 route-policy TO-LSW4 export
peer 10.0.240.1 advertise-community
#
#
route-policy TO-LSW3 permit node 1
if-match ip-prefix LOCAL-SUMM
apply as-path 1516 1516 1516 additive
apply community 456:1
#
route-policy TO-LSW3 permit node 2
apply as-path 1516 1516 1516 additive
#
route-policy TO-LSW4 permit node 1
if-match ip-prefix LOCAL-SUMM
apply community 456:1
#
```

Verify the configuration:

LSW3:

```
<LSW3>display bgp routing-table peer 10.0.120.1 received-routes
```

BGP Local router ID is 10.10.2.2

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 26

	Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*	10.0.0.0/16	10.0.120.1	0	0	1516 1516 1516 1516i	
*	75.75.0.0/24	10.0.120.1		0	1516 1516 1516 1516 1817 456 9876i	
*	87.1.0.0/24	10.0.120.1		0	1516 1516 1516 1516 18.765i	
*	87.1.1.0/24	10.0.120.1		0	1516 1516 1516 1516 18.765i	

* 87.1.2.0/24	10.0.120.1	0	1516 1516 1516 1516 18.765i
* 87.1.3.0/24	10.0.120.1	0	1516 1516 1516 1516 18.765i
* 87.1.4.0/24	10.0.120.1	0	1516 1516 1516 1516 18.765i
* 87.1.5.0/24	10.0.120.1	0	1516 1516 1516 1516 18.765i
* 87.1.6.0/24	10.0.120.1	0	1516 1516 1516 1516 18.765i

- Make sure that AS365.12 prefer to send traffic to AR3 from LSW4. Ensure that change affects only traffic through AS365.12 and is performed on AR3.

AR3:

```
<AR3>display current-configuration section bgp
[V200R003C00]
#
bgp 1817
#
ipv4-family unicast
undo synchronization
peer 10.10.8.1 enable
peer 10.10.8.1 route-policy TO-LSW3 export
peer 10.10.8.1 advertise-community
peer 10.10.9.1 enable
peer 10.10.9.1 route-policy TO-LSW4 export
peer 10.10.9.1 advertise-community
#
#
route-policy TO-LSW4 permit node 1
apply cost 50
#
route-policy TO-LSW3 permit node 1
apply cost 100
#
```

Verify the configuration:

LSW3:

LSW4>display bgp routing-table

BGP Local router ID is 10.10.5.2

Status codes: * - valid, > - best, d - damped,

h - history, i - internal, s - suppressed, S - Stale

Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 53

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 10.0.0.0/16	10.10.9.2	50	0	1817i	
* 10.0.120.1	0		0	1516i	
*> 10.0.130.0/24	10.10.9.2	50	0	1817i	
*> 75.75.0.0/24	10.10.9.2	50	0	1817 456 9876i	
* 10.0.120.1			0	1516 1817 456 9876i	
*> 87.1.0.0/24	10.0.120.1		0	1516 18.765i	
* 10.10.9.2	50		0	1817 1516 18.765i	
*> 87.1.1.0/24	10.0.120.1		0	1516 18.765i	
* 10.10.9.2	50		0	1817 1516 18.765i	
*> 87.1.2.0/24	10.0.120.1		0	1516 18.765i	
* 10.10.9.2	50		0	1817 1516 18.765i	

3.4. General requirements

- You should provide two way IP reachability between E1 and E2 Loopback100 interfaces.

AR8:

<AR8>display current-configuration section bgp

[V200R003C00]

#

bgp 456

#

ipv4-family unicast

undo synchronization

peer 172.20.160.1 enable

peer 172.20.160.1 route-policy FROM-AR6 import

peer 172.20.160.1 advertise-community

#

<AR8>display current-configuration section route-policy

[V200R003C00]

#

route-policy FROM-AR6 permit node 1

if-match as-path-filter 1

apply ip-address next-hop 172.20.170.1

#

route-policy FROM-AR6 permit node 2

#

<AR8>display current-configuration | include as-path

ip as-path-filter 1 deny 9876

```
ip as-path-filter 1 permit .*  
<AR8>
```

AR3:

```
#  
route-policy FROM-AR6 permit node 1  
  apply local-preference 200  
#  
<AR3> display current-configuration section bgp  
[V200R003C00]  
#  
bgp 1817  
#  
ipv4-family unicast  
  peer 172.20.170.1 enable  
  peer 172.20.170.1 route-policy FROM-AR6 import  
  peer 172.20.170.1 next-hop-local  
  peer 172.20.170.1 advertise-community  
#
```


AR6:

```
#
route-policy FROM-AR3 permit node 1
  apply local-preference 200
#
<AR6>display current-configuration section bgp
[V200R003C00]
#
bgp 456
#
ipv4-family unicast
  peer 172.20.1.1 enable
  peer 172.20.1.1 route-policy FROM-AR3 import
  peer 172.20.1.1 advertise-community
#
```

Verify the configuration:

E1:

```
<E1>ping -a 87.1.0.1 143.25.64.1
PING 143.25.64.1: 56 data bytes, press CTRL_C to break
  Reply from 143.25.64.1: bytes=56 Sequence=1 ttl=246 time=130 ms
  Reply from 143.25.64.1: bytes=56 Sequence=2 ttl=246 time=110 ms
  Reply from 143.25.64.1: bytes=56 Sequence=3 ttl=246 time=130 ms
  Reply from 143.25.64.1: bytes=56 Sequence=4 ttl=246 time=130 ms
  Reply from 143.25.64.1: bytes=56 Sequence=5 ttl=246 time=130 ms

--- 143.25.64.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 110/126/130 ms
```

2. MPLS and IPv6 services

3.1. MPLS service configuration

- Configure MPLS L3VPN service as show on the diagram below:
- Configure additional interface as described in the table below.

Device	Interface	IP address	Peer IP address
AR1	Gi 0/0/2	192.168.10.1/24	192.168.10.2
AR2	Gi 0/0/2	192.168.20.1/24	192.168.20.2
AR4	Gi 0/0/2	192.168.40.1/24	192.168.40.2

- Configure LDP as the label distribution protocol. Ensure that all PE routers accept only labels for /32 routes.

AR1:

```
#
ip vpn-instance Customer-1
  ipv4-family
    route-distinguisher 1516:100
    vpn-target 1516:100 export-extcommunity
    vpn-target 1516:100 import-extcommunity
#
mpls lsr-id 10.0.110.1
mpls
#
mpls ldp
  inbound peer 10.0.120.1 fec host
  inbound peer 10.0.140.1 fec host
#
#
interface GigabitEthernet0/0/2
  ip binding vpn-instance Customer-1
  ip address 192.168.10.1 255.255.255.0
#
```

AR2:

```
#
ip vpn-instance Customer-1
  ipv4-family
    route-distinguisher 1516:100
    vpn-target 1516:100 export-extcommunity
    vpn-target 1516:100 import-extcommunity
#
mpls lsr-id 10.0.120.1
mpls
#
mpls ldp
  outbound peer all fec ip-prefix LOOPBACK0
  inbound peer 10.0.140.1 fec host
  inbound peer 10.0.110.1 fec host
#
ip ip-prefix LOOPBACK0 index 10 permit 10.0.120.1 32
#
#
interface GigabitEthernet0/0/2
  ip binding vpn-instance Customer-1
  ip address 192.168.20.1 255.255.255.0
#
```

AR4:

```
#
ip vpn-instance Customer-1
  ipv4-family
    route-distinguisher 1516:100
    vpn-target 1516:100 export-extcommunity
    vpn-target 1516:100 import-extcommunity
#
mpls lsr-id 10.0.140.1
mpls
#
mpls ldp
  inbound peer 10.0.110.1 fec host
  inbound peer 10.0.120.1 fec host
#
#
interface GigabitEthernet0/0/2
  ip binding vpn-instance Customer-1
  ip address 192.168.40.1 255.255.255.0
#
```

Verify the configuration:

AR1:

<AR1>display mpls ldp peer

LDP Peer Information in Public network
A '*' before a peer means the peer is being deleted.

PeerID	TransportAddress	DiscoverySource
10.0.120.1:0	10.0.120.1	Serial3/0/0
10.0.140.1:0	10.0.140.1	Serial3/0/0

TOTAL: 2 Peer(s) Found.

<AR1>display mpls ldp lsp

LDP LSP Information

DestAddress/Mask	In/OutLabel	UpstreamPeer	NextHop	OutInterface
10.0.110.1/32	3/NULL	10.0.140.1	127.0.0.1	InLoop0
10.0.110.1/32	3/NULL	10.0.120.1	127.0.0.1	InLoop0
*10.0.110.1/32	Liberal/1024		DS/10.0.140.1	
10.0.120.1/32	NULL/3	-	10.0.10.2	S3/0/0
10.0.120.1/32	1026/3	10.0.120.1	10.0.10.2	S3/0/0
10.0.120.1/32	1026/3	10.0.140.1	10.0.10.2	S3/0/0
*10.0.120.1/32	Liberal/1028		DS/10.0.140.1	
10.0.140.1/32	NULL/3	-	10.0.10.4	S3/0/0
10.0.140.1/32	1024/3	10.0.140.1	10.0.10.4	S3/0/0
10.0.140.1/32	1024/3	10.0.120.1	10.0.10.4	S3/0/0

TOTAL: 8 Normal LSP(s) Found.
 TOTAL: 2 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is stale
 A '*' before a DS means the session is stale
 A '*' before a NextHop means the LSP is FRR LSP

AR2:

<AR2>display mpls ldp peer

LDP Peer Information in Public network
 A '*' before a peer means the peer is being deleted.

PeerID	TransportAddress	DiscoverySource
10.0.140.1:0	10.0.140.1	Serial3/0/0
10.0.110.1:0	10.0.110.1	Serial3/0/0

TOTAL: 2 Peer(s) Found.

<AR2>display mpls ldp lsp

LDP LSP Information

DestAddress/Mask	In/OutLabel	UpstreamPeer	NextHop	OutInterface
*10.0.110.1/32	Liberal/3	DS/10.0.110.1		
*10.0.110.1/32	Liberal/1024	DS/10.0.140.1		
10.0.120.1/32	3/NULL	10.0.110.1	127.0.0.1	InLoop0
10.0.120.1/32	3/NULL	10.0.140.1	127.0.0.1	InLoop0
*10.0.120.1/32	Liberal/1026	DS/10.0.110.1		
*10.0.120.1/32	Liberal/1028	DS/10.0.140.1		
10.0.140.1/32	NULL/3	-	10.0.10.4	S3/0/0
*10.0.140.1/32	Liberal/1024	DS/10.0.110.1		

TOTAL: 3 Normal LSP(s) Found.
 TOTAL: 5 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is stale
 A '*' before a DS means the session is stale
 A '*' before a NextHop means the LSP is FRR LSP

AR4:

<AR4>display mpls ldp peer

LDP Peer Information in Public network

A '*' before a peer means the peer is being deleted.

PeerID	TransportAddress	DiscoverySource
10.0.120.1:0	10.0.120.1	Serial3/0/0
10.0.110.1:0	10.0.110.1	Serial3/0/0

TOTAL: 2 Peer(s) Found.

<AR4>display mpls ldp lsp

LDP LSP Information

DestAddress/Mask	In/OutLabel	UpstreamPeer	NextHop	OutInterface
10.0.110.1/32	NULL/3	-	10.0.10.1	S3/0/0
10.0.110.1/32	1024/3	10.0.110.1	10.0.10.1	S3/0/0
10.0.110.1/32	1024/3	10.0.120.1	10.0.10.1	S3/0/0
10.0.120.1/32	NULL/3	-	10.0.10.2	S3/0/0
10.0.120.1/32	1028/3	10.0.120.1	10.0.10.2	S3/0/0
10.0.120.1/32	1028/3	10.0.110.1	10.0.10.2	S3/0/0
*10.0.120.1/32	Liberal/1026		DS/10.0.110.1	
10.0.140.1/32	3/NULL	10.0.110.1	127.0.0.1	InLoop0
10.0.140.1/32	3/NULL	10.0.120.1	127.0.0.1	InLoop0
*10.0.140.1/32	Liberal/1024		DS/10.0.110.1	

TOTAL: 8 Normal LSP(s) Found.

TOTAL: 2 Liberal LSP(s) Found.

TOTAL: 0 Frr LSP(s) Found.

A '*' before an LSP means the LSP is not established

A '*' before a Label means the USCB or DSCB is stale

A '*' before a UpstreamPeer means the session is stale

A '*' before a DS means the session is stale

A '*' before a NextHop means the LSP is FRR LSP

- Configure L3VPN service with name *Customer-1*. Ensure full reachability between all three CE routers.
- Use eBGP as PE-CE routing protocol on AR1.
- Assume that CE2 and CE4 do not support BGP, therefor OSPF should be used as the PE-CE routing protocol from AR2 and AR4 to CE2 and CE4.
- Make sure that CE2 and CE4 have only External OSPF routes in the routing table.

AR1:

```

<AR1>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family vpnv4
 policy vpn-target
 peer 10.0.120.1 enable
 peer 10.0.140.1 enable
#
ipv4-family vpn-instance Customer-1
 import-route direct
 peer 192.168.10.2 as-number 65432
 peer 192.168.10.2 substitute-as
#

```

AR2:

```

<AR2>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family vpnv4
 policy vpn-target
 peer 10.0.110.1 enable
 peer 10.0.140.1 enable
#
ipv4-family vpn-instance Customer-1
 import-route direct
 import-route ospf 2
#
<AR2>display current-configuration section ospf
[V200R003C00]
#
#
ospf 2 vpn-instance Customer-1
 import-route bgp
 area 0.0.0.0
 network 192.168.20.0 0.0.0.255
#

```

AR4:

```

<AR4>display current-configuration section bgp
[V200R003C00]
#
bgp 1516
#
ipv4-family vpnv4
  policy vpn-target
  peer 10.0.110.1 enable
  peer 10.0.120.1 enable
#
ipv4-family vpn-instance Customer-1
  import-route direct
  import-route ospf 2
#
<AR4>display current-configuration section ospf
[V200R003C00]
#
ospf 2 vpn-instance Customer-1
  import-route bgp
  domain-id 0.0.0.40
  area 0.0.0.0
  network 192.168.40.0 0.0.0.255
#

```

Verify the configuration:

AR1:

```

<AR1>display ip routing-table vpn-instance Customer-1
Route Flags: R - relay, D - download to fib
-----
Routing Tables: Customer-1
  Destinations : 9      Routes : 9

Destination/Mask  Proto  Pre  Cost   Flags NextHop         Interface
-----
172.16.10.0/24   EGBP   255  0       D  192.168.10.2   GigabitEthernet0
/0/2
172.16.20.1/32   IBGP   255  2       RD  10.0.120.1     Serial3/0/0
172.16.40.1/32   IBGP   255  2       RD  10.0.140.1     Serial3/0/0
192.168.10.0/24  Direct  0    0       D  192.168.10.1   GigabitEthernet0/0/2
192.168.10.1/32  Direct  0    0       D  127.0.0.1      GigabitEthernet0/0/2
192.168.10.255/32 Direct  0    0       D  127.0.0.1      GigabitEthernet0/0/2
192.168.20.0/24  IBGP   255  0       RD  10.0.120.1     Serial3/0/0
192.168.40.0/24  IBGP   255  0       RD  10.0.140.1     Serial3/0/0
255.255.255.255/32 Direct  0    0       D  127.0.0.1      InLoopBack0

```

AR2:

<AR2>display ip routing-table vpn-instance Customer-1

Route Flags: R - relay, D - download to fib

Routing Tables: Customer-1

Destinations : 7 Routes : 7

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
172.16.20.1/32	OSPF	10	1	D	192.168.20.2	GigabitEthernet0/0/2
172.16.40.1/32	IBGP	255	2	RD	10.0.140.1	Serial3/0/0
192.168.20.0/24	Direct	0	0	D	192.168.20.1	GigabitEthernet0/0/2
192.168.20.1/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/2
192.168.20.255/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/2
192.168.40.0/24	IBGP	255	0	RD	10.0.140.1	Serial3/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

AR4:

<AR4>display ip routing-table vpn-instance Customer-1

Route Flags: R - relay, D - download to fib

Routing Tables: Customer-1

Destinations : 9 Routes : 9

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
172.16.10.0/24	IBGP	255	0	RD	10.0.110.1	Serial3/0/0
172.16.20.1/32	IBGP	255	2	RD	10.0.120.1	Serial3/0/0
172.16.40.1/32	OSPF	10	1	D	192.168.40.2	GigabitEthernet0/0/2
192.168.10.0/24	IBGP	255	0	RD	10.0.110.1	Serial3/0/0
192.168.20.0/24	IBGP	255	0	RD	10.0.120.1	Serial3/0/0
192.168.40.0/24	Direct	0	0	D	192.168.40.1	GigabitEthernet0/0/2
192.168.40.1/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/2
192.168.40.255/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/2
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

CE1:

<CE1>display ip routing-table

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 14 Routes : 14

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.10.0/24	Direct	0	0	D	172.16.10.1	LoopBack0
172.16.10.1/32	Direct	0	0	D	127.0.0.1	LoopBack0
172.16.10.255/32	Direct	0	0	D	127.0.0.1	LoopBack0
172.16.20.1/32	EBGP	255	0	D	192.168.10.1	GigabitEthernet0/0/0


```

172.16.40.1/32 EBGP 255 0 D 192.168.10.1 GigabitEthernet0/0/0
192.168.10.0/24 Direct 0 0 D 192.168.10.2 GigabitEthernet0/0/0
192.168.10.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
192.168.10.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/0
192.168.20.0/24 EBGP 255 0 D 192.168.10.1 GigabitEthernet0/0/0
192.168.40.0/24 EBGP 255 0 D 192.168.10.1 GigabitEthernet0/0/0
255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

```

CE2:**<CE2>display ip routing-table**

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 12 Routes : 12

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.20.0/24	Direct	0	0	D	172.16.20.1	LoopBack0
172.16.20.1/32	Direct	0	0	D	127.0.0.1	LoopBack0
172.16.20.255/32	Direct	0	0	D	127.0.0.1	LoopBack0
172.16.40.1/32	O_ASE	150	2	D	192.168.20.1	GigabitEthernet0/0/0
192.168.20.0/24	Direct	0	0	D	192.168.20.2	GigabitEthernet0/0/0
192.168.20.2/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
192.168.20.255/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
192.168.40.0/24	O_ASE	150	1	D	192.168.20.1	GigabitEthernet0/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

CE4:**<CE4>display ip routing-table**

Route Flags: R - relay, D - download to fib

Routing Tables: Public

Destinations : 14 Routes : 14

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
127.0.0.0/8	Direct	0	0	D	127.0.0.1	InLoopBack0
127.0.0.1/32	Direct	0	0	D	127.0.0.1	InLoopBack0
127.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0
172.16.10.0/24	O_ASE	150	1	D	192.168.40.1	GigabitEthernet0/0/0
172.16.20.1/32	O_ASE	150	2	D	192.168.40.1	GigabitEthernet0/0/0
172.16.40.0/24	Direct	0	0	D	172.16.40.1	LoopBack0
172.16.40.1/32	Direct	0	0	D	127.0.0.1	LoopBack0
172.16.40.255/32	Direct	0	0	D	127.0.0.1	LoopBack0
192.168.10.0/24	O_ASE	150	1	D	192.168.40.1	GigabitEthernet0/0/0

192.168.20.0/24	O_ASE	150	1	D	192.168.40.1	GigabitEthernet0/0/0
192.168.40.0/24	Direct	0	0	D	192.168.40.2	GigabitEthernet0/0/0
192.168.40.2/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
192.168.40.255/32	Direct	0	0	D	127.0.0.1	GigabitEthernet0/0/0
255.255.255.255/32	Direct	0	0	D	127.0.0.1	InLoopBack0

3.2. IPv6 service configuration

- Configure Automatic IPv6 tunnel to provide connectivity between the IPv6 networks through the IPv4 backbone.
- Make sure that tunnel stays connected if any of direct interfaces on AR3 or AR8 goes down.
- You must configure BGP to verify the connectivity between IPv6 islands.

AR3:

```
#
ipv6
#
interface Tunnel0/0/0
  ipv6 enable
  ipv6 address ::10.0.130.1/96
  tunnel-protocol ipv6-ipv4 auto-tunnel
  source LoopBack0
#
bgp 1817
#
  ipv6-family unicast
    undo synchronization
  peer ::172.20.180.1 enable
  peer ::172.20.180.1 next-hop-local
#
```

AR8:

```
#
ipv6
#
#
interface Tunnel0/0/0
  ipv6 enable
  ipv6 address ::172.20.180.1/96
  tunnel-protocol ipv6-ipv4 auto-tunnel
  source LoopBack0
#
<AR8>display current-configuration section bgp
[V200R003C00]
#
bgp 456
  peer 172.20.160.1 as-number 456
  peer 172.20.160.1 connect-interface LoopBack0
  peer ::10.0.130.1 as-number 1817
#
  ipv4-family unicast
    undo synchronization
  peer 172.20.160.1 enable
  peer 172.20.160.1 route-policy FROM-AR6 import
  peer 172.20.160.1 advertise-community
#
  ipv6-family unicast
```

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```
undo synchronization
peer ::10.0.130.1 enable
peer ::10.0.130.1 next-hop-local
#
```

Verify the configuration:

AR3:

```
<AR3>display ipv6 interface tu0/0/0
Tunnel0/0/0 current state : UP
IPv6 protocol current state : UP
IPv6 is enabled, link-local address is FE80::A00:8201
Global unicast address(es):
  ::10.0.130.1, subnet is ::/96
Joined group address(es):
  FF02::1:FF00:8201
  FF02::2
  FF02::1
MTU is 1500 bytes
ND reachable time is 30000 milliseconds
ND retransmit interval is 1000 milliseconds
Hosts use stateless autoconfig for addresses

<AR3>dis bgp ipv6 peer

BGP local router ID : 10.10.8.2
Local AS number : 1817
Total number of peers : 1                Peers in established state : 1

Peer      V      AS  MsgRcvd  MsgSent  OutQ  Up/Down    State Pref
Rcv
::172.20.180.1 4    456   6558    6556    0 0109h13m Established    0

<AR3>ping ipv6 -a ::10.0.130.1 ::172.20.180.1
PING ::172.20.180.1 : 56 data bytes, press CTRL_C to break
Reply from ::172.20.180.1
bytes=56 Sequence=1 hop limit=64 time = 10 ms
Reply from ::172.20.180.1
bytes=56 Sequence=2 hop limit=64 time = 20 ms
Reply from ::172.20.180.1
bytes=56 Sequence=3 hop limit=64 time = 30 ms
Reply from ::172.20.180.1
bytes=56 Sequence=4 hop limit=64 time = 20 ms
Reply from ::172.20.180.1
bytes=56 Sequence=5 hop limit=64 time = 30 ms

--- ::172.20.180.1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
round-trip min/avg/max = 10/22/30 ms
```

AR8:

<AR8>display ipv6 interface tu0/0/0

Tunnel0/0/0 current state : UP

IPv6 protocol current state : UP

IPv6 is enabled, link-local address is FE80::AC14:B401

Global unicast address(es):

::172.20.180.1, subnet is ::/96

Joined group address(es):

FF02::1:FF14:B401

FF02::2

FF02::1

MTU is 1500 bytes

ND reachable time is 30000 milliseconds

ND retransmit interval is 1000 milliseconds

Hosts use stateless autoconfig for addresses

<AR8>display bgp ipv6 peer

BGP local router ID : 172.20.180.1

Local AS number : 456

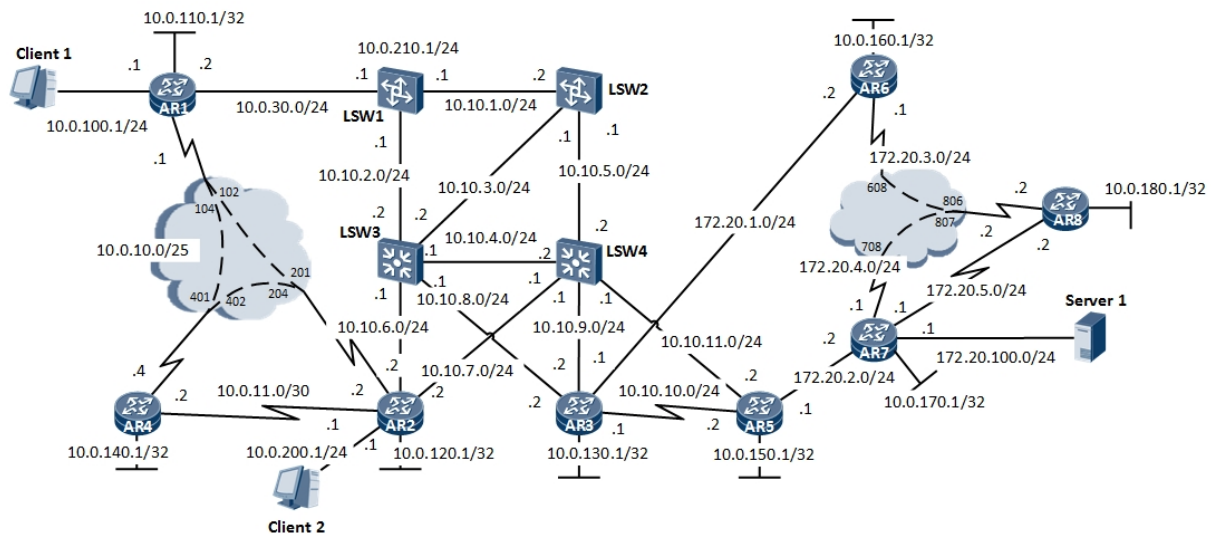
Total number of peers : 1

Peers in established state : 1

Peer	V	AS	MsgRcvd	MsgSent	OutQ	Up/Down	State	Pref
Rev								

::10.0.130.1	4	1817	6535	6538	0	0108h56m	Established	0

Task 5: Multicast



7.2 PIM configuration

- Configure IP multicast routing on AR1, AR2, AR4, AR5 and AR7.
- Configure two PIM domains – PD1 and PD2. Enable PIM sparse mode as described in the table below:

Domain	Device	Interface
PD1	AR1	Serial 3/0/0
	AR2	Serial 3/0/0
	AR2	Tunnel 0/0/0
	AR4	Serial 3/0/0
PD2	AR5	Gi 0/0/0
	AR5	Tunnel 0/0/0
	AR7	Gi 0/0/0

- Configure GRE tunnel between AR2 and AR5 for interconnecting both PIM domain. Make sure that the boundary between the PIM domains is that tunnel. Use subnet 3.3.3.0/24 for IP addresses on the tunnel interfaces.
- Configure additional interfaces for the multicast Server1 and both multicast Clients. Use the data from the table below:

Device	Interface	IP address
AR1	Gi 0/0/0	10.0.100.1/24
AR4	Gi 0/0/0	10.0.200.1/24
AR5	Gi 0/0/1	172.20.100.1/24

AR1:

```
#
multicast routing-enable
#
interface Serial3/0/0
pim sm
#
```

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```
#
interface GigabitEthernet0/0/0
ip address 10.0.100.1 255.255.255.0
pim sm
igmp enable
igmp version 3
#
#
pim
#
```

AR2:

```
#
multicast routing-enable
#
#
interface Vlanif42
ip address 10.10.7.2 255.255.255.0
isis enable 1
pim bsr-boundary
#
interface Serial3/0/0
ip address 10.0.10.2 255.255.255.128
pim sm
#
interface Serial3/0/1
ip address 10.0.11.1 255.255.255.252
pim sm
#
#
interface GigabitEthernet0/0/0
ip address 10.0.200.1 255.255.255.0
pim sm
igmp enable
#
#
interface Tunnel0/0/0
ip address 3.3.3.1 255.255.255.0
tunnel-protocol gre
source LoopBack0
destination 10.0.150.1
pim bsr-boundary
pim sm
#
#
pim
#
```

AR4:

```
#
multicast routing-enable
#
```

```
#
interface Serial3/0/0
ip address 10.0.10.4 255.255.255.128
pim sm
#
#
pim
#
```

AR5:

```
#
multicast routing-enable
#
#
interface Vlanif45
ip address 10.10.11.2 255.255.255.0
isis enable 1
isis cost 1000
pim sm
#
#
interface GigabitEthernet0/0/0
ip address 172.20.2.1 255.255.255.0
pim sm
nat outbound 3000
#
#
interface Tunnel0/0/0
ip address 3.3.3.2 255.255.255.0
tunnel-protocol gre
source LoopBack0
destination 10.0.120.1
pim bsr-boundary
pim sm
#
#
pim
#
```

AR7:

```
#
multicast routing-enable
#
interface GigabitEthernet0/0/0
ip address 172.20.2.2 255.255.255.0
pim sm
#
interface GigabitEthernet0/0/1
ip address 172.20.100.1 255.255.255.0
pim sm
igmp enable
#
```



```
#
pim
#
```

Verify the configuration:

AR2:

<AR2>display pim neighbor

VPN-Instance: public net

Total Number of Neighbors = 3

Neighbor	Interface	Uptime	Expires	Dr-Priority	BFD-Session
10.0.10.4	S3/0/0	5d:09h	00:01:38	1	N
10.0.10.1	S3/0/0	5d:09h	00:01:18	1	N
3.3.3.2	Tun0/0/0	5d:09h	00:01:38	1	N

<AR2>display interface tu0/0/0

Tunnel0/0/0 current state : UP

Line protocol current state : UP

Last line protocol up time : 2015-11-12 18:44:01 UTC-08:00

Description:HUAWEI, AR Series, Tunnel0/0/0 Interface

Route Port,The Maximum Transmit Unit is 1500

Internet Address is 3.3.3.1/24

Encapsulation is TUNNEL, loopback not set

Tunnel source 10.0.120.1 (LoopBack0), destination 10.0.150.1

Tunnel protocol/transport GRE/IP, key disabled

keepalive disabled

Checksumming of packets disabled

Current system time: 2015-11-18 04:18:43-08:00

300 seconds input rate 0 bits/sec, 0 packets/sec

300 seconds output rate 32 bits/sec, 0 packets/sec

0 seconds input rate 0 bits/sec, 0 packets/sec

0 seconds output rate 0 bits/sec, 0 packets/sec

0 packets input, 0 bytes

0 input error

30815 packets output, 2275027 bytes

0 output error

Input bandwidth utilization : --

Output bandwidth utilization : --

AR5:

<AR5>display pim neighbor

VPN-Instance: public net

Total Number of Neighbors = 2

Neighbor	Interface	Uptime	Expires	Dr-Priority	BFD-Session
172.20.2.2	GE0/0/0	5d:09h	00:01:27	1	N
3.3.3.1	Tun0/0/0	5d:09h	00:01:21	1	N

<AR5>display interface tu0/0/0

Tunnel0/0/0 current state : UP

Line protocol current state : UP

```

Last line protocol up time : 2015-11-12 18:42:33 UTC-08:00
Description:HUAWEI, AR Series, Tunnel0/0/0 Interface
Route Port,The Maximum Transmit Unit is 1500
Internet Address is 3.3.3.2/24
Encapsulation is TUNNEL, loopback not set
Tunnel source 10.0.150.1 (LoopBack0), destination 10.0.120.1
Tunnel protocol/transport GRE/IP, key disabled
keepalive disabled
Checksumming of packets disabled
Current system time: 2015-11-18 04:09:38-08:00
  300 seconds input rate 0 bits/sec, 0 packets/sec
  300 seconds output rate 32 bits/sec, 0 packets/sec
  0 seconds input rate 0 bits/sec, 0 packets/sec
  0 seconds output rate 0 bits/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  30819 packets output, 2274964 bytes
  0 output error
  Input bandwidth utilization : --
  Output bandwidth utilization : --

```

- The following multicast hosts are preconfigured and connected to the network. Make sure that directly attached routers are configured appropriately to provide multicast service for the hosts.

Host	IP address	Multicast Group
SERVER1	172.20.100.100	(172.20.100.100 , 239.49.39.1)
CLIENT1	10.0.100.100	(172.20.100.100 , 239.49.39.1)
CLIENT2	10.0.200.100	(* , 239.49.39.1)

- Configure additional Loopback interfaces on AR2 and AR5 dedicated for multicast RP.

Device	Interface	IP address
AR2	Loopback 100	1.1.1.1/32
AR5	Loopback 100	2.2.2.2/32

- You may use static routes to provide routing between both PIM domains through the GRE interface. Use the respected routing protocol inside the domains.

AR2:

```

<AR2>display current-configuration interface lo100
[V200R003C00]
#
interface LoopBack100
 ip address 1.1.1.1 255.255.255.255
 pim sm
#

<AR2>display current-configuration | include static
ip route-static 172.20.100.0 255.255.255.0 Tunnel0/0/0

```

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```

<AR2>display current-configuration section ospf
[V200R003C00]
#
ospf 1 router-id 10.0.120.1
import-route static route-policy S2O
#
#
route-policy S2O deny node 1
if-match ip-prefix LOCAL-SUMM
#
route-policy S2O permit node 2
#

```

AR5:

```

<AR5>display current-configuration interface lo100
[V200R003C00]
#
interface LoopBack100
ip address 2.2.2.2 255.255.255.255
pim sm
#

<AR5>display current-configuration | include static
ip route-static 10.0.100.0 255.255.255.0 Tunnel0/0/0
ip route-static 10.0.200.0 255.255.255.0 Tunnel0/0/0

<AR5>display current-configuration section rip
[V200R003C00]
#
rip 1
import-route static route-policy S2R
#

<AR5>display current-configuration section route-policy
[V200R003C00]
#
route-policy R2I deny node 1
if-match ip-prefix NO_MULTICAST_2_ISIS
#
route-policy R2I permit node 2
#
route-policy S2R deny node 1
if-match ip-prefix LOCAL-SUMM
#
route-policy S2R permit node 2
#

```

- For PD1 use BSR election for configuring RP. Configure IP address 1.1.1.1 on AR2 as candidate RP, and AR4 for candidate BSR.
- For PD2 configure IP address 2.2.2.2 for RP on AR5 and AR7.

- Configure additional protocols if needed to provide multicast connectivity between the source on SERVER1 and both receivers.

AR2:

```
#
pim
c-rp LoopBack100
#

<AR2>display current-configuration section msdp
[V200R003C00]
#
msdp
peer 3.3.3.2 connect-interface Tunnel0/0/0
#
```

AR4:

```
<AR4>display current-configuration section pim
[V200R003C00]
#
pim
c-bsr LoopBack0
ssm-policy acl-name SSM_EXTENDING
#
```

AR5:

```
<AR5>display current-configuration section pim
[V200R003C00]
#
pim
static-rp 2.2.2.2
#

<AR5>display current-configuration section msdp
[V200R003C00]
#
msdp
peer 3.3.3.1 connect-interface Tunnel0/0/0
#
```

AR7:

```
<AR7>display current-configuration section pim
[V200R003C00]
#
pim
static-rp 2.2.2.2
#
```

Verify the configuration:

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AR2:

<AR2>**display pim rp-info**

VPN-Instance: public net
 PIM-SM BSR RP Number: 1
 Group/MaskLen: 224.0.0.0/4
 RP: 1.1.1.1 (local)
 Priority: 0
 Uptime: 5d:10h
 Expires: 00:01:32

<AR2>**display pim bsr-info**

VPN-Instance: public net
 Elected AdminScoped BSR Count: 0
 Elected BSR Address: 10.0.140.1
 Priority: 0
 Hash mask length: 30
 State: Accept Preferred
 Scope: Not scoped
 Uptime: 5d:10h
 Expires: 00:01:36
 C-RP Count: 1

<AR2>**display msdp peer-status**

MSDP Peer Information of VPN-Instance: public net
 MSDP Peer 3.3.3.2, AS ?
 Description:
 Information about connection status:
 State: Up
 Up/down time: 5d10h
 Resets: 0
 Connection interface: Tunnel0/0/0 (3.3.3.1)
 Number of sent/received messages: 7703/7683
 Number of discarded output messages: 0
 Elapsed time since last connection or counters clear: 5d10h
 Information about (Source, Group)-based SA filtering policy:
 Import policy: none
 Export policy: none
 Information about SA-Requests:
 Policy to accept SA-Request messages: none
 Sending SA-Requests status: disable
 Minimum TTL to forward SA with encapsulated data: 0
 SAs learned from this peer: 0, SA-cache maximum for the peer: none
 Input queue size: 0, Output queue size: 0
 Counters for MSDP message:
 Count of RPF check failure: 0
 Incoming/outgoing SA messages: 0/0
 Incoming/outgoing SA requests: 0/0
 Incoming/outgoing SA responses: 0/0
 Incoming/outgoing data packets: 0/0
 Peer authentication: unconfigured
 Peer authentication type: none

AR4:

```
<AR4>display pim rp-info
VPN-Instance: public net
PIM-SM BSR RP Number: 1
Group/MaskLen: 224.0.0.0/4
  RP: 1.1.1.1
  Priority: 0
  Uptime: 5d:09h
  Expires: 00:02:06
```

AR5:

```
<AR5>display pim rp-info
VPN-Instance: public net
PIM SM static RP Number: 1
  Static RP: 2.2.2.2 (local)

<AR5>display msdp peer-status
MSDP Peer Information of VPN-Instance: public net
MSDP Peer 3.3.3.1, AS ?
Description:
Information about connection status:
  State: Up
  Up/down time: 5d10h
  Resets: 0
  Connection interface: Tunnel0/0/0 (3.3.3.2)
  Number of sent/received messages: 7683/7702
  Number of discarded output messages: 0
  Elapsed time since last connection or counters clear: 5d10h
Information about (Source, Group)-based SA filtering policy:
  Import policy: none
  Export policy: none
Information about SA-Requests:
  Policy to accept SA-Request messages: none
  Sending SA-Requests status: disable
Minimum TTL to forward SA with encapsulated data: 0
SAs learned from this peer: 0, SA-cache maximum for the peer: none
Input queue size: 0, Output queue size: 0
Counters for MSDP message:
  Count of RPF check failure: 0
  Incoming/outgoing SA messages: 0/0
  Incoming/outgoing SA requests: 0/0
  Incoming/outgoing SA responses: 0/0
  Incoming/outgoing data packets: 0/0
Peer authentication: unconfigured
Peer authentication type: none
```

AR7:

```
<AR7>display pim rp-info
VPN-Instance: public net
PIM SM static RP Number:1
Static RP: 2.2.2.2
```

7.2 General Multicast configuration

- Make sure that AR7 accepts multicast packets from source SERVER1 only and the multicast source lifetime is set to 10min.
- Configure AR1 and AR2 to stay on the RP tree until the traffic rate from the source is less than 3072kbit/s. This configuration should affect only traffic to group 239.49.39.1.

AR7:

```
<AR7>display current-configuration section pim
[V200R003C00]
#
pim
static-rp 2.2.2.2
source-policy acl-name MULTICAST_SOURCE
ssm-policy acl-name SSM_EXTENDING
source-lifetime 600
#
#
acl name MULTICAST_SOURCE 2998
rule 5 permit source 172.20.100.100 0
acl name SSM_EXTENDING 2999
rule 5 permit source 239.49.39.1 0
#
```

AR1 & AR2:

```
#
pim
spt-switch-threshold 3072 group-policy acl-name MULTICAST_GROUP
ssm-policy acl-name SSM_EXTENDING
#
#
acl name MULTICAST_GROUP 2998
rule 5 permit source 239.49.39.1 0
acl name SSM_EXTENDING 2999
rule 5 permit source 239.49.39.1 0
#
```

Task 6: QoS Configuration

7.2 Frame Relay QoS

- Frame Relay PVCs purchased from the provider for connectivity between AR1, AR2 and AR4 can transmit up to 384Kbit/s of traffic. Make sure that AR1, AR2 and AR4 are not allowed to transmit more than the purchased bandwidth.
- Configure the CIR between AR1, AR2 and AR4 to 256Kbit/s.
- Make sure that if the output queue reaches length of 20 packets the transmission rate of the PVC is reduced to limit the packet loss.

AR1, AR2 & AR4:

```
#
fr class FR_SHAPED
  cir allow outbound 384
  cir 256
  traffic-shaping adaptation interface-congestion 20
#

#
interface Serial3/0/0
  link-protocol fr
  fr traffic-shaping
  fr dlci 102
    fr-class FR_SHAPED
  fr dlci 104
    fr-class FR_SHAPED
  ip address 10.0.10.1 255.255.255.128
#
```

7.2 Layer 2 QoS configuration

- Configure LSW1 and LSW2 to classify and remark the traffic based on the table below.

Device	VLANs	802.1p
LSW1	500	5
	600	6
	710	7
LSW2	500	5
	600	6
	710	7

LSW1 & LSW2:

```
#
traffic classifier MATCH-ALL operator and
if-match any
#
traffic behavior VLAN500
remark 8021p 5
traffic behavior VLAN600
remark 8021p 6
traffic behavior VLAN710
remark 8021p 7
#
traffic policy VLAN500
classifier MATCH-ALL behavior VLAN500
traffic policy VLAN600
classifier MATCH-ALL behavior VLAN600
traffic policy VLAN710
classifier MATCH-ALL behavior VLAN710
#
drop-profile default
#
vlan 500
description servers
traffic-policy VLAN500 inbound
vlan 600
description engineering
traffic-policy VLAN600 inbound
vlan 610
description accounting
vlan 620
description administration
vlan 700
description terminals
vlan 710
description users
traffic-policy VLAN710 inbound
#
interface Ethernet0/0/5
port link-type trunk
port trunk allow-pass vlan 2 to 4094
stp loop-protection
qos queue 5 wrr weight 0
qos queue 6 wrr weight 40
qos queue 7 wrr weight 20
#
```

- Make sure that the traffic marked with 802.1p of 5 is transmitted with priority on all interfaces to LSW3 and LSW4. Configure those interfaces for Weighted Round Robin scheduling using the information from the table below.

VLANs	Weight
500	PQ
600	40
710	20

- Traffic coming down from LSW1 and LSW2 is causing congestion on LSW3 and LSW4. Classify, policy and remark the traffic coming to LSW3 and LSW4 according the table below. Ensure that you base your classification on both VLAN and 801.2p.

VLAN	802.1p marking	CIR (kbit/s)	PIR (kbit/s)	DSCP remarking
500	5	7000	20000	10
600	6	4000	10000	30
710	7	5000	10000	38

LSW3 & LSW4:

```
#
traffic classifier VLAN500 operator and
if-match vlan-id 500
if-match 8021p 5
traffic classifier VLAN600 operator and
if-match 8021p 6
if-match vlan-id 600
traffic classifier VLAN710 operator and
if-match vlan-id 710
if-match 8021p 7
#
traffic behavior VLAN500
car cir 7000 pir 20000 cbs 875000 pbs 2500000 green pass yellow pass red discard

remark dscp af11
traffic behavior VLAN600
remark dscp af33
car cir 4000 pir 10000 cbs 500000 pbs 1250000 green pass yellow pass red discard

traffic behavior VLAN710
remark dscp af43
car cir 5000 pir 10000 cbs 625000 pbs 1250000 green pass yellow pass red discard

#
traffic policy TP1
classifier VLAN500 behavior VLAN500
classifier VLAN600 behavior VLAN600
classifier VLAN710 behavior VLAN710
#
drop-profile default
#
#
interface GigabitEthernet0/0/3
```

```

port link-type trunk
port trunk allow-pass vlan 2 to 4094
stp loop-protection
traffic-policy TP1 inbound
#
interface GigabitEthernet0/0/4
port link-type trunk
port trunk allow-pass vlan 2 to 4094
stp loop-protection
stp instance 2 port priority 16
traffic-policy TP1 inbound
#

```

7.2 Layer 3 QoS configuration

- Limit the rate of traffic from each IP address sourced from 75.75.75.0/24 to 128kbit/s to E1. Make sure that a single IP can not exceed this limit.
- Configure all other subnets advertised to E1 to not exceed 200mbit/s of traffic. Ensure that up to 2 x the rate can be reached in case of high traffic demand.

AR4:

```

#
interface GigabitEthernet0/0/0
ip address 192.168.150.2 255.255.255.0
qos car outbound source-ip-address range 75.75.75.0 to 75.75.75.255 cir 64 cbs 12032 pbs 20032
green pass yellow pass red discard
qos car outbound acl 2000 cir 200000 cbs 37600000 pbs 62600000 green pass yellow pass red
discard
qos car outbound acl 2001 cir 200000 cbs 37600000 pbs 62600000 green pass yellow pass red
discard
#
interface GigabitEthernet0/0/1
ip address 192.168.151.2 255.255.255.0
qos car outbound source-ip-address range 75.75.75.0 to 75.75.75.255 cir 64 cbs 12032 pbs 20032
green pass yellow pass red discard
qos car outbound acl 2000 cir 200000 cbs 37600000 pbs 62600000 green pass yellow pass red
discard
qos car outbound acl 2001 cir 200000 cbs 37600000 pbs 62600000 green pass yellow pass red
discard
#

```

- To limit the congestion on interfaces connecting CE1, CE2 and CE4, configure the bandwidth restrictions following the table below:

DSCP Value	Queue Number	Scheduling Method	Drop Method
10	7	PQ	Tail Drop
30	6	WFQ	WRED: 90% Upper drop 50% Lower drop 15% Drop Probability
38	5	WFQ	WRED: 70% Upper drop 30% Lower drop 20% Drop Probability
28	5	WFQ	WRED: 60% Upper drop 20% Lower drop 30% Drop Probability

AR1, AR2 & AR4:

```
#
drop-profile 30_6
wred dscp
  dscp af33 low-limit 50 high-limit 90 discard-percentage 15
drop-profile 28_38_5
wred dscp
  dscp af32 low-limit 20 high-limit 60 discard-percentage 30
  dscp af43 low-limit 30 high-limit 70 discard-percentage 20
#
qos queue-profile qp1
  schedule wfq 5 to 6 pq 7
  queue 5 drop-profile 28_38_5
  queue 6 drop-profile 30_6
#
#
interface GigabitEthernet0/0/2
ip binding vpn-instance Customer-1
ip address 192.168.10.1 255.255.255.0
qos queue-profile qp1
#
```

Task 7: Security and Management features.

7.2 Layer 2 security features

- Hosts connected to interfaces from Ethernet 0/0/15 to 0/0/20 on LSW1 and LSW2 should be authenticated before receiving access to the network. Assign those interfaces to VLAN 900.
- Assume that a RADIUS server is available with IP address 192.168.90.9 with a preshared key *workbook*. Make sure that the authentication is done against that RADIUS server. To successfully authenticate the host you must use username ending with @lab1.
- Ensure that devices which need access to the network but cannot provide credentials (link printers) are not restricted.

LSW1 & LSW2:

```
#
dot1x retry 3
#
#
radius-server template rserver1
radius-server shared-key cipher +S9+=YM4^#ENZPO3JBXBHA!!
radius-server authentication 192.168.90.9 1812
#
#
aaa
domain lab1
radius-server rserver1
#
interface Ethernet0/0/15
port hybrid untagged vlan 900
dot1x mac-bypass
#
interface Ethernet0/0/16
port hybrid untagged vlan 900
dot1x mac-bypass
#
interface Ethernet0/0/17
port hybrid untagged vlan 900
dot1x enable
#
interface Ethernet0/0/18
port hybrid untagged vlan 900
dot1x enable
#
interface Ethernet0/0/19
port hybrid untagged vlan 900
dot1x enable
#
```

7.2 Device user and management access.

- Configure on all devices the users and privileges shown in the table below.

User	Password	Privileges
super	admin123	System maintenance commands
operator	oper123	Configuration and debugging commands

- Make sure that these users can access the devices via SSH.

All devices:

```
#
aaa
local-user super password cipher %$%$Px\S-xYc2*bH5|3Tf9a9,2n%$%$
local-user super privilege level 3
local-user super service-type ssh
local-user operator password cipher %$%$Wf#K^_"I3h,<(B#EPs/7pj/|O)7CCbpUVaKf9Mj
mS;@pj27%$%$
local-user operator privilege level 1
local-user operator service-type ssh
#
#
stelnet server enable
#
#
user-interface vty 0 4
authentication-mode aaa
protocol inbound ssh
user-interface vty 16 20
#
```

7.2 L3 security and NAT configuration.

- Configure the additional interface described in the Table below.

Device	Interface	IP Address
AR3	GE0/0/1	192.168.1.1/24
AR5	GE0/0/1	192.168.1.129/24

- Configure VRRP in load balancing mode across AR3 and AR5 using virtual IP addresses 192.168.1.100 and 192.168.1.200 respectively. Make sure that when the original master router is returned to service a delay of 30 sec is used.

AR3:

```
<AR3>display current-configuration interface gi0/0/1
[V200R003C00]
#
interface GigabitEthernet0/0/1
ip address 192.168.1.1 255.255.255.0
vrrp vrid 1 virtual-ip 192.168.1.100
vrrp vrid 1 priority 150
vrrp vrid 1 preempt-mode timer delay 30
```

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```
vrrp vrid 2 virtual-ip 192.168.1.200
#
```

AR5:

```
<AR5>display current-configuration interface gi0/0/1
[V200R003C00]
#
interface GigabitEthernet0/0/1
ip address 192.168.1.129 255.255.255.0
vrrp vrid 1 virtual-ip 192.168.1.100
vrrp vrid 2 virtual-ip 192.168.1.200
vrrp vrid 2 priority 150
vrrp vrid 2 preempt-mode timer delay 30
dhcp select global
#
```

Verify the configuration:

AR3:

```
<AR3>display vrrp 1
GigabitEthernet0/0/1 | Virtual Router 1
  State : Master
  Virtual IP : 192.168.1.100
  Master IP : 1.1.168.192
  PriorityRun : 150
  PriorityConfig : 150
  MasterPriority : 150
  Preempt : YES   Delay Time : 30 s
  TimerRun : 1 s
  TimerConfig : 1 s
  Auth type : NONE
  Virtual MAC : 0000-5e00-0101
  Check TTL : YES
  Config type : normal-vrrp
  Backup-forward : disabled
  Create time : 2015-11-12 18:43:19 UTC-08:00
  Last change time : 2015-11-12 18:43:30 UTC-08:00

<AR3>display vrrp 2
GigabitEthernet0/0/1 | Virtual Router 2
  State : Backup
  Virtual IP : 192.168.1.200
  Master IP : 192.168.1.129
  PriorityRun : 100
  PriorityConfig : 100
  MasterPriority : 150
  Preempt : YES   Delay Time : 0 s
  TimerRun : 1 s
  TimerConfig : 1 s
  Auth type : NONE
  Virtual MAC : 0000-5e00-0102
  Check TTL : YES
  Config type : normal-vrrp
  Backup-forward : disabled
```

Create time : 2015-11-12 18:43:19 UTC-08:00
Last change time : 2015-11-12 18:43:58 UTC-08:00

AR5:

```
<AR5>display vrrp 1
GigabitEthernet0/0/1 | Virtual Router 1
  State : Backup
  Virtual IP : 192.168.1.100
  Master IP : 192.168.1.1
  PriorityRun : 100
  PriorityConfig : 100
  MasterPriority : 150
  Preempt : YES   Delay Time : 0 s
  TimerRun : 1 s
  TimerConfig : 1 s
  Auth type : NONE
  Virtual MAC : 0000-5e00-0101
  Check TTL : YES
  Config type : normal-vrrp
  Backup-forward : disabled
  Create time : 2015-11-12 18:42:28 UTC-08:00
  Last change time : 2015-11-12 18:43:59 UTC-08:00
```

```
<AR5>display vrrp 2
GigabitEthernet0/0/1 | Virtual Router 2
  State : Master
  Virtual IP : 192.168.1.200
  Master IP : 192.168.1.129
  PriorityRun : 150
  PriorityConfig : 150
  MasterPriority : 150
  Preempt : YES   Delay Time : 30 s
  TimerRun : 1 s
  TimerConfig : 1 s
  Auth type : NONE
  Virtual MAC : 0000-5e00-0102
  Check TTL : YES
  Config type : normal-vrrp
  Backup-forward : disabled
  Create time : 2015-11-12 18:42:28 UTC-08:00
  Last change time : 2015-11-12 18:42:38 UTC-08:00
```

- Configure AR3 and AR5 to provide statefull address assignment through the DHCP protocol on interface GE0/0/1.

- Configure the DHCP server in a way to support the load balancing configuration.

AR3:

```
#
dhcp enable
#
#
ip pool pool1
 gateway-list 192.168.1.100 192.168.1.200
 network 192.168.1.0 mask 255.255.255.0
#
#
interface GigabitEthernet0/0/1
 ip address 192.168.1.1 255.255.255.0
 dhcp select global
#
```

AR5:

```
#
dhcp enable
#
#
ip pool pool1
 gateway-list 192.168.1.100 192.168.1.200
 network 192.168.1.0 mask 255.255.255.0
#
#
interface GigabitEthernet0/0/1
 ip address 192.168.1.1 255.255.255.0
 dhcp select global
#
```

- Ensure that configuration prevents conflict of IP addresses. You are not allowed to use **exclude-ip-address** option.

AR3 & AR5:

```
#
dhcp server ping packet 3
dhcp server ping timeout 200
#
```

- Make sure that the traffic send from subnet 192.168.1.0 to prefix 143.25.64.0/21 is translated to the interface IP address.

AR3:

```
#
acl number 3000
 rule 5 permit ip source 192.168.1.0 0.0.0.255 destination 143.25.64.0 0.0.15.255
#
#
interface Serial3/0/0
 link-protocol hdlc
 ip address 10.10.10.1 255.255.255.252
 isis enable 1
 nat outbound 3000
#
#
interface GigabitEthernet0/0/0
 ip address 172.20.1.1 255.255.255.0
 rip metricin 5
 rip metricout 5
 nat outbound 3000
#
```

AR5:

```
#
acl number 3000
 rule 5 permit ip source 192.168.1.0 0.0.0.255 destination 143.25.64.0 0.0.15.255
#
#
interface Serial3/0/0
 link-protocol hdlc
 ip address 10.10.10.2 255.255.255.252
 isis enable 1
 nat outbound 3000
#
#
interface GigabitEthernet0/0/0
 ip address 172.20.2.1 255.255.255.0
 pim sm
 nat outbound 3000
#
```

AR6:

```
<AR6>display current-configuration sec bgp
[V200R003C00]
#
bgp 456
#
ipv4-family unicast
 undo synchronization
 network 172.20.0.0
 peer 172.20.1.1 enable
 peer 172.20.1.1 route-policy FROM-AR3 import
 peer 172.20.1.1 route-policy TO-AR3 export
```

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```
peer 172.20.1.1 advertise-community
peer 172.20.170.1 enable
peer 172.20.170.1 route-policy TO-AR7 export
peer 172.20.170.1 advertise-community
peer 172.20.180.1 enable
peer 172.20.180.1 route-policy TO-AR8 export
peer 172.20.180.1 next-hop-local
peer 172.20.180.1 advertise-community
#
<AR6>display current-configuration section route-policy
[V200R003C00]
#
#
route-policy TO-AR3 deny node 1
if-match ip-prefix 172_20_SUMM
#
route-policy TO-AR3 permit node 2
#
route-policy TO-AR7 deny node 1
if-match ip-prefix 172_20_SUMM
#
route-policy TO-AR7 permit node 2
#
route-policy TO-AR8 deny node 1
if-match ip-prefix 172_20_SUMM
#
route-policy TO-AR8 permit node 2
#
<AR6>display current-configuration | include prefix
ip ip-prefix 172_20_SUMM index 10 permit 172.20.0.0 16 greater-equal 16 less-equal 16

<AR6>display current-configuration | include static
ip route-static 172.20.0.0 255.255.0.0 NULL0
```

Verify the configuration:

AR3:

```
<AR3>display nat outbound
```

NAT Outbound Information:

```
-----
Interface          Acl  Address-group/IP/Interface  Type
-----
GigabitEthernet0/0/0  3000          172.20.1.1  easyip
Serial3/0/0         3000          10.10.10.1  easyip
-----
Total : 2
```

AR6:

```
<AR6>display bgp routing-table peer 17.18.19.1 advertised-routes | include 172.20
```

BGP Local router ID is 172.20.1.2

Status codes: * - valid, > - best, d - damped,
h - history, i - internal, s - suppressed, S - Stale
Origin : i - IGP, e - EGP, ? - incomplete

Total Number of Routes: 18

Network	NextHop	MED	LocPrf	PrefVal	Path/Ogn
*> 172.20.0.0	17.18.19.2	0	0	654i	

END