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| **PRACTICAL NO 1**  **Configure IP SLA Tracking and Path Control TopologyNETWORK TOPOLOGY**    TASKS   * Configure and verify the IP SLA feature. * Test the IP SLA tracking feature. * Verify the configuration and operation using show and debug commands   R1  Router>enable Router#conf t  Router(config)#hostname R1 R1(config)#interface Loopback 0  R1(config-if)#ip address 192.168.1.1 255.255.255.0 R1(config-if)#exit  R1(config)#interface s1/0  R1(config-if)#ip address 209.165.201.2 255.255.255.252 R1(config-if)#no shutdown  R1(config-if)#exit  R1(config)#interface s1/1 | |  |
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| R1(config-if)#ip address 209.165.202.130 255.255.255.252 R1(config-if)#no shutdown  R1(config-if)#exit  R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1  R1(config)#ip sla 12  R1(config-ip-sla)#icmp-echo 209.165.201.30  R1(config-ip-sla-echo)#frequency 11 R1(config-ip-sla-echo)#exit  R1(config)#ip sla schedule 12 life forever start-time now R1#sh ip sla configuration 12  IP SLAs Infrastructure Engine-III Entry number: 12  Owner:  Tag:  Operation timeout (milliseconds): 5000 Type of operation to perform: icmp-echo  Target address/Source address: 209.165.201.30/0.0.0.0Type Of Service parameter: 0x0  Request size (ARR data portion): 28Verify data: No  Vrf Name:  Schedule:  Operation frequency (seconds): 11 (not considered if randomly scheduled)Next Scheduled Start Time: Start Time already passed  Group Scheduled : FALSE Randomly Scheduled : FALSE Life (seconds): Forever  Entry Ageout (seconds): never Recurring (Starting Everyday): FALSE  Status of entry (SNMP RowStatus): Active Threshold (milliseconds): 5000  Distribution Statistics:  Number of statistic hours kept: 2  Number of statistic distribution buckets kept: 1Statistic distribution interval (milliseconds): 20 | |  |
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| Enhanced History:  History Statistics:  Number of history Lives kept: 0 Number of history Buckets kept: 15History Filter Type: None  R1#sh ip sla statistics  IPSLAs Latest Operation Statistics  IPSLA operation id: 12  Latest RTT: 11 milliseconds  Latest operation start time: 18:21:25 EET Thu Apr 9 2020Latest operation return code: OK  Number of successes: 22 Number of failures: 0 Operation time to live:  Forever R1(config)#ip sla 24  R1(config-ip-sla)#icmp-echo 209.165.202.158  R1(config-ip-sla-echo)#frequency 10 R1(config-ip-sla-echo)#exit  R1(config)#ip sla schedule 24 life forever start-time now R1#sh ip sla configuration 24  IP SLAs Infrastructure Engine-III Entry number: 24  Owner:  Tag:  Operation timeout (milliseconds): 5000 Type of operation to perform: icmp-echo  Target address/Source address: 209.165.202.158/0.0.0.0Type Of Service parameter: 0x0  Request size (ARR data portion): 28Verify data: No  Vrf Name: | |  |
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| Schedule:  Operation frequency (seconds): 10 (not considered if randomly scheduled)Next Scheduled Start Time: Start Time already passed  Group Scheduled : FALSE Randomly Scheduled : FALSE Life (seconds): Forever  Entry Ageout (seconds): never Recurring (Starting Everyday): FALSE  Status of entry (SNMP RowStatus): Active Threshold (milliseconds): 5000  Distribution Statistics:  Number of statistic hours kept: 2  Number of statistic distribution buckets kept: 1Statistic distribution interval (milliseconds): 20  Enhanced History:  History Statistics:  Number of history Lives kept: 0 Number of history Buckets kept: 15History Filter Type: None  R1#sh ip sla statistics 24 IPSLAs Latest Operation Statistics IPSLA operation id: 24  Latest RTT: 20 milliseconds  Latest operation start time: 18:33:25 EET Thu Apr 9 2020Latest operation return code: OK  Number of successes: 16 Number of failures: 0 Operation time to live:  Forever  R1(config)#no ip route 0.0.0.0 0.0.0.0 209.165.201.1  R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 5  R1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - | |  |
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| periodic downloaded static route, H - NHRP, l - LISP a - application route  + - replicated route, % - next hop override  Gateway of last resort is 209.165.201.1 to network 0.0.0.0  S\* 0.0.0.0/0 [5/0] via 209.165.201.1  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected, Loopback0  L 192.168.1.1/32 is directly connected, Loopback0 209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks  C 209.165.201.0/30 is directly connected, Serial1/0L 209.165.201.2/32 is directly connected, Serial1/0  209.165.202.0/24 is variably subnetted, 2 subnets, 2 masksC 209.165.202.128/30 is directly connected, Serial1/1  L 209.165.202.130/32 is directly connected, Serial1/1 R1(config)#track 1 ip sla 12 reachability  R1(config-track)#delay down 10 up 1  R1(config-track)#exit  R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1  R1(config)#track 2 ip sla 12 reachability  R1(config-track)#delay down 10 up 1 R1(config-track)#exit  R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 3 track 2  R1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override  Gateway of last resort is 209.165.201.1 to network 0.0.0.0 | |  |
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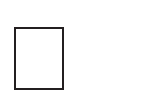
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| S\* 0.0.0.0/0 [3/0] via 209.165.201.1  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected, Loopback0  L 192.168.1.1/32 is directly connected, Loopback0 209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks  C 209.165.201.0/30 is directly connected, Serial1/0L 209.165.201.2/32 is directly connected, Serial1/0  209.165.202.0/24 is variably subnetted, 2 subnets, 2 masksC 209.165.202.128/30 is directly connected, Serial1/1  L 209.165.202.130/32 is directly connected, Serial1/1 R1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override  Gateway of last resort is 209.165.201.1 to network 0.0.0.0 S\* 0.0.0.0/0 [5/0] via 209.165.201.1  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected, Loopback0 L 192.168.1.1/32 is directly connected, Loopback0 209.165.201.0/24  is variably subnetted, 2 subnets, 2 masks  C 209.165.201.0/30 is directly connected, Serial1/0L 209.165.201.2/32 is directly connected, Serial1/0  209.165.202.0/24 is variably subnetted, 2 subnets, 2 masksC 209.165.202.128/30 is directly connected, Serial1/1  L 209.165.202.130/32 is directly connected, Serial1/1  R1#sh ip sla statistics  IPSLAs Latest Operation Statistics IPSLA operation id: 12 | |  |
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| Latest RTT: NoConnection/Busy/Timeout  Latest operation start time: 19:02:29 EET Thu Apr 9 2020Latest operation return code: Timeout  Number of successes: 227 Number of failures: 19 Operation time to live: ForeverIPSLA operation id: 24  Latest RTT: 20 milliseconds  Latest operation start time: 19:02:35 EET Thu Apr 9 2020Latest operation return code: OK  Number of successes: 190  Number of failures: 1 Operation time to live: Forever  R1#trace 209.165.200.254 source 192.168.1.1  Type escape sequence to abort. Tracing the route to 209.165.200.254  VRF info: (vrf in name/id, vrf out name/id)1 209.165.201.1 10 msec 14 msec \*  R1#sh ip sla statistics  IPSLAs Latest Operation Statistics IPSLA operation id: 12  Latest RTT: 10 milliseconds  Latest operation start time: 19:07:04 EET Thu Apr 9 2020Latest operation return code: OK  Number of successes: 236 Number of failures: 35 Operation time to live: ForeverIPSLA operation id: 24  Latest RTT: 21 milliseconds  Latest operation start time: 19:07:05 EET Thu Apr 9 2020Latest operation return code: OK  Number of successes: 217  Number of failures: 1  Operation time to live: Forever R1#sh ip route | |  |
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| Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override  Gateway of last resort is 209.165.201.1 to network 0.0.0.0  S\* 0.0.0.0/0 [3/0] via 209.165.201.1  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected, Loopback0  L 192.168.1.1/32 is directly connected, Loopback0 209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks  C 209.165.201.0/30 is directly connected, Serial1/0L 209.165.201.2/32 is directly connected, Serial1/0  209.165.202.0/24 is variably subnetted, 2 subnets, 2 masksC 209.165.202.128/30 is directly connected, Serial1/1  L 209.165.202.130/32 is directly connected, Serial1/1  ISP1 (R2)  Router>enable Router#conf t  Router(config)#hostname ISP1 ISP1(config)#interface Loopback0  ISP1(config-if)#description Simulated Internet Web Server ISP1(config-if)#ip address 209.165.200.254 255.255.255.255 ISP1(config-if)#exit  ISP1(config)#interface Loopback1  ISP1(config-if)#ip address 209.165.201.30 255.255.255.255 ISP1(config-if)#exit  ISP1(config)#interface s1/0  ISP1(config-if)#ip address 209.165.201.1 255.255.255.252 ISP1(config-if)#no shutdown  ISP1(config-if)#exit ISP1(config)#interface s1/1  ISP1(config-if)#ip address 209.165.200.225 255.255.255.252 | |  |
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| ISP1(config-if)#no shutdown ISP1(config-if)#exit ISP1(config)#router eigrp 200  ISP1(config-router)#network 209.165.200.224  ISP1(config-router)#network 209.165.201.0 ISP1(config-router)#no auto-summary ISP1(config- router)#exit  ISP1(config)#ip route 192.168.1.0 255.255.255.0 209.165.201.2  ISP1(config)#interface loopback 1 ISP1(config-if)#shut ISP1(config)#interface loopback 1 ISP1(config-if)#no shutdown  ISP2 (R3)  Router>enable Router#conf t  Router(config)#hostname ISP2 ISP2(config)#interface Loopback0  ISP2(config-if)#description Simulated Internet Web Server ISP2(config-if)#ip address 209.165.200.254 255.255.255.255 ISP2(config-if)#exit  ISP2(config)#interface Loopback1  ISP2(config-if)#ip address 209.165.202.158 255.255.255.255 ISP2(config-if)#exit  ISP2(config)#interface s1/1  ISP2(config-if)#ip address 209.165.200.226 255.255.255.252 ISP2(config-if)#no shutdown  ISP2(config-if)#exit ISP2(config)#interface s1/0  ISP2(config-if)#ip address 209.165.202.129 255.255.255.252 ISP2(config-if)#no shutdown  ISP2(config-if)#exit ISP2(config)#router eigrp 200  ISP2(config-router)#network 209.165.200.224  ISP2(config-router)#network 209.165.202.128 ISP2(config-router)#no auto-summary ISP2(config- router)#exit  ISP2(config)#ip route 192.168.1.0 255.255.255.0 209.165.202.130 | |  |
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| **PRACTICAL NO 2**  **Using the AS\_PATH AttributeNETWORK TOPOLOGY**    TASKS  Use BGP commands to prevent private AS numbers from being advertisedto the outside world.  Use the AS\_PATH attribute to filter BGP routes based on their source ASnumbers.  SanJose Router>enable Router#conf t  Router(config)#hostname SanJose SanJose(config)#interface Loopback0 SanJose(config-if)#ip address 10.1.1.1 255.255.255.0SanJose(config-if)#exit  SanJose(config)#interface Serial1/0  SanJose(config-if)#ip address 192.168.1.5 255.255.255.252 SanJose(config-if)#no shutdown  SanJose(config-if)#end SanJose(config)#router bgp 100  SanJose(config-router)#network 10.1.1.0 mask 255.255.255.0  SanJose(config-router)#neighbor 192.168.1.6 remote-as 300 SanJose(config-router)#exit | |  |
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| SanJose#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 4 subnets, 2 masksC 10.1.1.0/24 is directly connected, Loopback0  L 10.1.1.1/32 is directly connected, Loopback0B 10.2.2.0/24 [20/0] via 192.168.1.6, 00:05:47  B 10.3.3.0/24 [20/0] via 192.168.1.6, 00:02:13  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.4/30 is directly connected, Serial1/0  L 192.168.1.5/32 is directly connected, Serial1/0  SanJose#sh ip bgp  BGP table version is 4, local router ID is 10.1.1.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path | |  |
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| \*> 10.1.1.0/24  0.0.0.0 0 32768 i\*>  10.2.2.0/24 | 192.168.1.6 | 0 | 0 300 i |
| \*> 10.3.3.0/24  SanJose#sh ip bgp | 192.168.1.6 |  | 0 300 65000 i |

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| BGP table version is 5, local router ID is 10.1.1.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S  Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \*> 10.1.1.0/24 0.0.0.0 0 32768 i  \*> 10.2.2.0/24 192.168.1.6 0 0 300 i  \*> 10.3.3.0/24 192.168.1.6 0 300 i  ISP  Router>enable Router#conf t  Router(config)#hostname ISP ISP(config)#interface Loopback0  ISP(config-if)#ip address 10.2.2.1 255.255.255.0 ISP(config-if)#exit  ISP(config)#interface Serial1/0  ISP(config-if)#ip address 192.168.1.6 255.255.255.252 ISP(config-if)#no shutdown  ISP(config-if)#exit ISP(config)#interface Serial1/1  ISP(config-if)#ip address 172.24.1.17 255.255.255.252 ISP(config-if)#no shutdown  ISP(config-if)#end ISP(config)#router bgp 300  ISP(config-router)#network 10.2.2.0 mask 255.255.255.0  ISP(config-router)#neighbor 192.168.1.5 remote-as 100  ISP(config-router)#neighbor 172.24.1.18 remote-as 65000  ISP(config)#router bgp 300  ISP(config-router)#neighbor 192.168.1.5 remove-private-asISP(config- router)#end  ISP#clear ip bgp \* soft | |  |
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| ISP(config)#ip as-path access-list 1 deny ^100$ ISP(config)#ip as-path access-list 1 permit .\* ISP(config)#router bgp 300  ISP(config-router)#neighbor 172.24.1.18 filter-list 1 out ISP(config-router)#end  ISP#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks B 10.1.1.0/24 [20/0] via 192.168.1.5, 00:46:41  C 10.2.2.0/24 is directly connected, Loopback0 L 10.2.2.1/32 is directly connected, Loopback0 B 10.3.3.0/24 [20/0] via 172.24.1.18, 00:43:07  172.24.0.0/16 is variably subnetted, 2 subnets, 2 masks C 172.24.1.16/30 is directly connected, Serial1/1  L 172.24.1.17/32 is directly connected, Serial1/1 192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks  C 192.168.1.4/30 is directly connected, Serial1/0 L 192.168.1.6/32 is directly connected, Serial1/0  ISP#show ip bgp regexp ^100$  BGP table version is 4, local router ID is 10.2.2.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \*> 10.1.1.0/24 192.168.1.5 0 0 100 i | |  |
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| CustRtr Router>enable Router#conf t  Router(config)#hostname CustRtr CustRtr(config)#interface Loopback0 CustRtr(config-if)#ip address 10.3.3.1 255.255.255.0 CustRtr(config-if)#exit  CustRtr(config)#interface Serial1/0  CustRtr(config-if)#ip address 172.24.1.18 255.255.255.252 CustRtr(config-if)#no shutdown  CustRtr(config-if)#end CustRtr(config)#router bgp 65000  CustRtr(config-router)#network 10.3.3.0 mask 255.255.255.0  CustRtr(config-router)#neighbor 172.24.1.17 remote-as 300 CustRtr(config-router)#end  CustRtr#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l – LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 3 subnets, 2 masksB 10.2.2.0/24 [20/0] via 172.24.1.17, 00:45:59  C 10.3.3.0/24 is directly connected, Loopback0L 10.3.3.1/32 is directly connected, Loopback0  172.24.0.0/16 is variably subnetted, 2 subnets, 2 masksC 172.24.1.16/30 is directly connected, Serial1/0  L 172.24.1.18/32 is directly connected, Serial1/0 | |  |
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| **PRACTICAL NO 3**  **Configuring IBGP and EBGP Sessions, Local Preference, andMED NETWORK TOPOLOGY**    TASKS   * For IBGP peers to correctly exchange routing information, use the next- hop-self command with the Local-Preference and MED attributes. * Ensure that the flat-rate, unlimited-use T1 link is used for sending and receiving data to and from the AS 200 on ISP and that the metered T1 only be used in the event that the primary T1 link has failed   R1(ISP)  Router>enable Router#conf t  Router(config)#hostname ISP ISP(config)#interface Loopback0  ISP(config-if)#ip address 192.168.100.1 255.255.255.0 ISP(config-if)#exit  ISP(config)#interface Serial1/0  ISP(config-if)#ip address 192.168.1.5 255.255.255.252  ISP(config-if)#no shutdown | |  |
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| ISP(config-if)#exit ISP(config)#interface Serial1/1  ISP(config-if)#ip address 192.168.1.1 255.255.255.252 ISP(config-if)#no shutdown  ISP(config-if)#exit ISP(config)#router bgp 200  ISP(config-router)#network 192.168.100.0  ISP(config-router)#neighbor 192.168.1.6 remote-as 64512  ISP(config-router)#neighbor 192.168.1.2 remote-as 64512 ISP(config-router)#exit  ISP#sh ip bgp  BGP table version is 3, local router ID is 192.168.100.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? – incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* 172.16.0.0 192.168.1.2 0 0 64512 i  \*> 192.168.1.6 0 0 64512 i  \*> 192.168.100.0 0.0.0.0 0 32768 i  ISP#ping 172.16.1.1 source 192.168.100.1  Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:Packet sent with a source address of 192.168.100.1  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 10/10/11 msISP#ping 172.16.32.1 source 192.168.100.1  Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 172.16.32.1, timeout is 2 seconds:Packet sent with a source address of 192.168.100.1  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 15/15/16 msISP#ping  172.16.1.2 source 192.168.100.1 Type escape sequence to abort. | |  |
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| Sending 5, 100-byte ICMP Echos to 172.16.1.2, timeout is 2 seconds:Packet sent with a source address of 192.168.100.1  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 15/17/25 ms ISP(config)#router bgp 200  ISP(config-router)#network 192.168.1.0 mask 255.255.255.252  ISP(config-router)#network 192.168.1.4 mask 255.255.255.252ISP(config- router)#exit  ISP#sh ip bgp  BGP table version is 5, local router ID is 192.168.100.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* 172.16.0.0 192.168.1.6 0 0 64512 i  \*> 192.168.1.2 0 0 64512 i  \*> 192.168.1.0/30 0.0.0.0 0 32768 i  \*> 192.168.1.4/30 0.0.0.0 0 32768 i  \*> 192.168.100.0 0.0.0.0 0 32768 i  ISP#sh ip bgp  BGP table version is 6, local router ID is 192.168.100.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \*> 172.16.0.0 192.168.1.6 50 0 64512 i  \* 192.168.1.2 75 0 64512 i  ISP#ping 172.16.1.1 | |  |
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| \*> | 192.168.1.0/30 | 0.0.0.0 | 0 | 32768 i |
| \*> | 192.168.1.4/30 | 0.0.0.0 | 0 | 32768 i |
| \*> | 192.168.100.0 | 0.0.0.0 | 0 | 32768 i |

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| Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 9/10/11 ms ISP#ping 172.16.1.2  Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 172.16.1.2, timeout is 2 seconds:  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 20/21/25 ms ISP#traceroute 172.16.1.1  Type escape sequence to abort. Tracing the route to 172.16.1.1  VRF info: (vrf in name/id, vrf out name/id)1 192.168.1.6 10 msec 10 msec \*  ISP#traceroute 172.16.1.2 Type escape sequence to abort.  Tracing the route to 172.16.1.2  VRF info: (vrf in name/id, vrf out name/id)1 192.168.1.6 10 msec 10 msec 13 msec  2 172.16.1.2 [AS 64512] 20 msec 19 msec \*  R2 (SanJose1) Router>enable Router#conf t  Router(config)#hostname SanJose1 SanJose1(config)#interface Loopback0  SanJose1(config-if)#ip address 172.16.64.1 255.255.255.0  SanJose1(config-if)#ip address 172.16.64.1 255.255.255.0 SanJose1(config-if)#exit  SanJose1(config)#interface Serial1/0  SanJose1(config-if)#ip address 192.168.1.6 255.255.255.252 SanJose1(config-if)#no shutdown  SanJose1(config-if)#exit SanJose1(config)#interface Serial1/1  SanJose1(config-if)#ip address 172.16.1.1 255.255.255.0 SanJose1(config-if)#no shutdown | |  |
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| SanJose1(config-if)#exit SanJose1(config)#router eigrp 64512  SanJose1(config-router)#network 172.16.0.0 SanJose1(config-router)#no auto-summary SanJose1(config-router)#exit SanJose1(config)#router bgp 64512  SanJose1(config-router)#neighbor 172.16.32.1 remote-as 64512 SanJose1(config- router)#neighbor 172.16.32.1 update-source loopback0SanJose1(config-router)#exit  SanJose1(config)#ip route 172.16.0.0 255.255.0.0 null 0  SanJose1(config)#router bgp 64512  SanJose1(config-router)#network 172.16.0.0  SanJose1(config-router)#neighbor 192.168.1.5 remote-as 200 SanJose1(config-router)#exit  SanJose1(config)#router bgp 64512  SanJose1(config-router)#neighbor 172.16.32.1 next-hop-self SanJose1(config-router)#exit  SanJose1#sh ip bgp  BGP table version is 5, local router ID is 172.16.64.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* i 172.16.0.0 172.16.32.1 0 100 0 i  \*> 0.0.0.0 0 32768 i  \* i 192.168.1.0/30 172.16.32.1 0 100 0 200 i  \*> 192.168.1.5 0 0 200 i  r i 192.168.1.4/30 172.16.32.1 0 100 0 200 i  r> 192.168.1.5 0 0 200 i  \* i 192.168.100.0 172.16.32.1 0 100 0 200 i  \*> 192.168.1.5 0 0 200 i  SanJose1(config)#route-map PRIMARY\_T1\_IN permit 10 SanJose1(config-route-map)#set local-preference 160 SanJose1(config-route-map)#exit SanJose1(config)#router bgp 64512 | |  |
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| SanJose1(config-router)#neighbor 192.168.1.5 route-map PRIMARY\_T1\_IN in SanJose1(config-router)#exit  SanJose1#clear ip bgp \* soft SanJose1#sh ip bgp  BGP table version is 8, local router ID is 172.16.64.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* i 172.16.0.0 172.16.32.1 0 100 0 i  \*> 0.0.0.0 0 32768 i  \*> 192.168.1.0/30 192.168.1.5 0 160 0 200 i  r> 192.168.1.4/30 192.168.1.5 0 160 0 200 i  \*> 192.168.100.0 192.168.1.5 0 160 0 200 i  SanJose1(config)#route-map PRIMARY\_T1\_MED\_OUT permit 10 SanJose1(config-route-map)#set Metric 50  SanJose1(config-route-map)#exit SanJose1(config)#router bgp 64512  SanJose1(config-router)#neighbor 192.168.1.5 route-map PRIMARY\_T1\_MED\_OUT out  SanJose1(config-router)#exit SanJose1(config)#exit SanJose1#clear ip bgp \* soft  SanJose1#sh ip bgp  BGP table version is 8, local router ID is 172.16.64.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* i 172.16.0.0 172.16.32.1 0 100 0 i  \*> 0.0.0.0 0 32768 i  \*> 192.168.1.0/30 192.168.1.5 0 160 0 200 i  r> 192.168.1.4/30 192.168.1.5 0 160 0 200 i | |  |
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| \*> 192.168.100.0 192.168.1.5 0 160 0 200 i  SanJose1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l – LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  172.16.0.0/16 is variably subnetted, 6 subnets, 3 masksS 172.16.0.0/16 is directly connected, Null0  C 172.16.1.0/24 is directly connected, Serial1/1L 172.16.1.1/32 is directly connected, Serial1/1  D 172.16.32.0/24 [90/2297856] via 172.16.1.2, 01:28:25, Serial1/1  C 172.16.64.0/24 is directly connected, Loopback0L 172.16.64.1/32 is directly connected, Loopback0  192.168.1.0/24 is variably subnetted, 3 subnets, 2 masksB 192.168.1.0/30 [20/0] via 192.168.1.5, 00:45:28  C 192.168.1.4/30 is directly connected, Serial1/0L 192.168.1.6/32 is directly connected, Serial1/0  B 192.168.100.0/24 [20/0] via 192.168.1.5, 00:45:28  After issuing ip default-network SanJose1(config)#ip default- network 192.168.100.0SanJose1(config)#end  SanJose1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP | |  |
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| a - application route  + - replicated route, % - next hop override  Gateway of last resort is 192.168.1.5 to network 192.168.100.0  S\* 0.0.0.0/0 [20/0] via 192.168.1.5  172.16.0.0/16 is variably subnetted, 6 subnets, 3 masksS 172.16.0.0/16 is directly connected, Null0C 172.16.1.0/24 is directly connected, Serial1/1L 172.16.1.1/32 is directly connected, Serial1/1  D 172.16.32.0/24 [90/2297856] via 172.16.1.2, 01:33:38, Serial1/1  C 172.16.64.0/24 is directly connected, Loopback0L 172.16.64.1/32 is directly connected, Loopback0  192.168.1.0/24 is variably subnetted, 3 subnets, 2 masksB 192.168.1.0/30 [20/0] via 192.168.1.5, 00:50:41  C 192.168.1.4/30 is directly connected, Serial1/0L 192.168.1.6/32 is directly connected, Serial1/0  B\* 192.168.100.0/24 [20/0] via 192.168.1.5, 00:50:41  SanJose1#ping 192.168.1.2 Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 14/15/16 msSanJose1#traceroute 192.168.1.2 Type escape sequence to abort.Tracing  the route to 192.168.1.2  VRF info: (vrf in name/id, vrf out name/id)  1 192.168.1.5 [AS 200] 10 msec 10 msec 10 msec  2 192.168.1.2 [AS 200] 15 msec 15 msec \*  SanJose1#ping 192.168.1.1 Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 9/9/11 msSanJose1#traceroute 192.168.1.1  Type escape sequence to abort.Tracing the route to 192.168.1.1 | |  |
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| VRF info: (vrf in name/id, vrf out name/id)1 192.168.1.5 [AS 200] 10 msec 11 msec \*  R3 (SanJose2) Router>en Router#conf t  Router(config)#hostname SanJose2 SanJose2(config)#interface Loopback0  SanJose2(config-if)#ip address 172.16.32.1 255.255.255.0 SanJose2(config-if)#exit  SanJose2(config)#interface Serial1/1  SanJose2(config-if)#ip address 192.168.1.2 255.255.255.252 SanJose2(config-if)#no shutdown  SanJose2(config-if)#exit SanJose2(config)#interface Serial1/0  SanJose2(config-if)#ip address 172.16.1.2 255.255.255.0 SanJose2(config-if)#no shutdown  SanJose2(config-if)#exit SanJose2(config)#router eigrp 64512  SanJose2(config-router)#network 172.16.0.0 SanJose2(config-router)#no auto-summary SanJose2(config-router)#exit SanJose2(config)#router bgp 64512  SanJose2(config-router)#neighbor 172.16.64.1 remote-as 64512 SanJose2(config- router)#neighbor 172.16.64.1 update-source loopback0SanJose2(config-router)#exit  SanJose2(config)#ip route 172.16.0.0 255.255.0.0 null 0  SanJose2(config)#router bgp 64512  SanJose2(config-router)#network 172.16.0.0  SanJose2(config-router)#neighbor 192.168.1.1 remote-as 200 SanJose2(config-router)#exit  SanJose2#sh ip bgp summary  BGP router identifier 172.16.32.1, local AS number 64512BGP table version is 4, main routing table version 4 | |  |
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| 2 network entries using 280 bytes of memory4 path entries using 320 bytes of memory  4/2 BGP path/bestpath attribute entries using 576 bytes of memory1 BGP AS- PATH entries using 24 bytes of memory  0 BGP route-map cache entries using 0 bytes of memory  0 BGP filter-list cache entries using 0 bytes of memoryBGP using 1200 total bytes of memory  BGP activity 2/0 prefixes, 4/0 paths, scan interval 60 secs  Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd  172.16.64.1 4 64512 31 32 4 0 0 00:24:41 2  192.168.1.1 4 200 8 6 4 0 0 00:01:22 1  SanJose2#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  172.16.0.0/16 is variably subnetted, 6 subnets, 3 masksS 172.16.0.0/16 is directly connected, Null0  C 172.16.1.0/24 is directly connected, Serial1/0L 172.16.1.2/32 is directly connected, Serial1/0  C 172.16.32.0/24 is directly connected, Loopback0L 172.16.32.1/32 is directly connected, Loopback0  D 172.16.64.0/24 [90/2297856] via 172.16.1.1, 00:08:46, Serial1/0  192.168.1.0/24 is variably subnetted, 3 subnets, 2 masksC 192.168.1.0/30 is directly connected, Serial1/1  L 192.168.1.2/32 is directly connected, Serial1/1 B 192.168.1.4/30 [20/0] via 192.168.1.1, 00:02:19  B 192.168.100.0/24 [20/0] via 192.168.1.1, 00:07:40  SanJose2#sh ip bgp  BGP table version is 5, local router ID is 172.16.32.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S  Stale, m multipath, b backup-path, f RT-Filter, | |  |
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| x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* i 172.16.0.0 172.16.64.1 0 100 0 i  \*> 0.0.0.0 0 32768 i  r i 192.168.1.0/30 192.168.1.5 0 100 0 200 i  r> 192.168.1.1 0 0 200 i  \* i 192.168.1.4/30 192.168.1.5 0 100 0 200 i  \*> 192.168.1.1 0 0 200 i  \* i 192.168.100.0 192.168.1.5 0 100 0 200 i  \*> 192.168.1.1 0 0 200 i  SanJose2(config)#router bgp 64512  SanJose2(config-router)#neighbor 172.16.64.1 next-hop-self SanJose2(config-router)#exit  SanJose2#sh ip bgp  BGP table version is 5, local router ID is 172.16.32.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* i 172.16.0.0 172.16.64.1 0 100 0 i  \*> 0.0.0.0 0 32768 i  r i 192.168.1.0/30 172.16.64.1 0 100 0 200 i  r> 192.168.1.1 0 0 200 i  \* i 192.168.1.4/30 172.16.64.1 0 100 0 200 i  \*> 192.168.1.1 0 0 200 i  \* i 192.168.100.0 172.16.64.1 0 100 0 200 i  \*> 192.168.1.1 0 0 200 i  SanJose2(config)#route-map SECONDARY\_T1\_IN permit 10SanJose2(config-route-map)#set local- preference 125 SanJose2(config-route-map)#exit  SanJose2(config)#router bgp 64512  SanJose2(config-router)#neighbor 192.168.1.1 route-map SECONDARY\_T1\_IN in SanJose2(config-router)#exit  SanJose2#clear ip bgp \* soft SanJose2#sh ip bgp  BGP table version is 8, local router ID is 172.16.32.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S | |  |
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| Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path  \* i 172.16.0.0 172.16.64.1 0 100 0 i  \*> 0.0.0.0 0 32768 i  r>i 192.168.1.0/30 172.16.64.1 0 160 0 200 i  r 192.168.1.1 0 125 0 200 i  \*>i 192.168.1.4/30 172.16.64.1 0 160 0 200 i  \* 192.168.1.1 0 125 0 200 i  \*>i 192.168.100.0 172.16.64.1 0 160 0 200 i  \* 192.168.1.1 0 125 0 200 i  SanJose2(config)#route-map SECONDARY\_T1\_MED\_OUT permit 10 SanJose2(config-route-map)#set Metric 75  SanJose2(config-route-map)#exit SanJose2(config)#router bgp 64512  SanJose2(config-router)#$2.168.1.1 route-map SECONDARY\_T1\_MED\_OUT out SanJose2(config-router)#end  SanJose2#clear ip bgp \* soft SanJose2#sh ip bgp  BGP table version is 8, local router ID is 172.16.32.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found Network Next Hop Metric LocPrf Weight Path  \* i 172.16.0.0 172.16.64.1 0 100 0 i  \*> 0.0.0.0 0 32768 i  r>i 192.168.1.0/30 172.16.64.1 0 160 0 200 i  r 192.168.1.1 0 125 0 200 i  \*>i 192.168.1.4/30 172.16.64.1 0 160 0 200 i  \* 192.168.1.1 0 125 0 200 i  \*>i 192.168.100.0 172.16.64.1 0 160 0 200 i  \* 192.168.1.1 0 125 0 200 i | |  |
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| **PRACTICAL NO 4**  **Secure the Management PlaneNETWORK TOPOLOGY**  E:\Important Notes and PDF of Bsc-IT and Engineering\MSC-IT\MSC-IT-19\Black Books _ Manuals\Sem2 (2019-20)\Modern Networking\Prac 4\Secure the Management Plane.JPG  TASKS   * Secure Management Access * Configure enhanced username password security * Enable AAA RADIUS authentication * Enable Secure Remote Management   R1  Router>en Router#conf t  Enter configuration commands, one per line. End with CNTL/Z. Router(config)#hostname R1  R1(config)#interface Loopback 0  \*Dec 19 07:53:42.473: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up  R1(config-if)#ip address 192.168.1.1 255.255.255.0 R1(config-if)#exit | |  |
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| R1(config)#interface s1/0  R1(config-if)#ip address 10.1.1.1 255.255.255.252 R1(config-if)#no shutdown  \*Dec 19 07:57:21.998: %LINK-3-UPDOWN: Interface Serial1/0, changed state toup  \*Dec 19 07:57:22.999: %LINEPROTO-5-UPDOWN: Line protocol on InterfaceSerial1/0, changed state to up  R1(config-if)#exit R1(config)#exit  Configure static routes  a. On R1, configure a default static route to ISP.R1(config)# ip route 0.0.0.0 0.0.0.0 10.1.1.2  R1#show ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B – BGP D - EIGRP, EX  - EIGRP external, O - OSPF, IA - OSPF inter area N1 - OSPF NSSA  external type 1, N2 - OSPF NSSA external type 2 E1 - OSPF external type 1,E2 - OSPF external type 2 i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 -  IS-IS level-2  ia - IS-IS inter area, \* - candidate default,U - per-user static route o - ODR, P - periodic downloaded static route,H - NHRP,l - LISPa -  application route  + - replicated route, % - next hop override Gateway of last resort is 10.1.1.2 to network 0.0.0.0 S\* 0.0.0.0/0 [1/0] via 10.1.1.2  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masksC 10.1.1.0/30 is directly connected, Serial1/0  L 10.1.1.1/32 is directly connected, Serial1/0 192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks  C 192.168.1.0/24 is directly connected, Loopback0L 192.168.1.1/32 is directly connected, Loopback0  Secure management access R1(config)#security passwords min-length 10R1(config)#enable secret class12345 R1(config)#line console 0  R1(config-line)#password ciscoconpass R1(config-line)#exec-timeout 5 0 R1(config- line)#login | |  |
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| R1(config-line)#logging synchronous R1(config-line)#exit  R1(config)#line vty 0 4  R1(config-line)#password ciscovtypass R1(config-line)#exec-timeout 5 0 R1(config- line)#login  R1(config-line)#exit R1(config)#line aux 0 R1(config-line)#no exec R1(config-line)#end  R1(config)#service password-encryption  R1(config)#banner motd $Unauthorized access strictly prohibited!$ R1(config)#exit  Configure enhanced username password security R1(config)#username JR-ADMIN secret class12345 R1(config)#username ADMIN secret class54321 R1(config)#line console 0  R1(config-line)#login local R1(config-line)#end R1(config)#line vty 0 4 R1(config-line)#login local R1(config-line)#end  Enabling AAA RADIUS Authentication with Local User for Backup R1(config)# aaa new-model  R1(config)# radius server RADIUS-1  R1(config-radius-server)# address ipv4 192.168.1.101 R1(config-radius-server)# key RADIUS-1-pa55w0rd R1(config-radius-server)# exit  R1(config)# radius server RADIUS-2  R1(config-radius-server)# address ipv4 192.168.1.102 R1(config-radius-server)# key RADIUS-2-pa55w0rd R1(config-radius-server)# exit  R1(config)# aaa group server radius RADIUS-GROUP R1(config-sg-radius)# server name RADIUS-1 R1(config-sg- radius)# server name RADIUS-2 R1(config-sg-radius)# exit  R1(config)# aaa authentication login default group RADIUS-GROUP local R1(config)# aaa | |  |
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| authentication login TELNET-LOGIN group RADIUS-GROUP local-case R1(config)# line vty 0 4  R1(config-line)# login authentication TELNET-LOGIN  R1(config-line)# exit R2  Router>enable Router#conf t  Enter configuration commands, one per line. End with CNTL/Z. Router(config)#hostname R2  R2(config)#interface s1/0  R2(config-if)#ip address 10.1.1.2 255.255.255.252 R2(config-if)#no shutdown  \*Dec 19 08:01:10.279: %LINK-3-UPDOWN: Interface Serial1/0, changed state toup  \*Dec 19 08:01:11.279: %LINEPROTO-5-UPDOWN: Line protocol on InterfaceSerial1/0, changed state to up  R2(config-if)#exit R2(config)#interface s1/1  R2(config-if)#ip address 10.2.2.1 255.255.255.252 R2(config-if)#no shutdown  \*Dec 19 08:02:33.002: %LINK-3-UPDOWN: Interface Serial1/1, changed state toup  \*Dec 19 08:02:34.009: %LINEPROTO-5-UPDOWN: Line protocol on InterfaceSerial1/1, changed state to up  R2(config-if)#exit R2(config)#exit  Configure static routes  a. On R2, configure two static routes.  R2(config)# ip route 192.168.1.0 255.255.255.0 10.1.1.1  R2(config)# ip route 192.168.3.0 255.255.255.0 10.2.2.2  R2#show ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B – BGP D - EIGRP, EX  - EIGRP external, O - OSPF, IA - OSPF inter area N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2 E1 - OSPF external type 1,  E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2 ia - IS-IS interarea, \*  - candidate default, U - per-user static route  o - ODR, P - periodic downloaded static route, H - NHRP, l - LISPa - application route  + - replicated route, % - next hop override | |  |
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| Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks C 10.1.1.0/30 is directly connected, Serial1/0  L 10.1.1.2/32 is directly connected, Serial1/0 C 10.2.2.0/30 is directly connected, Serial1/1 L 10.2.2.1/32 is directly connected, Serial1/1 S 192.168.1.0/24 [1/0] via 10.1.1.1  S 192.168.3.0/24 [1/0] via 10.2.2.2  Secure management access R2(config)#security passwords min-length 10R2(config)#enable secret class12345 R2(config)#line console 0  R2(config-line)#password ciscoconpass R2(config-line)#exec-timeout 5 0 R2(config- line)#login  R2(config-line)#logging synchronous R2(config-line)#exit  R2(config)#line vty 0 4  R2(config-line)#password ciscovtypass R2(config-line)#exec-timeout 5 0 R2(config- line)#login  R2(config-line)#exit R2(config)#line aux 0 R2(config-line)#no exec R2(config-line)#end  R2(config)#service password-encryption  R2(config)#banner motd $Unauthorized access strictly prohibited!$R2(config)#exit Configure enhanced username password security  R2(config)#username JR-ADMIN secret class12345 R2(config)#username ADMIN secret class54321 R2(config)#line console 0  R2(config-line)#login local R2(config-line)#end | |  |
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| R2(config)#line vty 0 4 R2(config-line)#login local R2(config-line)#end  Enabling AAA RADIUS Authentication with Local User for Backup R2(config)# aaa new-model  R2(config)# radius server RADIUS-1  R2(config-radius-server)# address ipv4 192.168.1.101 R2(config-radius-server)# key RADIUS-1-pa55w0rd R2(config-radius-server)# exit  R2(config)# radius server RADIUS-2  R2(config-radius-server)# address ipv4 192.168.1.102 R2(config-radius-server)# key RADIUS-2-pa55w0rd R2(config-radius-server)# exit  R2(config)# aaa group server radius RADIUS-GROUP R2(config-sg-radius)# server name RADIUS-1 R2(config-sg- radius)# server name RADIUS-2 R2(config-sg-radius)# exit  R2(config)# aaa authentication login default group RADIUS-GROUP local R2(config)# aaa authentication login TELNET-LOGIN group RADIUS-GROUP local-case  R2(config)# line vty 0 4  R2(config-line)# login authentication TELNET-LOGIN R2(config-line)# exit  R3  Router>enable Router#conf t  Enter configuration commands, one per line. End with CNTL/Z. Router(config)#hostname R3  R3(config)#interface loopback 0  \*Dec 19 08:07:50.079: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up  R3(config-if)#ip address 192.168.3.1 255.255.255.0 R3(config-if)#exit  R3(config)#interface s1/0  R3(config-if)#ip address 10.2.2.2 255.255.255.252 R3(config-if)#no shutdown  R3(config-if)#exit  \*Dec 19 08:09:26.986: %LINK-3-UPDOWN: Interface Serial1/0, changed state toup  \*Dec 19 08:09:27.996: %LINEPROTO-5-UPDOWN: Line protocol on InterfaceSerial1/0, changed state to up | |  |
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| R3(config)#end  Configure static routes   1. On R3, configure a default static route to ISP.R3(config)# ip route 0.0.0.0 0.0.0.0 10.2.2.1 R3#show ip route 2. Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B – BGP D - EIGRP, EX - EIGRP external, O -   OSPF, IA - OSPF inter area N1 - OSPF NSSA  external type 1, N2 - OSPF NSSA external type 2 E1 - OSPF external type 1,  E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is 10.2.2.1 to network 0.0.0.0 S\* 0.0.0.0/0 [1/0] via 10.2.2.1  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masksC 10.2.2.0/30 is directly connected, Serial1/0  L 10.2.2.2/32 is directly connected, Serial1/0 192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks  C 192.168.3.0/24 is directly connected, Loopback0L 192.168.3.1/32 is directly connected, Loopback0  Secure management access R3(config)#security passwords min-length 10R3(config)#enable secret class12345 R3(config)#line console 0  R3(config-line)#password ciscoconpass R3(config-line)#exec-timeout 5 0  R3(config-line)#login  R3(config-line)#logging synchronous R3(config-line)#exit  R3(config)#line vty 0 4  R3(config-line)#password ciscovtypass R3(config-line)#exec-timeout 5 0 R3(config-  line)#login | |  |
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| R3(config-line)#exit R3(config)#line aux 0 R3(config-line)#no exec R3(config-line)#end  R3(config)#service password-encryption  R3(config)#banner motd $Unauthorized access strictly prohibited!$ Configure enhanced username password security  R3(config)#username JR-ADMIN secret class12345 R3(config)#username ADMIN secret class54321 R3(config)#line console 0  R3(config-line)#login local R3(config-line)#exit R3(config)#line vty 0 4 R3(config-line)#login local R3(config-line)#exit  Enabling AAA RADIUS Authentication with Local User for Backup R3(config)# aaa new-model R3(config)#  radius server RADIUS-1  R3(config-radius-server)# address ipv4 192.168.1.101 R3(config-radius-server)# key RADIUS-1-pa55w0rd R3(config-radius-server)# exit  R3(config)# radius server RADIUS-2  R3(config-radius-server)# address ipv4 192.168.1.102 R3(config-radius-server)# key RADIUS-2-pa55w0rd R3(config-radius-server)# exit  R3(config)# aaa group server radius RADIUS-GROUP R3(config-sg-radius)# server name RADIUS-1 R3(config-sg- radius)# server name RADIUS-2 R3(config-sg-radius)# exit  R3(config)# aaa authentication login default group RADIUS-GROUP local R3(config)# aaa authentication login TELNET-LOGIN group RADIUS-GROUP local-case  R3(config)# line vty 0 4  R3(config-line)# login authentication TELNET-LOGIN R3(config-line)# exit | |  |
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| **PRACTICAL NO 5**  **Configure and Verify Path Control Using PBR**  **NETWORK TOPOLOGY**    TASKS   * Configure and verify policy-based routing. * Select the required tools and commands to configure policy-based routingoperations. * Verify the configuration and operation by using the proper show anddebug commands   R1  Router>enable Router#conf t  Enter configuration commands, one per line. End with CNTL/Z. Router(config)#hostname R1  R1(config)#interface Lo1  R1(config-if)#ip address 192.168.1.1 255.255.255.0 R1(config-if)#exit  R1(config)#interface s1/0  R1(config-if)#ip address 172.16.12.1 255.255.255.248 R1(config-if)#no shutdown  R1(config-if)#exit R1(config)#interface s1/1  R1(config-if)#ip address 172.16.13.1 255.255.255.248 | |  |
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| R1(config-if)#no shutdown R1(config-if)#exit R1(config)#router eigrp 100  R1(config-router)#network 192.168.1.0  R1(config-router)#network 172.16.12.0  R1(config-router)#network 172.16.13.0 R1(config-router)#no auto-summary R1(config-router)#exit  R1#sh ip eigrp neighbors  EIGRP-IPv4 Neighbors for AS(100)  H Address Interface Hold Uptime SRTT RTO Q Seq  (sec) (ms) Cnt Num  R1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks C 172.16.12.0/29 is directly connected, Serial1/0  L 172.16.12.1/32 is directly connected, Serial1/0 C 172.16.13.0/29 is directly connected, Serial1/1 L 172.16.13.1/32 is directly connected, Serial1/1  D 172.16.23.0/29 [90/2681856] via 172.16.13.3, 00:08:31, Serial1/1 [90/2681856] via 172.16.12.2, 00:08:31, Serial1/0  D 172.16.34.0/29 [90/2681856] via 172.16.13.3, 00:08:31, Serial1/1  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC | |  |
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| 1 | 172.16.13.3 | Se1/1 | 14 00:04:43 11 100 0 10 |
| 0 | 172.16.12.2 | Se1/0 | 12 00:07:05 19 114 0 8 |

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| 192.168.1.0/24 is directly connected, Loopback1 L 192.168.1.1/32 is directly connected, Loopback1  D 192.168.2.0/24 [90/2297856] via 172.16.12.2, 00:08:31, Serial1/0D 192.168.3.0/24 [90/2297856] via 172.16.13.3, 00:08:31, Serial1/1  192.168.4.0/25 is subnetted, 2 subnets  D 192.168.4.0 [90/2809856] via 172.16.13.3, 00:05:15, Serial1/1  D 192.168.4.128 [90/2809856] via 172.16.13.3, 00:05:15, Serial1/1 R2  Router>enable Router#conf t  Router(config)#hostname R2 R2(config)#interface Lo2  R2(config-if)#ip address 192.168.2.1 255.255.255.0 R2(config-if)#exit  R2(config)#interface s1/0  R2(config-if)#ip address 172.16.12.2 255.255.255.248 R2(config-if)#no shutdown  R2(config-if)#exit R2(config)#interface s1/1R2(config-if)#ip address 172.16.23.2 255.255.255.248  R2(config-if)#no shutdown R2(config-if)#exit  R2(config)#router eigrp 100  R2(config-router)#network 192.168.2.0  R2(config-router)#network 172.16.12.0  R2(config-router)#network 172.16.23.0 R2(config-router)#no auto-summary  R2#sh ip eigrp neighbors  EIGRP-IPv4 Neighbors for AS(100)  H Address Interface Hold Uptime SRTT RTO Q Seq | |  |
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|  |  | (sec) | (ms) Cnt Num |  |  |  |
| 1 | 172.16.23.3 | Se1/1 | 12 00:05:23 12 | 100 | 0 | 11 |
| 0 | 172.16.12.1 | Se1/0 | 12 00:07:45 22 | 132 | 0 | 8 |

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| R3  Router>enable Router#conf t  Router(config)#hostname R3 R3(config)#interface Lo3  R3(config-if)#ip address 192.168.3.1 255.255.255.0 R3(config-if)#exit  R3(config)#interface s1/0  R3(config-if)#ip address 172.16.13.3 255.255.255.248R3(config-if)#no shutdown R3(config-if)#exit  R3(config)#interface s1/1  R3(config-if)#ip address 172.16.23.3 255.255.255.248 R3(config-if)#no shutdown  R3(config-if)#exit R3(config)#interface s1/2  R3(config-if)#ip address 172.16.34.3 255.255.255.248 R3(config-if)#no shutdown  R3(config-if)#exit R3(config)#router eigrp 100  R3(config-router)#network 192.168.3.0  R3(config-router)#network 172.16.13.0  R3(config-router)#network 172.16.23.0  R3(config-router)#network 172.16.34.0  R3(config-router)#no auto-summary R3#sh ip eigrp neighbors  EIGRP-IPv4 Neighbors for AS(100)  H Address Interface Hold Uptime SRTT RTO Q Seq  R3#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD – | |  |
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|  |  | (sec) | (ms) Cnt Num |  |  |  |
| 2 | 172.16.34.4 | Se1/2 | 14 00:03:09 15 | 100 | 0 | 3 |
| 1 | 172.16.13.1 | Se1/0 | 14 00:06:25 21 | 126 | 0 | 9 |
| 0 | 172.16.23.2 | Se1/1 | 13 00:06:25 20 | 120 | 0 | 9 |

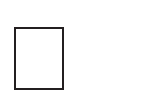
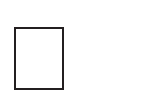
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| EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  172.16.0.0/16 is variably subnetted, 7 subnets, 2 masks  D 172.16.12.0/29 [90/2681856] via 172.16.23.2, 00:16:48, Serial1/1 [90/2681856] via 172.16.13.1, 00:16:48, Serial1/0  C 172.16.13.0/29 is directly connected, Serial1/0 L 172.16.13.3/32 is directly connected, Serial1/0 C 172.16.23.0/29 is directly connected, Serial1/1 L 172.16.23.3/32 is directly connected, Serial1/1 C 172.16.34.0/29 is directly connected, Serial1/2 L 172.16.34.3/32 is directly connected, Serial1/2  D 192.168.1.0/24 [90/2297856] via 172.16.13.1, 00:16:48, Serial1/0 D 192.168.2.0/24 [90/2297856] via 172.16.23.2, 00:16:48, Serial1/1  192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks C 192.168.3.0/24 is directly connected, Loopback3  L 192.168.3.1/32 is directly connected, Loopback3 192.168.4.0/25 is subnetted, 2 subnets  D 192.168.4.0 [90/2297856] via 172.16.34.4, 00:13:32, Serial1/2  D 192.168.4.128 [90/2297856] via 172.16.34.4, 00:13:32, Serial1/2  R3(config)#ip access-list standard PBR-ACL  R3(config-std-nacl)#remark ACL matches R4 LAN B traffic R3(config-std-nacl)#permit 192.168.4.128 0.0.0.127 R3(config-std- nacl)#exit  R3(config)#route-map R3-to-R1 permit  R3(config-route-map)#match ip address PBR-ACL | |  |
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| R3(config-route-map)#set ip next-hop 172.16.13.1 R3(config-route-map)#end  R3(config)#int s1/2  R3(config-if)#ip policy route-map R3-to-R1 R3(config-if)#exit  R3#sh route-map  route-map R3-to-R1, permit, sequence 10Match clauses:  ip address (access-lists): PBR-ACLSet clauses:  ip next-hop 172.16.13.1  Policy routing matches: 0 packets, 0 bytes R3(config)#access- list 1 permit 192.168.4.0 0.0.0.255  R4  Router>enable Router#conf t  Router(config)#hostname R4 R4(config)#interface lo4  R4(config-if)#ip address 192.168.4.1 255.255.255.128 R4(config-if)#exit  R4(config)#interface lo5  R4(config-if)#ip address 192.168.4.129 255.255.255.128 R4(config-if)#exit  R4(config)#interface s1/0  R4(config-if)#ip address 172.16.34.4 255.255.255.248 R4(config-if)#no shutdown  R4(config-if)#exit R4(config)#router eigrp 100  R4(config-router)#network 192.168.4.0  R4(config-router)#network 172.16.34.0 R4(config-router)#no auto-summary  R4#sh ip eigrp neighbors | |  |
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| EIGRP-IPv4 Neighbors for AS(100)  H Address Interface Hold Uptime SRTT RTO Q Seq  (sec) (ms) Cnt Num  0 172.16.34.3 Se1/0 14 00:04:07 25 150 0 9  Before Route Maps  R4#traceroute 192.168.1.1 source 192.168.4.1Type escape sequence to abort.  Tracing the route to 192.168.1.1  VRF info: (vrf in name/id, vrf out name/id)1 172.16.34.3 13 msec 11 msec 10 msec  2 172.16.13.1 20 msec 17 msec \*  R4#traceroute 192.168.1.1 source 192.168.4.129Type escape sequence to abort.  Tracing the route to 192.168.1.1  VRF info: (vrf in name/id, vrf out name/id)1 172.16.34.3 15 msec 10 msec 10 msec  2 172.16.13.1 19 msec 24 msec \*  After Route Maps  R4#traceroute 192.168.1.1 source 192.168.4.1Type escape sequence to abort.  Tracing the route to 192.168.1.1  VRF info: (vrf in name/id, vrf out name/id)1 172.16.34.3 11 msec 10 msec 10 msec  2 172.16.13.1 21 msec 22 msec \*  R4#traceroute 192.168.1.1 source 192.168.4.129Type escape sequence to abort.  Tracing the route to 192.168.1.1  VRF info: (vrf in name/id, vrf out name/id)1 172.16.34.3 10 msec 10 msec 10 msec  2 172.16.13.1 18 msec 18 msec \* | |  |
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| **PRACTICAL NO 6**  **IP Service Level Agreements and Remote SPAN in a CampusEnvironment NETWORK TOPOLOGY**    TASKS  Configure trunking, VTP, and SVIs  Implement IP SLAs to monitor various network performance characteristics  Implement Remote Span  DLS1  Switch>en Switch#conf t  Switch(config)#hostname DLS1 DLS1(config)#interface vlan 1  DLS1(config-if)#ip address 172.16.1.1 255.255.255.0 DLS1(config-if)#no shutdown  DLS1(config-if)#exit  Configure the trunks and EtherChannel from DLS1 to ALS1.DLS1(config)#interface range e0/0-1  DLS1(config-if-range)#switchport trunk encapsulation dot1q | |  |
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| DLS1(config-if-range)#switchport mode trunk  DLS1(config-if-range)#channel-group 1 mode desirableCreating a port-channel interface Port-channel 1 DLS1(config-if- range)#exit  Configure the trunks and EtherChannel from DLS1 to ALS2.DLS1(config)#interface range e0/2-3  DLS1(config-if-range)#switchport trunk encapsulation dot1q DLS1(config-if-range)#switchport mode trunk  DLS1(config-if-range)#channel-group 2 mode desirableCreating a port-channel interface Port-channel 2 DLS1(config-if- range)#exit  Configure VTP on DLS1 and create VLANs 100 and 200 for the domain DLS1(config)#vtp domain SWPOD  Changing VTP domain name from NULL to SWPOD DLS1(config)#vtp version 2  DLS1(config)#vlan 100 DLS1(config-vlan)#name Payroll DLS1(config-vlan)#exit DLS1(config)#vlan 200  DLS1(config-vlan)#name Engineering DLS1(config-vlan)#exit  On DLS1, create the SVIs for VLANs 100 and 200. Note that the correspondingLayer 2 VLANs must be configured for the Layer 3 SVIs to activate  DLS1(config)#interface vlan 100  DLS1(config-if)#ip address 172.16.100.1 255.255.255.0 DLS1(config-if)#no shutdown  DLS1(config-if)#exit DLS1(config)#interface vlan 200  DLS1(config-if)#ip address 172.16.200.1 255.255.255.0 DLS1(config-if)#no shutdown | |  |
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| DLS1(config-if)#exit  The ip routing command is also needed to allow the DLS1 switch to act as a Layer 3 device to route between these VLANs. Because the VLANs are all considered directly connected, a routing protocol is not needed at this time. Thedefault configuration on 3560 switches is no ip routing.  DLS1(config)#ip routing  DLS1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks C 172.16.1.0/24 is directly connected, Vlan1  L 172.16.1.1/32 is directly connected, Vlan1  C 172.16.100.0/24 is directly connected, Vlan100 L 172.16.100.1/32 is directly connected, Vlan100 C 172.16.200.0/24 is directly connected, Vlan200 L 172.16.200.1/32 is directly connected, Vlan200  Configure the Cisco IOS IP SLA source to measure network performanceDLS1(config)#ip sla 1  DLS1(config-ip-sla)#icmp-echo 172.16.100.101  DLS1(config-ip-sla-echo)#exit DLS1(config)#ip sla 2  DLS1(config-ip-sla)#icmp-echo 172.16.200.101  DLS1(config-ip-sla-echo)#exit DLS1(config)#ip sla 3  DLS1(config-ip-sla)#udp-jitter 172.16.1.101 5000 DLS1(config-ip-sla-jitter)#exit | |  |
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| DLS1(config)#ip sla 4  DLS1(config-ip-sla)#udp-jitter 172.16.1.102 5000 DLS1(config-ip-sla-jitter)#exit  DLS1(config)#ip sla schedule 1 life forever start-time now DLS1(config)#ip sla schedule 2 life forever start-time now DLS1(config)#ip sla schedule 3 life forever start-time now DLS1(config)#ip sla schedule 4 life forever start-time now  Monitor IP SLAs operations DLS1#show ip sla configuration 1IP SLAs Infrastructure Engine-III Entry number: 1  Owner:  Tag:  Operation timeout (milliseconds): 5000 Type of operation to perform: icmp-echo  Target address/Source address: 172.16.100.101/0.0.0.0Type Of Service parameter: 0x0  Request size (ARR data portion): 28Data pattern: 0xABCDABCD  Verify data: No Vrf Name:  Schedule:  Operation frequency (seconds): 60 (not considered if randomly scheduled)Next Scheduled Start Time: Start Time already passed  Group Scheduled : FALSE Randomly Scheduled : FALSE Life (seconds): Forever  Entry Ageout (seconds): never Recurring (Starting Everyday): FALSE  Status of entry (SNMP RowStatus): Active Threshold (milliseconds): 5000 | |  |
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| Distribution Statistics:  Number of statistic hours kept: 2  Number of statistic distribution buckets kept: 1Statistic distribution interval (milliseconds): 20  Enhanced History:  History Statistics:  Number of history Lives kept: 0 Number of history Buckets kept: 15History Filter Type: None  DLS1#show ip sla configuration 3IP SLAs Infrastructure Engine-III Entry number: 3  Owner:  Tag:  Operation timeout (milliseconds): 5000 Type of operation to perform: udp-jitter  Target address/Source address: 172.16.1.101/0.0.0.0Target port/Source port: 5000/0  Type Of Service parameter: 0x0 Request size (ARR data portion): 32  Packet Interval (milliseconds)/Number of packets: 20/10Verify data: No  Vrf Name:  Control Packets: enabled Schedule:  Operation frequency (seconds): 60 (not considered if randomly scheduled)Next Scheduled Start Time: Start Time already passed  Group Scheduled : FALSE  Randomly Scheduled : FALSE Life (seconds): Forever  Entry Ageout (seconds): never Recurring (Starting Everyday): FALSE  Status of entry (SNMP RowStatus): Active Threshold (milliseconds): 5000  Distribution Statistics: | |  |
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| Number of statistic hours kept: 2  Number of statistic distribution buckets kept: 1Statistic distribution interval (milliseconds): 20  Enhanced History:  Percentile:  DLS1#show ip sla application  IP Service Level Agreements  Version: Round Trip Time MIB 2.2.0, Infrastructure Engine-III Supported Operation Types:  icmpEcho, path-echo, path-jitter, udpEcho, tcpConnect, httpdns, udpJitter, dhcp, ftp, lsp Group, lspPing, lspTrace pseudowirePing, udpApp, wspApp, mcast, generic  Supported Features: IPSLAs Event Publisher  IP SLAs low memory water mark: 225778552 Estimated system max number of entries: 165365  Estimated number of configurable operations: 165241Number of Entries configured : 4  Number of active Entries 4  Number of pending Entries 0  Number of inactive Entries 0  Time of last change in whole IP SLAs: \*14:08:46.139 EET Sat Apr 11 2020  DLS1#show ip sla statistics 1 IPSLAs Latest Operation StatisticsIPSLA operation id: 1  Latest RTT: 1 milliseconds  Latest operation start time: 14:34:23 EET Sat Apr 11 2020Latest operation return code: OK  Number of successes: 26 Number of failures: 1 Operation time to live: Forever  DLS1#show ip sla statistics 3 IPSLAs  Latest Operation StatisticsIPSLA | |  |
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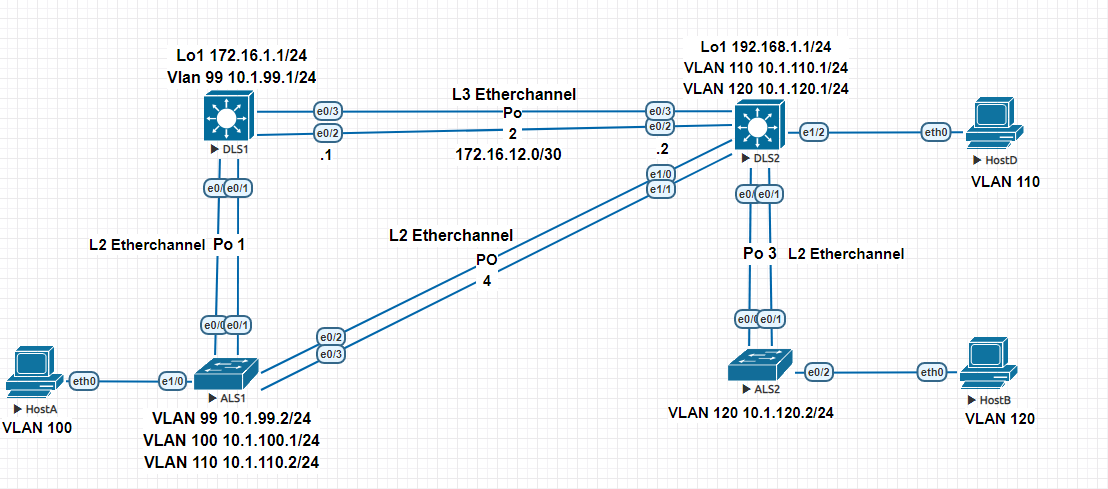
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| operation id: 3  Type of operation: udp-jitter Latest RTT: 1 milliseconds  Latest operation start time: 14:34:36 EET Sat Apr 11 2020Latest operation return code: OK  RTT Values:  Number Of RTT: 10 RTT Min/Avg/Max: 1/1/2 milliseconds Latency one-way time:  Number of Latency one-way Samples: 6  Source to Destination Latency one way Min/Avg/Max: 0/0/1 millisecondsDestination to Source Latency one way Min/Avg/Max: 0/0/1 milliseconds  Jitter Time:  Number of SD Jitter Samples: 9 Number of DS Jitter Samples: 9  Source to Destination Jitter Min/Avg/Max: 0/1/1 millisecondsDestination to Source Jitter Min/Avg/Max: 0/1/1 milliseconds  Over Threshold:  Number Of RTT Over Threshold: 0 (0%) Packet Loss Values:  Loss Source to Destination: 0  Source to Destination Loss Periods Number: 0  Source to Destination Loss Period Length Min/Max: 0/0 Source to Destination Inter Loss Period Length Min/Max: 0/0Loss Destination to Source: 0  Destination to Source Loss Periods Number: 0 Destination to Source Loss Period Length Min/Max: 0/0  Destination to Source Inter Loss Period Length Min/Max: 0/0Out Of Sequence: 0 Tail Drop: 0  Packet Late Arrival: 0 Packet Skipped: 0Voice Score Values:  Calculated Planning Impairment Factor (ICPIF): 0Mean Opinion Score (MOS): 0 | |  |
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| Number of successes: 27 Number of failures: 0 Operation time to live:  Forever  Configure Remote Span DLS1(config)#vlan 100 DLS1(config-vlan)#remote-span DLS1(config-vlan)#exit  DLS1(config)#monitor session 1 source interface e0/0 both DLS1(config)# monitor session 1 destination remote vlan 100  ALS1  Switch>en Switch#conf t  Switch(config)#hostname ALS1 ALS1(config)#interface vlan 1  ALS1(config-if)#ip address 172.16.1.101 255.255.255.0 ALS1(config-if)#no shutdown  ALS1(config-if)#exit  ALS1(config)#ip default-gateway 172.16.1.1  Configure the trunks and EtherChannel between ALS1 and DLS1 ALS1(config)#interface range e0/0-1  ALS1(config-if-range)# switchport trunk encapsulation dot1q ALS1(config-if-range)#switchport mode trunk  ALS1(config-if-range)#channel-group 1 mode desirableCreating a port-channel interface Port-channel 1 ALS1(config-if- range)#exit  Configure the trunks and EtherChannel between ALS1 and ALS2 ALS1(config)#interface range e0/2-3  ALS1(config-if-range)#switchport trunk encapsulation dot1q ALS1(config-if-range)#switchport mode trunk  ALS1(config-if-range)#channel-group 2 mode desirableCreating a port-channel interface Port-channel 2 | |  |
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| Configure VTP on ALS1 ALS1(config)#vtp mode client  Setting device to VTP Client mode for VLANS. ALS1(config)#int e1/0  ALS1(config-if)#switchport mode access  ALS1(config-if)#switchport access vlan 100 ALS1(config-if)#exit  Configure Cisco IOS IP SLA responders. ALS1(config)#ip sla responder  ALS1(config)#ip sla responder udp-echo ipaddress 172.16.1.1 port 5000 ALS1#show ip sla responder  General IP SLA Responder on Control port 1967 General IP SLA Responder on Control V2 port 1167  General IP SLA Responder is: Enabled  Number of control message received: 16 Number of errors: 0Recent sources:  172.16.1.1 [14:23:36.259 EET Sat Apr 11 2020]  172.16.1.1 [14:22:36.257 EET Sat Apr 11 2020]  172.16.1.1 [14:21:36.255 EET Sat Apr 11 2020]  172.16.1.1 [14:20:36.256 EET Sat Apr 11 2020]  172.16.1.1 [14:19:36.258 EET Sat Apr 11 2020]  Recent error sources:  Number of control v2 message received: 0 Number of errors: 0Recent sources:  Recent error sources:  Permanent Port IP SLA Responder Permanent Port IP SLA Responder is: EnabledudpEcho Responder:  IP Address Port  172.16.1.1 5000  ALS2  Switch>en Switch#conf t  Enter configuration commands, one per line. End with CNTL/Z. Switch(config)#hostname ALS2 | |  |
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| ALS2(config)#interface vlan 1  ALS2(config-if)#ip address 172.16.1.102 255.255.255.0 ALS2(config-if)#no shutdown  ALS2(config-if)#exit  ALS2(config)#ip default-gateway 172.16.1.1  Configure the trunks and EtherChannel between ALS2 and ALS1 ALS2(config)#interface range e0/0-1  ALS2(config-if-range)#switchport trunk encapsulation dot1q ALS2(config-if-range)#switchport mode trunk  ALS2(config-if-range)#channel-group 2 mode desirableCreating a port-channel interface Port-channel 2 ALS2(config-if- range)#exit  Configure the trunks and EtherChannel between ALS2 and DLS1 ALS2(config)#interface range e0/2-3  ALS2(config-if-range)#switchport trunk encapsulation dot1q ALS2(config-if-range)#switchport mode trunk  ALS2(config-if-range)#channel-group 1 mode desirableCreating a port-channel interface Port-channel 1 ALS2(config-if- range)#exit  Configure VTP on ALS2 ALS2(config)#vtp mode client  Setting device to VTP Client mode for VLANS  ALS2(config)#int e1/0  ALS2(config-if)#switchport mode access ALS2(config-if)#switchport access vlan 200 ALS2(config-if)#exit  Configure Cisco IOS IP SLA responders. ALS2(config)#ip sla responder  ALS2(config)#ip sla responder udp-echo ipaddress 172.16.1.1 port 5000 | |  |
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| **PRACTICAL NO 7**  **Inter-VLAN RoutingNETWORK TOPOLOGY**  TASKS   * Implement a Layer 3 EtherChannel * Implement Static Routing * Implement Inter-Vlan Routing DLS1   Switch>enable Switch#conf t  Switch(config)#hostname DLS1 DLS1(config)#interface loopback 1  DLS1(config-if)#ip address 172.16.1.1 255.255.255.0 DLS1(config-if)#exit  DLS1(config)#interface vlan 99  DLS1(config-if)#ip address 10.1.99.1 255.255.255.0 DLS1(config-if)#no shutdown | |  |
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| Implement a Layer 3 EtherChannel DLS1(config)#int range e0/2-3 DLS1(config-if-range)#no switchport DLS1(config-if-range)#no ip address  DLS1(config-if-range)#channel-group 2 mode onCreating a port-channel interface Port-channel 2DLS1(config-if- range)#exit DLS1(config)#interface port-channel 2 DLS1(config-if)#ip address 172.16.12.1 255.255.255.252 DLS1(config-if)#end  DLS1(config)#int range e0/0-1  DLS1(config-if-range)#switchport trunk encapsulation dot1q DLS1(config-if-range)#switchport mode trunk  DLS1(config-if-range)#channel-group 1 mode desirableCreating a port-channel interface Port-channel 1 DLS1(config-if- range)#end  DLS1#sh interfaces trunk  Port Mode Encapsulation Status Native vlanPo1 on 802.1q trunking 1  Port Vlans allowed on trunkPo1 1-4094  Port Vlans allowed and active in management domainPo1 1,99  Port Vlans in spanning tree forwarding state and not prunedPo1 1,99  Implement Static Routing DLS1(config)#ip routing  DLS1(config)#ip route 192.168.1.0 255.255.255.252 172.16.12.2  DLS1(config)# ip route 192.168.1.0 255.255.255.0 10.1.120.1  DLS1(config)# ip route 192.168.1.0 255.255.255.0 10.1.110.1  DLS1#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area | |  |
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| N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masksC 10.1.99.0/24 is directly connected, Vlan99  L 10.1.99.1/32 is directly connected, Vlan99 172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks  C 172.16.1.0/24 is directly connected, Loopback1 L 172.16.1.1/32 is directly connected, Loopback1  C 172.16.12.0/30 is directly connected, Port-channel2L 172.16.12.1/32 is directly connected, Port-channel2  192.168.1.0/30 is subnetted, 1 subnetsS 192.168.1.0 [1/0] via 172.16.12.2  DLS2  Switch>en Switch#conf t  Switch(config)#hostname DLS2 DLS2(config)#interface loopback 1  DLS2(config-if)#ip address 192.168.1.1 255.255.255.0 DLS2(config-if)#exit  DLS2(config)#interface vlan 110  DLS2(config-if)#ip address 10.1.110.1 255.255.255.0 DLS2(config-if)#no shutdown  DLS2(config-if)#exit DLS2(config)#interface vlan 120  DLS2(config-if)#ip address 10.1.120.1 255.255.255.0 DLS2(config-if)#no shutdown  DLS2(config-if)#exit  Implement a Layer 3 EtherChannel  DLS2(config)#interface range e0/2-3 DLS2(config-if-range)#no switchport | |  |
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| DLS2(config-if-range)#no ip DLS2(config- if-range)#no ip address  DLS2(config-if-range)#channel-group 2 mode onCreating a port-channel interface Port-channel 2DLS2(config-if- range)#exit DLS2(config)#interface port-channel 2 DLS2(config-if)#ip address 172.16.12.2 255.255.255.252 DLS2(config-if)#end  DLS2(config)#interface range e0/0-1  DLS2(config-if-range)#switchport trunk encapsulation dot1q DLS2(config-if-range)#switchport mode trunk  DLS2(config-if-range)#channel-group 3 mode desirableCreating a port-channel interface Port-channel 3 DLS2(config-if- range)#exit  DLS2(config)#interface range e1/0-1  DLS2(config-if-range)#switchport trunk encapsulation dot1q DLS2(config-if-range)#switchport mode trunk  DLS2(config-if-range)#channel-group 4 mode desirableCreating a port-channel interface Port-channel 4 DLS2(config-if- range)#end  DLS2#sh interfaces trunk  Port Vlans allowed on trunkPo3 1-4094  Po4 1-4094  Port Vlans allowed and active in management domainPo3 1,110,120  Po4 1,110,120  Port Vlans in spanning tree forwarding state and not prunedPo3 1,110,120  Po4 1,110,120 | |  |
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| Port | Mode | Encapsulation Status | Native vlan |
| Po3 | on | 802.1q trunking | 1 |
| Po4 | on | 802.1q trunking | 1 |

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| Implement Static Routing DLS2(config)#ip routing  DLS2(config)#ip route 172.16.1.0 255.255.255.252 172.16.12.1  DLS2(config)# ip route 172.16.1.0 255.255.255.0 10.1.99.1  Configure the host ports for the appropriate VLANs according to the diagram DLS2(config)#interface e1/2  DLS2(config-if)#switchport mode access DLS2(config-if)#switchport access vlan 110  DLS2#sh ip route  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks C 10.1.110.0/24 is directly connected, Vlan110  L 10.1.110.1/32 is directly connected, Vlan110 C 10.1.120.0/24 is directly connected, Vlan120 L 10.1.120.1/32 is directly connected, Vlan120  172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks S 172.16.1.0/30 [1/0] via 172.16.12.1  C 172.16.12.0/30 is directly connected, Port-channel2L 172.16.12.2/32 is directly connected, Port-channel2  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected, Loopback1  L 192.168.1.1/32 is directly connected, Loopback1 ALS1  Switch>en | |  |
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| Switch#conf t  Switch(config)#hostname ALS1 ALS1(config)#ip default-gateway 10.1.99.1  ALS1(config)#ip default-gateway 10.1.110.1  ALS1(config)#ip default-gateway 10.1.100.2 Implement a Layer 3 EtherChannel  ALS1(config)#int range e0/0-1  ALS1(config-if-range)#switchport trunk encapsulation dot1q ALS1(config-if-range)#switchport mode trunk  ALS1(config-if-range)#channel-group 1 mode desirableCreating a port-channel interface Port-channel 1 ALS1(config-if- range)#exit  ALS1(config)#int range e0/2-3  ALS1(config-if-range)#switchport trunk encapsulation dot1q ALS1(config-if-range)#switchport mode trunk ALS1(config-if-  range)#channel-group 4 mode desirableCreating a port-channel interface Port-channel 4 ALS1(config-if-range)#end  ALS1#sh etherchannel summary  Flags: D - down P - bundled in port-channelI - stand-alone s - suspended  H - Hot-standby (LACP only)R - Layer3 S - Layer2  U - in use N - not in use, no aggregationf - failed to allocate aggregator  M - not in use, minimum links not met  m - not in use, port not aggregated due to minimum links not metu - unsuitable for bundling  w - waiting to be aggregatedd - default port  A - formed by Auto LAG Number of channel-groups in use: 2Number of aggregators: 2  Group Port-channel Protocol Ports  + + +  Configure the host ports for the appropriate VLANs according to the diagram | |  |
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| 1 | Po1(SU) | PAgP | Et0/0(P) | Et0/1(P) |
| 4 | Po4(SU) | PAgP | Et0/2(P) | Et0/3(P) |

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| ALS1(config)#interface e1/0 ALS1(config-if)#switchport mode access  ALS1(config-if)#switchport access vlan 100 ALS2  Switch>en Switch#conf t  Switch(config)#hostname ALS2 ALS2(config)#ip default-gateway 10.1.120.1  Implement a Layer 3 EtherChannel ALS2(config)#int range e0/0-1  ALS2(config-if-range)#switchport trunk encapsulation dot1q ALS2(config-if-range)#switchport mode trunk  ALS2(config-if-range)#channel-group 3 mode desirableCreating a port-channel interface Port-channel 3 ALS2(config-if- range)#end  ALS2#sh etherchannel summary  Flags: D - down P - bundled in port-channelI - stand-alone s - suspended  H - Hot-standby (LACP only)R - Layer3 S - Layer2  U - in use N - not in use, no aggregationf - failed to allocate aggregator  M - not in use, minimum links not met  m - not in use, port not aggregated due to minimum links not metu - unsuitable for bundling  w - waiting to be aggregatedd - default port  A - formed by Auto LAG Number of channel-groups in use: 1  Number of aggregators: 1  Group Port-channel Protocol Ports  + + +  3 Po3(SU) PAgP Et0/0(P) Et0/1(P)  Configure the host ports for the appropriate VLANs according to the diagram ALS2(config)#interface e0/2  ALS2(config-if)#switchport mode access  ALS2(config-if)#switchport access vlan 120 HOST A  VPCS> ip 10.1.100.1 255.255.255.0 10.1.100.2 HOST B  VPCS> ip 10.1.120.2 255.255.255.0 10.1.120.1 HOST D  VPCS> ip 10.1.110.2 255.255.255.0 10.1.110.1 | |  |
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| **PRACTICAL NO 8**  **Simulating MPLS environmentNETWORK TOPOLOGY**  E:\Networking B.SC-IT and M.SC-IT\MPLS TOPOLOGY.JPG  TASKS   * Configure the basic IP Addressing according to the diagram * Configure OSPF Area 0 as IGP Protocol running inside the MPLS SPNetwork * Advertise the loopback 0 interface also inside the IGP * Configure MPLS on all Routers * Configure LDP router ID has to be the loopback 0 ID * Configure the routers to select the labels as below * R1-100-199 * R2-200-299 * R3-300-399   R1  Router>enable Router#conf t  Router(config)#hostname R1 R1(config)# interface loopback 0  R1(config-if)#ip address 1.1.1.1 255.255.255.255 R1(config-if)#exit  R1(config)#int e0/0  R1(config-if)#ip address 10.0.0.1 255.255.255.0  R1(config-if)#no shut | |  |
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| R1(config)#router ospf 1  R1(config-router)#network 1.1.1.0 0.0.0.255 area 0  R1(config-router)#network 10.0.0.0 0.0.0.255 area 0 R1(config-router)#exit  R1#show ip route ospf  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set 2.0.0.0/32 is  subnetted, 1 subnets  O 2.2.2.2 [110/11] via 10.0.0.2, 00:15:40, Ethernet0/0  3.0.0.0/32 is subnetted, 1 subnets  O 3.3.3.3 [110/21] via 10.0.0.2, 00:04:01, Ethernet0/0  10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks  O 10.0.1.0/24 [110/20] via 10.0.0.2, 00:09:25, Ethernet0/0  R1#sh ip cef  Prefix Next Hop Interface | |  |
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| 0.0.0.0/0 | no route |  |
| 0.0.0.0/8 | drop |  |
| 0.0.0.0/32 | receive |  |
| 1.1.1.1/32 | receive | Loopback0 |
| 2.2.2.2/32 | 10.0.0.2 | Ethernet0/0 |
| 3.3.3.3/32 | 10.0.0.2 | Ethernet0/0 |
| 10.0.0.0/24 | attached | Ethernet0/0 |
| 10.0.0.0/32 | receive | Ethernet0/0 |
| 10.0.0.1/32 | receive | Ethernet0/0 |
| 10.0.0.2/32 | attached | Ethernet0/0 |
| 10.0.0.255/32 | receive | Ethernet0/0 |
| 10.0.1.0/24 | 10.0.0.2 | Ethernet0/0 |

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| 255.255.255.255/32 receive R1#sh ip route 2.2.2.2 Routing  entry for 2.2.2.2/32  Known via "ospf 1", distance 110, metric 11, type intra areaLast update from 10.0.0.2 on Ethernet0/0, 00:30:34 ago Routing Descriptor Blocks:  \* 10.0.0.2, from 2.2.2.2, 00:30:34 ago, via Ethernet0/0Route metric is 11, traffic share count is 1  R1#sh ip route 3.3.3.3 Routing entry for 3.3.3.3/32  Known via "ospf 1", distance 110, metric 21, type intra areaLast update from 10.0.0.2 on Ethernet0/0, 00:11:43 ago Routing Descriptor Blocks:  \* 10.0.0.2, from 3.3.3.3, 00:11:43 ago, via Ethernet0/0Route metric is 21, traffic share count is 1  R1#sh ip cef 2.2.2.2 2.2.2.2/32  nexthop 10.0.0.2 Ethernet0/0 R1#sh ip cef 3.3.3.3  3.3.3.3/32  nexthop 10.0.0.2 Ethernet0/0  R1(config)#mpls label range 100 199 R1(config)#mpls label protocol ldp R1(config)#mpls ldp router-id loopback 0 R1(config)#int e0/0  R1(config-if)#mpls ip R1#sh mpls interfaces  Interface IP Tunnel BGP Static Operational  Ethernet0/0 Yes (ldp) No No No Yes R1#sh mpls ldp neighbor | |  |
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| 127.0.0.0/8 | drop |
| 224.0.0.0/4 | drop |
| 224.0.0.0/24 | receive |
| 240.0.0.0/4 | drop |

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| Peer LDP Ident: 2.2.2.2:0; Local LDP Ident 1.1.1.1:0TCP connection: 2.2.2.2.27963 - 1.1.1.1.646  State: Oper; Msgs sent/rcvd: 13/14; DownstreamUp time: 00:05:21  LDP discovery sources:  Ethernet0/0, Src IP addr: 10.0.0.2 Addresses bound to peer LDP Ident:  10.0.0.2 10.0.1.2 2.2.2.2  R1#sh ip cef 3.3.3.3 3.3.3.3/32  nexthop 10.0.0.2  Ethernet0/0 label 201 R1#sh ip cef 2.2.2.2 2.2.2.2/32  nexthop 10.0.0.2 Ethernet0/0 R1#sh mpls forwarding-table  Local Outgoing Prefix Bytes Label Outgoing Next HopLabel Label or Tunnel Id Switched interface  100 Pop Label 2.2.2.2/32 0 Et0/0 10.0.0.2  101 201 3.3.3.3/32 0 Et0/0 10.0.0.2  102 Pop Label 10.0.1.0/24 0 Et0/0 10.0.0.2  R1#sh mpls ldp bindings lib entry: 1.1.1.1/32, rev 2  local binding: label: imp-null  remote binding: lsr: 2.2.2.2:0, label: 200lib entry: 2.2.2.2/32, rev 4  local binding: label: 100  remote binding: lsr: 2.2.2.2:0, label: imp-nulllib entry: 3.3.3.3/32, rev 6  local binding: label: 101  remote binding: lsr: 2.2.2.2:0, label: 201lib entry: 10.0.0.0/24, rev 8  local binding: label: imp-null  remote binding: lsr: 2.2.2.2:0, label: imp-nulllib | |  |
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| entry: 10.0.1.0/24, rev 10 local binding: label: 102  remote binding: lsr: 2.2.2.2:0, label: imp-null  R1#ping 3.3.3.3 source 10.0.0.1Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:Packet sent with a source address of 10.0.0.1  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms R1#traceroute 3.3.3.3 source 10.0.0.1Type  scape sequence to abort. Tracing the route to 3.3.3.3  VRF info: (vrf in name/id, vrf out name/id)  1 10.0.0.2 [MPLS: Label 201 Exp 0] 1 msec 1 msec 0 msec  2 10.0.1.3 1 msec 2 msec \* R1#ping 2.2.2.2 source 10.0.0.1Type  escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:Packet sent with a source address of 10.0.0.1  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 5/5/6 msR1#traceroute  2.2.2.2 source 10.0.0.1  Type escape sequence to abort. Tracing the route to 2.2.2.2  VRF info: (vrf in name/id, vrf out name/id)1  10.0.0.2 2 msec 1 msec \* R2  Router>enable  Router#conf t Router(config)#hostname R2 R2(config)# interface loopback 0  R2(config-if)#ip address 2.2.2.2 255.255.255.255 | |  |
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| R2(config-if)# exit R2(config)#int e0/0  R2(config-if)#ip address 10.0.0.2 255.255.255.0 R2(config-if)#no shut  R2(config)#int e0/1  R2(config-if)#ip address 10.0.1.2 255.255.255.0 R2(config-if)#no shut  R2(config)#router ospf 1  R2(config-router)#network 2.2.2.0 0.0.0.255 area 0  R2(config-router)#network 10.0.0.0 0.0.0.255 area 0  R2(config-router)#network 10.0.1.0 0.0.0.255 area 0 R2(config-router)#exit  R2#show ip route ospf  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set 1.0.0.0/32 is  subnetted, 1 subnets  O 1.1.1.1 [110/11] via 10.0.0.1, 00:15:32,  Ethernet0/0  3.0.0.0/32 is subnetted, 1 subnets  O 3.3.3.3 [110/11] via 10.0.1.3, 00:03:58, Ethernet0/1  R2#sh ip cef  Prefix Next Hop Interface | |  |
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| 0.0.0.0/0 | no route |
| 0.0.0.0/8 | drop |
| 0.0.0.0/32 | receive |

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| 255.255.255.255/32 receive R2#sh ip route 1.1.1.1 Routing  entry for 1.1.1.1/32  Known via "ospf 1", distance 110, metric 11, type intra areaLast update from 10.0.0.1 on Ethernet0/0, 00:33:11 ago Routing Descriptor Blocks:  \* 10.0.0.1, from 1.1.1.1, 00:33:11 ago, via Ethernet0/0Route metric is 11, traffic share count is 1R2#sh ip route 3.3.3.3 Routing entry for 3.3.3.3/32  Known via "ospf 1", distance 110, metric 11, type intra areaLast update from 10.0.1.3 on Ethernet0/1, 00:21:49 ago Routing Descriptor Blocks: | |  |
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| 1.1.1.1/32 | 10.0.0.1 | Ethernet0/0 |
| 2.2.2.2/32 | receive | Loopback0 |
| 3.3.3.3/32 | 10.0.1.3 | Ethernet0/1 |
| 10.0.0.0/24 | attached | Ethernet0/0 |
| 10.0.0.0/32 | receive | Ethernet0/0 |
| 10.0.0.1/32 | attached | Ethernet0/0 |
| 10.0.0.2/32 | receive | Ethernet0/0 |
| 10.0.0.255/32 | receive | Ethernet0/0 |
| 10.0.1.0/24 | attached | Ethernet0/1 |
| 10.0.1.0/32 | receive | Ethernet0/1 |
| 10.0.1.2/32 | receive | Ethernet0/1 |
| 10.0.1.3/32 | attached | Ethernet0/1 |
| 10.0.1.255/32 | receive | Ethernet0/1 |
| 127.0.0.0/8 | drop |  |
| 224.0.0.0/4 | drop |  |
| 224.0.0.0/24 | receive |  |
| 240.0.0.0/4 | drop |  |

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| \* 10.0.1.3, from 3.3.3.3, 00:21:49 ago, via Ethernet0/1Route metric is 11, traffic share count is 1  R2#sh ip cef 1.1.1.1 1.1.1.1/32  nexthop 10.0.0.1 Ethernet0/0  R2#sh ip cef 3.3.3.3 3.3.3.3/32  nexthop 10.0.1.3 Ethernet0/1  R2(config)#mpls label range 200 299 R2(config)#mpls label protocol ldp R2(config)#mpls ldp router-id loopback 0 R2(config)#int e0/0  R2(config-if)#mpls ip R2(config-if)#int e0/1 R2(config-if)#mpls ip  R2#sh mpls interfaces  Interface IP Tunnel BGP Static Operational  R2#sh mpls forwarding-table  Local Outgoing Prefix Bytes Label Outgoing Next HopLabel Label or Tunnel Id Switched interface  200 Pop Label 1.1.1.1/32 0 Et0/0 10.0.0.1  201 Pop Label 3.3.3.3/32 1266 Et0/1 10.0.1.3  R2#sh mpls ldp neighbor  Peer LDP Ident: 1.1.1.1:0; Local LDP Ident 2.2.2.2:0TCP connection: 1.1.1.1.646 - 2.2.2.2.27963  State: Oper; Msgs sent/rcvd: 41/42; DownstreamUp time: 00:29:24  LDP discovery sources: Ethernet0/0, Src IP addr: 10.0.0.1  Addresses bound to peer LDP Ident: | |  |
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| Ethernet0/0 | Yes (ldp) | No | No No | Yes |
| Ethernet0/1 | Yes (ldp) | No | No No | Yes |

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| 10.0.0.1 1.1.1.1  Peer LDP Ident: 3.3.3.3:0; Local LDP Ident 2.2.2.2:0TCP connection: 3.3.3.3.44196 - 2.2.2.2.646  State: Oper; Msgs sent/rcvd: 38/38; DownstreamUp time: 00:27:24  LDP discovery sources: Ethernet0/1, Src IP addr: 10.0.1.3 Addresses bound to peer LDP Ident:10.0.1.3 3.3.3.3  R2#sh mpls ldp bindings lib entry: 1.1.1.1/32, rev 2  local binding: label: 200  remote binding: lsr: 1.1.1.1:0, label: imp-nullremote binding: lsr: 3.3.3.3:0, label: 300  lib entry: 2.2.2.2/32, rev 4  local binding: label: imp-null  remote binding: lsr: 1.1.1.1:0, label: 100 remote binding: lsr: 3.3.3.3:0, label: 301lib  entry: 3.3.3.3/32, rev 6  local binding: label: 201  remote binding: lsr: 1.1.1.1:0, label: 101 remote binding: lsr: 3.3.3.3:0, label: imp-null  lib entry: 10.0.0.0/24, rev 8 local binding: label: imp-null  remote binding: lsr: 1.1.1.1:0, label: imp-nullremote binding: lsr: 3.3.3.3:0, label: 302  lib entry: 10.0.1.0/24, rev 10 local binding: label: imp-null  remote binding: lsr: 1.1.1.1:0, label: 102 remote binding: lsr: 3.3.3.3:0, label: imp-null  R2#ping 1.1.1.1 source 10.0.0.2Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:Packet sent | |  |
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| with a source address of 10.0.0.2  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms R2#traceroute 1.1.1.1 source 10.0.0.2Type  escape sequence to abort.  Tracing the route to 1.1.1.1  VRF info: (vrf in name/id, vrf out name/id)1  10.0.0.1 2 msec 1 msec \*  R2#ping 3.3.3.3 source 10.0.1.2Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:Packet sent with a source address of 10.0.1.2  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms R2#traceroute 3.3.3.3 source 10.0.1.2Type  escape sequence to abort. Tracing the route to 3.3.3.3  VRF info: (vrf in name/id, vrf out name/id)1  10.0.1.3 0 msec 1 msec \* R3  Router>enable  Router#conf t Router(config)#hostname R3 R3(config)#interface loopback 0  R3(config-if)#ip address 3.3.3.3 255.255.255.255 R3(config-if)#exit  R3(config)#int e0/0  R3(config-if)#ip address 10.0.1.3 255.255.255.0 R3(config-if)#no shut  R3(config-if)#exit R3(config)#router ospf 1  R3(config-router)#network 3.3.3.0 0.0.0.255 area 0  R3(config-router)#network 10.0.1.0 0.0.0.255 area 0 | |  |
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| R3(config-router)#exit R3#sh ip route ospf  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set 1.0.0.0/32 is  subnetted, 1 subnets  O 1.1.1.1 [110/21] via 10.0.1.2, 00:03:45, Ethernet0/0  2.0.0.0/32 is subnetted, 1 subnets  O 2.2.2.2 [110/11] via 10.0.1.2, 00:03:45, Ethernet0/0  10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks  O 10.0.0.0/24 [110/20] via 10.0.1.2, 00:03:45, Ethernet0/0  R3#sh ip cef  Prefix Next Hop Interface | |  |
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| 0.0.0.0/0 | no route |  |
| 0.0.0.0/8 | drop |  |
| 0.0.0.0/32 | receive |  |
| 1.1.1.1/32 | 10.0.1.2 | Ethernet0/0 |
| 2.2.2.2/32 | 10.0.1.2 | Ethernet0/0 |
| 3.3.3.3/32 | receive | Loopback0 |
| 10.0.0.0/24 | 10.0.1.2 | Ethernet0/0 |
| 10.0.1.0/24 | attached | Ethernet0/0 |
| 10.0.1.0/32 | receive | Ethernet0/0 |
| 10.0.1.2/32 | attached | Ethernet0/0 |

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| 255.255.255.255/32 receive  R3#sh ip route 1.1.1.1 Routing entry for 1.1.1.1/32  Known via "ospf 1", distance 110, metric 21, type intra areaLast update from 10.0.1.2 on Ethernet0/0, 00:23:51 ago  Routing Descriptor Blocks:  \* 10.0.1.2, from 1.1.1.1, 00:23:51 ago, via Ethernet0/0Route metric is 21, traffic share count is 1  R3#sh ip route 2.2.2.2 Routing entry for 2.2.2.2/32  Known via "ospf 1", distance 110, metric 11, type intra areaLast update from 10.0.1.2 on Ethernet0/0, 00:23:58 ago Routing Descriptor Blocks:  \* 10.0.1.2, from 2.2.2.2, 00:23:58 ago, via Ethernet0/0Route  metric is 11, traffic share count is 1 R3#sh ip cef 1.1.1.1  1.1.1.1/32  nexthop 10.0.1.2 Ethernet0/0 R3#sh ip cef 2.2.2.2  2.2.2.2/32  nexthop 10.0.1.2 Ethernet0/0  R3(config)#mpls label range 300 399 R3(config)#mpls label protocol ldp R3(config)#mpls ldp router-id loopback 0 R3(config)#int e0/0  R3(config-if)#mpls ip | |  |
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| 10.0.1.3/32 | receive | Ethernet0/0 |
| 10.0.1.255/32 | receive | Ethernet0/0 |
| 127.0.0.0/8 | drop |  |
| 224.0.0.0/4 | drop |  |
| 224.0.0.0/24 | receive |  |
| 240.0.0.0/4 | drop |  |

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| R3#sh mpls interfaces  Interface IP Tunnel BGP Static Operational  Ethernet0/0 Yes (ldp) No No No Yes R3#sh mpls ldp binding  lib entry: 1.1.1.1/32, rev 2 local binding: label: 300  remote binding: lsr: 2.2.2.2:0, label: 200lib entry: 2.2.2.2/32, rev 4  local binding: label: 301  remote binding: lsr: 2.2.2.2:0, label: imp-nulllib entry: 3.3.3.3/32, rev 6  local binding: label: imp-null  remote binding: lsr: 2.2.2.2:0, label: 201lib entry: 10.0.0.0/24, rev 8  local binding: label: 302  remote binding: lsr: 2.2.2.2:0, label: imp-nulllib entry: 10.0.1.0/24, rev 10  local binding: label: imp-null  remote binding: lsr: 2.2.2.2:0, label: imp-nullR3#sh mpls ldp neighbor  Peer LDP Ident: 2.2.2.2:0; Local LDP Ident 3.3.3.3:0TCP connection: 2.2.2.2.646 - 3.3.3.3.44196  State: Oper; Msgs sent/rcvd: 51/51; DownstreamUp time: 00:38:15  LDP discovery sources:  Ethernet0/0, Src IP addr: 10.0.1.2 Addresses bound to peer LDP Ident:  10.0.0.2 10.0.1.2 2.2.2.2  R3#sh mpls forwarding-table  Local Outgoing Prefix Bytes Label Outgoing Next HopLabel Label or Tunnel Id Switched interface  300 200 1.1.1.1/32 0 Et0/0 10.0.1.2  301 Pop Label 2.2.2.2/32 0 Et0/0 10.0.1.2  302 Pop Label 10.0.0.0/24 0 Et0/0 10.0.1.2  R3#sh ip cef 1.1.1.1 | |  |
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| 1.1.1.1/32  nexthop 10.0.1.2 Ethernet0/0 label 200 R3#sh ip cef 2.2.2.22.2.2.2/32  nexthop 10.0.1.2 Ethernet0/0  R3#ping 1.1.1.1 source 10.0.1.3Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:Packet sent with a source address of 10.0.1.3  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/3 ms R3#traceroute 1.1.1.1 source 10.0.1.3Type  escape sequence to abort. Tracing the route to 1.1.1.1  VRF info: (vrf in name/id, vrf out name/id)  1 10.0.1.2 [MPLS: Label 200 Exp 0] 1 msec 2 msec 1 msec  2 10.0.0.1 2 msec 2 msec \* R3#ping 2.2.2.2 source 10.0.1.3Type  escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:Packet sent with a source address of 10.0.1.3  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms R3#traceroute 2.2.2.2 source 10.0.1.3Type  escape sequence to abort. Tracing the route to 2.2.2.2  VRF info: (vrf in name/id, vrf out name/id)1  10.0.1.2 2 msec 2 msec \* | |  |
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| **PRACTICAL NO 9**  **Simulating VRFNETWORK TOPOLOGY**    Tasks   * Configure IGP inside SP Core(R1/R2/R3) Under OSPF Area 0 * Configure MPLS LDP inside the SP Core(R1/R2/R3) * Connect R4 & R5 and Assign IP Addressing as per the diagram and verifyconnectivity * Create VRF-A1 on Site 1 (on R4) and VRF-A2 on Site 2(on R5) * RD & Route Target value should be 500:1 for both sites * On R1 Assign Interfaces facing CE(R4) Under VRF-A1 * On R3 Assign Interfaces facing CE(R5) Under VRF-A2 * Configure Routing between PE and CE using OSPF on both the ends * Ensure that PE routers(R1&R3) should be able to Ping CE routers(R4&R5)LAN Interfaces respectively * Configure VPNV4 peering between both the PE Routers (R1/R3). * Configure Mutual Redistribution on PE Routers between OSPF & BGPunder VRF. * Ensure that CE Routers on both sides (R4/R5) should have Reachabilitybetween them   The first two tasks are Preconfigured in the Practical 8 MPLS LDP Lab R1  Router>enable Router#conf t  Router(config)#hostname R1 R1(config)# interface loopback 0  R1(config-if)#ip address 1.1.1.1 255.255.255.255 | |  |
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| R1(config-if)#exit  R1(config)#int e0/0  R1(config-if)#ip address 10.0.0.1 255.255.255.0 R1(config-if)#no shut  R1(config)#int e0/1  R1(config-if)#ip address 192.168.1.1 255.255.255.0 R1(config-if)#no shut  R1(config)#router ospf 1  R1(config-router)#network 1.1.1.0 0.0.0.255 area 0  R1(config-router)#network 10.0.0.0 0.0.0.255 area 0 R1(config-router)#exit  R1(config)#mpls label range 100 199 R1(config)#mpls label protocol ldp R1(config)#mpls ldp router-id loopback 0 R1(config)#int e0/0  R1(config-if)#mpls ip R1(config)#ip vrf A-1 R1(config-vrf)#rd 500:1  R1(config-vrf)#route-target import 500:1  R1(config-vrf)#route-target export 500:1 R1(config-vrf)#exit  R1(config)#exit R1#sh ip vrf  Name Default RD Interfaces  A-1 500:1  R1#sh ip vrf detail  VRF A-1 (VRF Id = 1); default RD 500:1; default VPNID <not set>Old CLI format, supports IPv4 only  Flags: 0xC No interfaces  Address family ipv4 unicast (Table ID = 0x1):Flags: 0x0 Export VPN route-target communities | |  |
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| RT:500:1  Import VPN route-target communities RT:500:1  No import route-map  No global export route-mapNo  export route-map  VRF label distribution protocol: not configured  VRF label allocation mode: per-prefixR1(config)#int e0/1 R1(config-if)#ip vrf forwarding A-1  % Interface Ethernet0/1 IPv4 disabled and address(es) removed due to enablingVRF A-1 R1(config-if)#ip address 192.168.1.1 255.255.255.0  R1(config-if)#end R1#sh ip route vrf A-1 Routing Table: A-1  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected, Ethernet0/1  L 192.168.1.1/32 is directly connected, Ethernet0/1 R1#sh ip vrf  Name Default RD Interfaces  A-1 500:1 Et0/1  R1(config)#router ospf 10 vrf A-1  R1(config-router)#network 192.168.1.0 0.0.0.255 area 10R1(config- router)#end  R1#sh ip ospf neighbor | |  |
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| Neighbor ID Pri State Dead Time Address Interface 2.2.2.2 1 FULL/DR 00:00:39 10.0.0.2 Ethernet0/0  4.4.4.4 1 FULL/DR 00:00:38 192.168.1.4 Ethernet0/1  R1#sh ip ospf 10 neighbor  Neighbor ID Pri State Dead Time Address Interface 4.4.4.4 1 FULL/DR 00:00:38 192.168.1.4 Ethernet0/1  R1#sh ip route vrf A-1 ospf Routing Table: A-1  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2 ia - IS-IS inter area, \* - candidate default, U - per-user static route  o - ODR, P - periodic downloaded static route, H - NHRP, l - LISPa - application route  + - replicated route, % - next hop override Gateway of last resort is not set  4.0.0.0/32 is subnetted, 1 subnets  O 4.4.4.4 [110/11] via 192.168.1.4, 00:03:58, Ethernet0/1  R1(config)#router bgp 500  R1(config-router)#no bgp default ipv4-unicast R1(config- router)#neighbor 3.3.3.3 remote-as 500  R1(config-router)#neighbor 3.3.3.3 update-source loopback 0R1(config- router)#address-family vpnv4 unicast  R1(config-router-af)#neighbor 3.3.3.3 activate  R1(config-router-af)#neighbor 3.3.3.3 send-community extendedR1(config- router-af)#neighbor 3.3.3.3 next-hop-self  R1(config-router-af)#end  R1#sh ip bgp vpnv4 all summary  BGP router identifier 1.1.1.1, local AS number 500 BGP table version is 1, main routing table version 1 | |  |
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| Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd  3.3.3.3 4 500 6 7 1 0 0 00:03:19 0  R1(config)#router bgp 500  R1(config-router)#address-family ipv4 vrf A-1  R1(config-router-af)#redistribute ospf 10 vrf A-1 match internal external 1external 2 R1(config-router-af)#exit R1(config-  router)#exit R1(config)#router ospf 10 vrf A-1  R1(config-router)#redistribute bgp 500 subnets R1(config-router)#end  R1#sh ip bgp vpnv4 all  BGP table version is 7, local router ID is 1.1.1.1  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S  Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path Route Distinguisher: 500:1 (default for vrf A-1)  \*> 4.4.4.4/32 192.168.1.4 11 32768 ?  \*>i 5.5.5.5/32 3.3.3.3 11 100 0 ?  \*> 192.168.1.0 0.0.0.0 0 32768 ?  \*>i 192.168.2.0 3.3.3.3 0 100 0 ?  R1#sh ip route vrf A-1 Routing Table: A-1  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route | |  |
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| + - replicated route, % - next hop override Gateway of last resort is not set 4.0.0.0/32 is  subnetted, 1 subnets  O 4.4.4.4 [110/11] via 192.168.1.4, 07:36:09, Ethernet0/1  5.0.0.0/32 is subnetted, 1 subnets  B 5.5.5.5 [200/11] via 3.3.3.3, 00:06:15  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected, Ethernet0/1  L 192.168.1.1/32 is directly connected, Ethernet0/1B 192.168.2.0/24 [200/0] via 3.3.3.3, 00:06:15  R1#sh ip route vrf A-1 bgp Routing Table: A-1  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 –  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set 5.0.0.0/32 is  subnetted, 1 subnets  B 5.5.5.5 [200/11] via 3.3.3.3, 00:07:31  B 192.168.2.0/24 [200/0] via 3.3.3.3, 00:07:31  R1#ping vrf A-1 4.4.4.4  Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/6 ms R2  Router>enable Router#conf t  Router(config)#hostname R2 | |  |
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| R2(config)# interface loopback 0  R2(config-if)#ip address 2.2.2.2 255.255.255.255 R2(config-if)# exit  R2(config)#int e0/0  R2(config-if)#ip address 10.0.0.2 255.255.255.0 R2(config-if)#no shut  R2(config)#int e0/1  R2(config-if)#ip address 10.0.1.2 255.255.255.0 R2(config-if)#no shut  R2(config)#router ospf 1  R2(config-router)#network 2.2.2.0 0.0.0.255 area 0  R2(config-router)#network 10.0.0.0 0.0.0.255 area 0  R2(config-router)#network 10.0.1.0 0.0.0.255 area 0 R2(config-router)#exit  R2(config)#mpls label range 200 299 R2(config)#mpls label protocol ldp R2(config)#mpls ldp router-id loopback 0 R2(config)#int e0/0  R2(config-if)#mpls ip R2(config-if)#int e0/1  R2(config-if)#mpls ip R3  Router>enable Router#conf t  Router(config)#hostname R3 R3(config)#interface loopback 0  R3(config-if)#ip address 3.3.3.3 255.255.255.255 R3(config-if)#exit  R3(config)#int e0/0  R3(config-if)#ip address 10.0.1.3 255.255.255.0 R3(config-if)#no shut  R3(config-if)#exit R3(config)#interface e0/1 | |  |
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| R3(config-if)#ip address 192.168.2.3 255.255.255.0 R3(config-if)#no shut  R3(config-if)#exit R3(config)#router ospf 1  R3(config-router)#network 3.3.3.0 0.0.0.255 area 0  R3(config-router)#network 10.0.1.0 0.0.0.255 area 0 R3(config-router)#exit  R3(config)#mpls label range 300 399 R3(config)#mpls label protocol ldp R3(config)#mpls ldp router-id loopback 0 R3(config)#int e0/0  R3(config-if)#mpls ip R3(config)#ip vrf A-2 R3(config-vrf)#rd 500:1  R3(config-vrf)#route-target import 500:1  R3(config-vrf)#route-target export 500:1 R3#sh ip vrf  Name Default RD Interfaces  A-2 500:1  R3#sh ip vrf detail  VRF A-2 (VRF Id = 1); default RD 500:1; default VPNID <not set>Old CLI format, supports IPv4 only  Flags: 0xC No interfaces  Address family ipv4 unicast (Table ID = 0x1):Flags: 0x0 Export VPN route-target communities  RT:500:1  Import VPN route-target communities RT:500:1  No import route-map  No global export route-mapNo export route-map  VRF label distribution protocol: not configuredVRF  label allocation mode: per-prefix | |  |
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| R3(config)#int e0/1  R3(config-if)#ip vrf forwarding A-2  % Interface Ethernet0/1 IPv4 disabled and address(es) removed due to enablingVRF A-2 R3(config-if)#ip address 192.168.2.3 255.255.255.0  R3(config-if)#end R3#sh ip route vrf A-2 Routing Table: A-2  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  192.168.2.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.2.0/24 is directly connected, Ethernet0/1  L 192.168.2.3/32 is directly connected, Ethernet0/1 R3#sh ip vrf  Name Default RD Interfaces  A-2 500:1 Et0/1  R3(config)#router ospf 10 vrf A-2  R3(config-router)#network 192.168.2.0 0.0.0.255 area 0R3(config- router)#end  R3#sh ip ospf 10 neighbor  Neighbor ID Pri State Dead Time Address Interface 5.5.5.5 1 FULL/DR 00:00:33 192.168.2.5 Ethernet0/1  R3#sh ip route vrf A-2 ospf Routing Table: A-2  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 - | |  |
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| OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  5.0.0.0/32 is subnetted, 1 subnets  O 5.5.5.5 [110/11] via 192.168.2.5, 00:06:37, Ethernet0/1  R3(config)#router bgp 500  R3(config-router)#no bgp default ipv4-unicast R3(config- router)#neighbor 1.1.1.1 remote-as 500  R3(config-router)#neighbor 1.1.1.1 update-source loopback 0R3(config- router)#address-family vpnv4 unicast  R3(config-router-af)#neighbor 1.1.1.1 activate  R3(config-router-af)#neighbor 1.1.1.1 send-community extendedR3(config- router-af)#neighbor 1.1.1.1 next-hop-self  R3#sh ip bgp vpnv4 all summary  BGP router identifier 3.3.3.3, local AS number 500 BGP table version is 1, main routing table version 1  Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd  1.1.1.1 4 500 7 6 1 0 0 00:03:01  R3(config)#router bgp 500  R3(config-router)#address-family ipv4 vrf A-2  R3(config-router-af)#redistribute ospf 10 vrf A-2 match internal external 1external 2 R3(config-router-af)#exit R3(config-  router)#exit R3(config)#router ospf 10 vrf A-2  R3(config-router)#redistribute bgp 500 subnets R3(config-router)#end  R3#sh ip bgp vpnv4 all  BGP table version is 7, local router ID is 3.3.3.3  Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,  x best-external, a additional-path, c RIB-compressed,Origin | |  |
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| codes: i - IGP, e - EGP, ? - incomplete  RPKI validation codes: V valid, I invalid, N Not found  Network Next Hop Metric LocPrf Weight Path Route Distinguisher: 500:1 (default for vrf A-2)  \*>i 4.4.4.4/32 1.1.1.1 11 100 0 ?  \*> 5.5.5.5/32 192.168.2.5 11 32768 ?  \*>i 192.168.1.0 1.1.1.1 0 100 0 ?  \*> 192.168.2.0 0.0.0.0 0 32768 ?  R3#sh ip route vrf A-2 Routing Table: A-2  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set  4.0.0.0/32 is subnetted, 1 subnets  B 4.4.4.4 [200/11] via 1.1.1.1, 00:55:23  5.0.0.0/32 is subnetted, 1 subnets  O 5.5.5.5 [110/11] via 192.168.2.5, 01:50:21, Ethernet0/1  B 192.168.1.0/24 [200/0] via 1.1.1.1, 00:55:23  192.168.2.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.2.0/24 is directly connected, Ethernet0/1  L 192.168.2.3/32 is directly connected, Ethernet0/1 R3#ping vrf A-2 5.5.5.5  Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 5.5.5.5, timeout is 2 seconds:  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms R4  Router>enable Router#conf t  Router(config)#hostname R4 | |  |
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| R4(config)#int loopback 0  R4(config-if)#ip address 4.4.4.4 255.255.255.255 R4(config-if)#exit  R4(config)#int e0/0  R4(config-if)#ip address 192.168.1.4 255.255.255.0 R4(config-if)#no shutdown  R4(config-if)#exit R4(config)#router ospf 1  R4(config-router)#network 4.4.4.0 0.0.0.255 area 10  R4(config-router)#network 192.168.1.0 0.0.0.255 area 10R4(config- router)#exit  R4#sh ip route ospf  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set 5.0.0.0/32 is  subnetted, 1 subnets  O IA 5.5.5.5 [110/21] via 192.168.1.1, 00:23:41, Ethernet0/0  O IA 192.168.2.0/24 [110/11] via 192.168.1.1, 00:23:41, Ethernet0/0  R4#ping 5.5.5.5 source lo 0 Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 5.5.5.5, timeout is 2 seconds:Packet sent with a source address of 4.4.4.4  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms R5  Router>enable Router#conf t  Router(config)#hostname R5 R5(config)#int loopback 0 | |  |
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| R5(config-if)#ip address 5.5.5.5 255.255.255.255 R5(config-if)#exit  R5(config)#int e0/0  R5(config-if)#ip address 192.168.2.5 255.255.255.0 R5(config-if)#no shutdown  R5(config-if)#exit R5(config)#router ospf 1  R5(config-router)#network 5.5.5.0 0.0.0.255 area 0  R5(config-router)#network 192.168.2.0 0.0.0.255 area 0R5(config- router)#exit  R5#sh ip route ospf  Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGPD - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2E1 -  OSPF external type 1, E2 - OSPF external type 2  i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2  ia - IS-IS inter area, \* - candidate default, U - per-user static routeo - ODR, P - periodic downloaded static route, H - NHRP, l - LISP  a - application route  + - replicated route, % - next hop override Gateway of last resort is not set 4.0.0.0/32 is  subnetted, 1 subnets  O IA 4.4.4.4 [110/21] via 192.168.2.3, 00:23:51, Ethernet0/0  O IA 192.168.1.0/24 [110/11] via 192.168.2.3, 00:23:51, Ethernet0/0  R5#ping 4.4.4.4 source lo 0 Type escape sequence to abort.  Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:Packet sent with a source address of 5.5.5.5  !!!!!  Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms | |  |
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