C8000V IPsec Testbed

Test evidence — every command run on every device

Run started	07 September 2026, 19:21 UTC
Duration	19.4 minutes
Result	208 of 208 tests passed
Suites	22
Device commands recorded	1406
Topology	hub-and-spoke: R1 hub, R2 and R3 spokes, one Linux host per router
Encryption	IKEv2 + static VTI, ESP-AES-256 / SHA256, one tunnel per spoke
Routing	eBGP inside the tunnels; AS 65001 hub, AS 65002 / 65003 spokes

Suite results

Suite	Tests	Passed	Failed	Commands	Time
01 Platform	5	5	0	10	1s
02 Configuration	5	5	0	14	2s
03 Wan	6	6	0	19	1s
04 Dmvpn	13	13	0	37	25s
05 Capture State	12	12	0	79	16s
06 Wire Encryption	3	3	0	27	34s
07 Ipsec Negative	3	3	0	63	124s
08 Management Api	6	6	0	7	3s
09 Bgp	26	26	0	623	302s
10 Host To Host	10	10	0	47	79s
11 Throughput	3	3	0	10	81s
12 Nat	10	10	0	51	79s
13 Nat Pool	13	13	0	50	89s
14 Ntp	12	12	0	39	3s
15 Syslog	10	10	0	21	47s
16 Snmpv3	13	13	0	87	15s

17 Snmp Polling	14	14	0	74	17s
18 Mtu	8	8	0	17	21s
19 Oob	9	9	0	68	31s
20 Tacacs	12	12	0	35	25s
21 Vty Acl	9	9	0	22	1s
22 Banner	6	6	0	6	21s

Each test below lists the commands it issued, in order, with the device that ran them and the output it returned. Router commands are marked in teal, Linux host commands in amber. Long output is trimmed to the first 14 lines; complete captures are in `results/`.

01 Platform

PASS Both Routers Report Catalyst 8000V Software (0.2s, 2 commands)

R1 show version

```
Cisco IOS XE Software, Version 17.15.06
Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-UNIVERSALK9-M), Version 17.15.6, RELEASE
SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
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GPL code under the terms of GPL Version 2.0.  For more details, see the
documentation or "License Notice" file accompanying the IOS-XE software,
... 52 more lines
```

R2 show version

```
Cisco IOS XE Software, Version 17.15.06
Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-UNIVERSALK9-M), Version 17.15.6, RELEASE
SOFTWARE (fc2)
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GPL code under the terms of GPL Version 2.0.  For more details, see the
documentation or "License Notice" file accompanying the IOS-XE software,
... 52 more lines
```

PASS Hostnames Match The Day0 Bootstrap Configs (0.2s, 2 commands)

R1 show running-config | include ^hostname

```
hostname c8000v-r1
```

R2 show running-config | include ^hostname

```
hostname c8000v-r2
```

PASS Management Interfaces Are Up With DHCP Addresses (0.1s, 2 commands)

R1 show ip interface brief GigabitEthernet1

```
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet1       10.0.2.15       YES DHCP   up                    up
```

R2 show ip interface brief GigabitEthernet1

```
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet1       10.0.2.15       YES DHCP   up                    up
```

PASS Crypto Feature License Is Active (0.1s, 2 commands)

Without a feature license the crypto CLI does not exist at all, so every IPsec test downstream depends on this.

R1 show version | include License Level

```
License Level: network-premier
Addon License Level: dna-premier
```

R2 show version | include License Level

```
License Level: network-premier
Addon License Level: dna-premier
```

PASS Management Plane Services Are Enabled (0.2s, 2 commands)

```
R1 show running-config | include ^netconf-yang|^restconf
  netconf-yang
  restconf
R2 show running-config | include ^netconf-yang|^restconf
  netconf-yang
  restconf
```

02 Configuration

PASS Create A Loopback Interface (0.1s, 6 commands)

```
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 interface Loopback100
  ${output} =
R1 description ROBOT-MANAGED
  ${output} =
R1 ip address 192.0.2.1 255.255.255.0
  ${output} =
R1 no shutdown
  ${output} =
R1 end
  ${output} =
```

PASS Loopback Appears In The Interface Table (0.0s, 1 commands)

```
R1 show ip interface brief Loopback100
  Interface              IP-Address      OK? Method Status                Protocol
  Loopback100            192.0.2.1       YES manual up                    up
```

PASS Loopback Is Reachable From The Device Itself (2.1s, 2 commands)

```
R1 ping 192.0.2.1 repeat 2
  Type escape sequence to abort.
  Sending 2, 100-byte ICMP Echos to 192.0.2.1, timeout is 2 seconds:
  .!
  Success rate is 50 percent (1/2), round-trip min/avg/max = 1/1/1 ms
R1 ping 192.0.2.1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 192.0.2.1, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

PASS Loopback Is Present In The Running Config (0.0s, 1 commands)

```
R1 show running-config interface Loopback100
  Building configuration...

  Current configuration : 92 bytes
  !
  interface Loopback100
   description ROBOT-MANAGED
   ip address 192.0.2.1 255.255.255.0
  end
```

PASS Removing The Loopback Cleans It Up (0.1s, 4 commands)

```
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 no interface Loopback100
  ${output} =
R1 end
  ${output} =
R1 show ip interface brief Loopback100
  ^
  % Invalid input detected at '^' marker.
```

03 Wan

PASS Every Router Is On The Shared WAN Segment (0.1s, 3 commands)

```
R1 show ip interface brief | include GigabitEthernet2
  GigabitEthernet2       100.64.0.1      YES TFTP   up                    up
R2 show ip interface brief | include GigabitEthernet2
  GigabitEthernet2       100.64.0.2      YES TFTP   up                    up
R3 show ip interface brief | include GigabitEthernet2
  GigabitEthernet2       100.64.0.3      YES TFTP   up                    up
```

PASS Every Router Can Reach Every Other Router On It (0.2s, 6 commands)

Including spoke to spoke, which is the precondition for a direct tunnel and the property the VTI lab deliberately did not have. Tested at the underlay, before any tunnel exists.

```
R2 ping 100.64.0.2 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 100.64.0.2, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R3 ping 100.64.0.3 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 100.64.0.3, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R1 ping 100.64.0.1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 100.64.0.1, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3 ping 100.64.0.3 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 100.64.0.3, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R1 ping 100.64.0.1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 100.64.0.1, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2 ping 100.64.0.2 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 100.64.0.2, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

PASS The Spokes Reach Each Other Directly, Not Through The Hub (0.0s, 1 commands)

One hop at the underlay. If this became two the spokes would still have connectivity, and DMVPN would still form tunnels -- but every "direct" spoke-to-spoke path would quietly be transiting the hub anyway.

```
R2 traceroute 100.64.0.3 probe 1 timeout 1 numeric
  Type escape sequence to abort.
  Tracing the route to 100.64.0.3
  VRF info: (vrf in name/id, vrf out name/id)
    1 100.64.0.3 1 msec
```

PASS Each Router Learns The Others On The Segment (0.1s, 3 commands)

A shared segment, so every router should have resolved every other -- unlike a point-to-point link with exactly one neighbour.

```
R1 show ip arp GigabitEthernet2
  Protocol  Address          Age (min)  Hardware Addr   Type   Interface
  Internet  100.64.0.1               -   5254.00c8.0102  ARPA   GigabitEthernet2
  Internet  100.64.0.2              67   5254.00c8.0202  ARPA   GigabitEthernet2
  Internet  100.64.0.3              66   5254.00c8.0302  ARPA   GigabitEthernet2
```

```
R2 show ip arp GigabitEthernet2
  Protocol  Address          Age (min)  Hardware Addr   Type   Interface
  Internet  100.64.0.2               -   5254.00c8.0202  ARPA   GigabitEthernet2
  Internet  100.64.0.1              67   5254.00c8.0102  ARPA   GigabitEthernet2
  Internet  100.64.0.3              66   5254.00c8.0302  ARPA   GigabitEthernet2
```

```
R3 show ip arp GigabitEthernet2
  Protocol  Address          Age (min)  Hardware Addr   Type   Interface
  Internet  100.64.0.3               -   5254.00c8.0302  ARPA   GigabitEthernet2
  Internet  100.64.0.1              67   5254.00c8.0102  ARPA   GigabitEthernet2
  Internet  100.64.0.2              66   5254.00c8.0202  ARPA   GigabitEthernet2
```

PASS The Underlay Carries No Site Prefixes (0.1s, 3 commands)

The WAN is a transport, not a routing domain. A site prefix appearing here would mean traffic could reach a LAN without ever entering the tunnel -- unencrypted, and invisible to every test that watches the overlay.

```
R1 show ip route | include GigabitEthernet2
  C        100.64.0.0/24 is directly connected, GigabitEthernet2
  L        100.64.0.1/32 is directly connected, GigabitEthernet2
```

```
R2 show ip route | include GigabitEthernet2
  C        100.64.0.0/24 is directly connected, GigabitEthernet2
  L        100.64.0.2/32 is directly connected, GigabitEthernet2
```

```
R3 show ip route | include GigabitEthernet2
  C        100.64.0.0/24 is directly connected, GigabitEthernet2
  L        100.64.0.3/32 is directly connected, GigabitEthernet2
```

PASS No Routing Protocol Runs On The WAN Segment (0.1s, 3 commands)

BGP peers over the tunnel, so the underlay should carry no adjacency at all. One here would be a second, unprotected path for the control plane.

```
R1 show bgp ipv4 unicast summary | begin Neighbor
  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  172.20.0.2      4        65002      21      24       28    0    0 00:02:16        3
  172.20.0.3      4        65003     100     110       28    0    0 00:14:48        3
```

```
R2 show bgp ipv4 unicast summary | begin Neighbor
  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  172.20.0.1      4        65001      24      21       46    0    0 00:02:16        6
```

```
R3 show bgp ipv4 unicast summary | begin Neighbor
  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  172.20.0.1      4        65001     110     100      146    0    0 00:14:49        6
```

04 Dmvpn

PASS Every Router Runs One Multipoint Tunnel With No Destination (0.1s, 4 commands)

The structural difference from a static VTI. A configured destination would make this point-to-point again and there would be nothing for NHRP to resolve.

```
R1 show running-config interface Tunnel0
  Building configuration...

  Current configuration : 399 bytes
  !
  interface Tunnel0
   description DMVPN hub
   ip address 172.20.0.1 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp redirect
   ip tcp adjust-mss 1360
  ... 6 more lines
R2 show running-config interface Tunnel0
  Building configuration...

  Current configuration : 433 bytes
  !
  interface Tunnel0
   description DMVPN spoke
   ip address 172.20.0.2 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
   ip tcp adjust-mss 1360
  ... 6 more lines
R3 show running-config interface Tunnel0
  Building configuration...

  Current configuration : 433 bytes
  !
  interface Tunnel0
   description DMVPN spoke
   ip address 172.20.0.3 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
   ip tcp adjust-mss 1360
  ... 6 more lines
R1 show ip interface brief | count Tunnel
  Number of lines which match regexp = 1
```

PASS The Tunnel Is Protected By IPsec On Every Router (0.1s, 3 commands)

```
R1 show running-config interface Tunnel0
  Building configuration...

  Current configuration : 399 bytes
  !
  interface Tunnel0
   description DMVPN hub
   ip address 172.20.0.1 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp redirect
   ip tcp adjust-mss 1360
```

```
  ... 6 more lines
```

R2 show running-config interface Tunnel0

```
  Building configuration...

  Current configuration : 433 bytes
  !
  interface Tunnel0
   description DMVPN spoke
   ip address 172.20.0.2 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
   ip tcp adjust-mss 1360
  ... 6 more lines
```

R3 show running-config interface Tunnel0

```
  Building configuration...

  Current configuration : 433 bytes
  !
  interface Tunnel0
   description DMVPN spoke
   ip address 172.20.0.3 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
   ip tcp adjust-mss 1360
  ... 6 more lines
```

PASS NHRP Shares A Network ID And Authentication Everywhere (0.1s, 3 commands)

Both must match across the cloud; a mismatch in either leaves registrations silently unanswered.

R1 show running-config interface Tunnel0

```
  Building configuration...

  Current configuration : 399 bytes
  !
  interface Tunnel0
   description DMVPN hub
   ip address 172.20.0.1 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp redirect
   ip tcp adjust-mss 1360
  ... 6 more lines
```

R2 show running-config interface Tunnel0

```
  Building configuration...

  Current configuration : 433 bytes
  !
  interface Tunnel0
   description DMVPN spoke
   ip address 172.20.0.2 255.255.255.0
   no ip redirects
   ip nat outside
   ip nhrp authentication LabNhrp
   ip nhrp network-id 100
   ip nhrp holdtime 300
   ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
   ip tcp adjust-mss 1360
  ... 6 more lines
```

R3 show running-config interface Tunnel0

```
  Building configuration...

  Current configuration : 433 bytes
  !
  interface Tunnel0
   description DMVPN spoke
```

```
 ip address 172.20.0.3 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
... 6 more lines
```

PASS The Hub Is The Next Hop Server And The Spokes Point At It (0.1s, 4 commands)

R2 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 433 bytes
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.2 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
... 6 more lines
```

R3 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 433 bytes
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.3 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
... 6 more lines
```

R1 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 399 bytes
!
interface Tunnel0
 description DMVPN hub
 ip address 172.20.0.1 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp redirect
 ip tcp adjust-mss 1360
... 6 more lines
```

R1 show dmvpn

```
Legend: Attrb --> S - Static, D - Dynamic, I - Incomplete
        N - NATed, L - Local, X - No Socket
        T1 - Route Installed, T2 - Nexthop-override, B - BGP
        C - CTS Capable, I2 - Temporary
        # Ent --> Number of NHRP entries with same NBMA peer
        NHS Status: E --> Expecting Replies, R --> Responding, W --> Waiting
        UpDn Time --> Up or Down Time for a Tunnel
==========================================================================

Interface: Tunnel0, IPv4 NHRP Details
Type:Hub, NHRP Peers:2,

 # Ent  Peer NBMA Addr Peer Tunnel Add State  UpDn Tm Attrb
 ----- --------------- --------------- ----- -------- -----
... 2 more lines
```

PASS This Is Phase 3, Not Phase 1 Or 2 (0.1s, 3 commands)

Redirect on the hub and shortcut on the spokes are what make the overlay reorganise itself. Without them the tests below about direct paths cannot pass, and the design is a different one.

R1 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 399 bytes
!
interface Tunnel0
 description DMVPN hub
 ip address 172.20.0.1 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp redirect
 ip tcp adjust-mss 1360
... 6 more lines
```

R2 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 433 bytes
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.2 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
... 6 more lines
```

R3 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 433 bytes
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.3 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
... 6 more lines
```

PASS Both Spokes Register With The Hub (0.0s, 1 commands)

Registration is dynamic: the hub is configured with no spoke addresses at all and learns them as they arrive.

R1 show dmvpn

```
Legend: Attrb --> S - Static, D - Dynamic, I - Incomplete
        N - NATed, L - Local, X - No Socket
        T1 - Route Installed, T2 - Nexthop-override, B - BGP
        C - CTS Capable, I2 - Temporary
        # Ent --> Number of NHRP entries with same NBMA peer
        NHS Status: E --> Expecting Replies, R --> Responding, W --> Waiting
        UpDn Time --> Up or Down Time for a Tunnel
==========================================================================

Interface: Tunnel0, IPv4 NHRP Details
Type:Hub, NHRP Peers:2,

 # Ent  Peer NBMA Addr Peer Tunnel Add State  UpDn Tm Attrb
 ----- --------------- --------------- ----- -------- -----
... 2 more lines
```

PASS The Hub Maps Each Spoke's Tunnel Address To Its NBMA Address (0.0s, 1 commands)

R1 show ip nhrp

```
172.20.0.2/32 via 172.20.0.2
   Tunnel0 created 00:00:49, expire 00:04:46
   Type: dynamic, Flags: registered nhop bfd
   NBMA address: 100.64.0.2
172.20.0.3/32 via 172.20.0.3
   Tunnel0 created 00:00:49, expire 00:04:10
   Type: dynamic, Flags: registered nhop bfd
   NBMA address: 100.64.0.3
```

PASS Every DMVPN Peering Is Encrypted (0.0s, 2 commands)

One IPsec profile protects the multipoint tunnel, so each peering formed over it -- including ones the configuration never named -- is protected by construction.

R2 show crypto session brief

```
Status: A- Active, U - Up, D - Down, I - Idle, S - Standby, N - Negotiating
        K - No IKE
ivrf = (none)
Peer            I/F          Username        Group/Phase1_id          Uptime   Status
100.64.0.3      Tu0                          100.64.0.3               00:00:45 UA
100.64.0.1      Tu0                          100.64.0.1               00:00:49 UA
```

R3 show crypto session brief

```
Status: A- Active, U - Up, D - Down, I - Idle, S - Standby, N - Negotiating
        K - No IKE
ivrf = (none)
Peer            I/F          Username        Group/Phase1_id          Uptime   Status
100.64.0.2      Tu0                          100.64.0.2               00:00:45 UA
100.64.0.1      Tu0                          100.64.0.1               00:00:49 UA
```

PASS A Spoke Learns The Far Spoke As The BGP Next Hop (0.1s, 2 commands)

The routing half of Phase 3, and the reason "next-hop-unchanged" is configured on the hub. If the hub rewrote the next hop to itself, every spoke-to-spoke prefix would resolve to the hub, NHRP would never be asked to find the far spoke, and no shortcut could form.

R2 show bgp ipv4 unicast 10.20.3.1

```
BGP routing table entry for 10.20.3.1/32, version 43
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001 65003
    172.20.0.3 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65003:1
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:19:46 UTC
```

R3 show bgp ipv4 unicast 10.20.2.1

```
BGP routing table entry for 10.20.2.1/32, version 144
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001 65002
    172.20.0.2 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65002:1
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:20:08 UTC
```

PASS Spoke To Spoke Traffic Works Before Any Shortcut Exists (12.1s, 4 commands)

The fallback path. With the NHRP cache cleared there is no direct entry, so the first packets go through the hub -- which is what makes the shortcut an optimisation rather than a prerequisite for connectivity.

R2 clear ip nhrp

```
${output} =
```

R3 clear ip nhrp

```
${output} =
```

```
R2 show ip nhrp 172.20.0.3
  ${output} =
R2 ping 10.20.3.1 source Loopback1 repeat 30
  Type escape sequence to abort.
  Sending 30, 100-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  .!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  Success rate is 96 percent (29/30), round-trip min/avg/max = 1/1/7 ms
```

PASS A Shortcut Forms On Demand (12.1s, 6 commands)

The defining behaviour. Cleared first so the entry cannot be left over from an earlier test: it has to be created by this traffic, here.

```
R2 clear ip nhrp
  ${output} =
R3 clear ip nhrp
  ${output} =
R2 show ip nhrp 172.20.0.3
  ${output} =
R2 ping 10.20.3.1 source Loopback1 repeat 20
  Type escape sequence to abort.
  Sending 20, 100-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  .!!!!!!!!!!!!!!!!!!!!
  Success rate is 95 percent (19/20), round-trip min/avg/max = 1/1/1 ms
R2 show ip nhrp 172.20.0.3
  172.20.0.3/32 via 172.20.0.3
     Tunnel0 created 00:00:02, expire 00:04:58
     Type: dynamic, Flags: router nhop bfd
     NBMA address: 100.64.0.3
R3 show ip nhrp 172.20.0.2
  172.20.0.2/32 via 172.20.0.2
     Tunnel0 created 00:00:02, expire 00:04:58
     Type: dynamic, Flags: router implicit nhop bfd
     NBMA address: 100.64.0.2
```

PASS Traffic Then Leaves The Hub Out Of The Path (0.1s, 2 commands)

The point of the shortcut, and the strongest statement this suite makes: with the direct path installed, a trace from one spoke to the other reaches it in a single hop instead of transiting the hub.

```
R2 show ip nhrp 172.20.0.3
  172.20.0.3/32 via 172.20.0.3
     Tunnel0 created 00:00:02, expire 00:04:57
     Type: dynamic, Flags: router nhop bfd
     NBMA address: 100.64.0.3
R2 traceroute 10.20.3.1 source Loopback1 probe 1 timeout 1 numeric
  Type escape sequence to abort.
  Tracing the route to 10.20.3.1
  VRF info: (vrf in name/id, vrf out name/id)
    1 172.20.0.3 2 msec
```

PASS The Shortcut Gets Its Own IPsec Session (0.0s, 2 commands)

A direct path between two routers that were never configured with each other's addresses, protected all the same, because the profile is bound to the tunnel rather than to a peer.

```
R2 show ip nhrp 172.20.0.3
  172.20.0.3/32 via 172.20.0.3
     Tunnel0 created 00:00:02, expire 00:04:57
     Type: dynamic, Flags: router nhop bfd
     NBMA address: 100.64.0.3
R2 show crypto session brief
  Status: A- Active, U - Up, D - Down, I - Idle, S - Standby, N - Negotiating
          K - No IKE
  ivrf = (none)
  Peer            I/F          Username        Group/Phase1_id          Uptime   Status
  100.64.0.3      Tu0                          100.64.0.3               00:00:02 UA
  100.64.0.1      Tu0                          100.64.0.1               00:01:14 UA
```

05 Capture State

PASS Capture Running Config From Every Router (13.1s, 3 commands)

R1 show running-config

```
Building configuration...

Current configuration : 21292 bytes
!
! Last configuration change at 23:22:01 UTC Mon Sep 7 2026 by lab
!
version 17.15
service timestamps debug datetime msec
service timestamps log datetime msec show-timezone
service sequence-numbers
platform qfp utilization monitor load 80
platform sslvpn use-pd
platform console serial
!
... 624 more lines
```

R2 show running-config

```
Building configuration...

Current configuration : 19872 bytes
!
! Last configuration change at 23:21:14 UTC Mon Sep 7 2026 by lab
!
version 17.15
service timestamps debug datetime msec
service timestamps log datetime msec show-timezone
service sequence-numbers
platform qfp utilization monitor load 80
platform sslvpn use-pd
platform console serial
!
... 582 more lines
```

R3 show running-config

```
Building configuration...

Current configuration : 19832 bytes
!
! Last configuration change at 23:21:14 UTC Mon Sep 7 2026 by lab
!
version 17.15
service timestamps debug datetime msec
service timestamps log datetime msec show-timezone
service sequence-numbers
platform qfp utilization monitor load 80
platform sslvpn use-pd
platform console serial
!
... 579 more lines
```

PASS Capture Routing Table From Every Router (0.2s, 3 commands)

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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is 10.0.2.2 to network 0.0.0.0
... 24 more lines
```

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, m - OMP
        n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
        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
        H - NHRP, G - NHRP registered, g - NHRP registration summary
        o - ODR, P - periodic downloaded static route, l - LISP
        a - application route
        + - replicated route, % - next hop override, p - overrides from PfR
        & - replicated local route overrides by connected

  Gateway of last resort is 10.0.2.2 to network 0.0.0.0
  ... 24 more lines
```

R3 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, m - OMP
        n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
        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
        H - NHRP, G - NHRP registered, g - NHRP registration summary
        o - ODR, P - periodic downloaded static route, l - LISP
        a - application route
        + - replicated route, % - next hop override, p - overrides from PfR
        & - replicated local route overrides by connected

  Gateway of last resort is 10.0.2.2 to network 0.0.0.0
  ... 24 more lines
```

PASS Capture BGP Table And Neighbours From Every Router (0.2s, 6 commands)

R1 show bgp ipv4 unicast

```
  BGP table version is 28, local router ID is 172.16.1.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.1.1/32     0.0.0.0                  0         32768 i
   *>   10.20.2.1/32     172.20.0.2               0             0 65002 i
   *>   10.20.3.1/32     172.20.0.3               0             0 65003 i
   *>   10.30.1.0/24     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     172.20.0.2               0             0 65002 i
  ... 4 more lines
```

R1 show bgp ipv4 unicast summary

```
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 28, main routing table version 28
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  6 BGP community entries using 144 bytes of memory
  0 BGP route-map cache entries using 0 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5720 total bytes of memory
  BGP activity 136/127 prefixes, 139/130 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:48:55.594 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
```

R2 show bgp ipv4 unicast

```
  BGP table version is 46, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.1.1/32     172.20.0.1               0             0 65001 i
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.20.3.1/32     172.20.0.3                             0 65001 65003 i
   *>   10.30.1.0/24     172.20.0.1               0             0 65001 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
```

```
  ... 4 more lines
```

R2 show bgp ipv4 unicast summary

```
  BGP router identifier 172.16.2.1, local AS number 65002
  BGP table version is 46, main routing table version 46
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 64 bytes of memory
  6 BGP community entries using 144 bytes of memory
  0 BGP route-map cache entries using 0 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5736 total bytes of memory
  BGP activity 160/151 prefixes, 162/153 paths, scan interval 60 secs
  31 networks peaked at 22:34:42 Sep 7 2026 UTC (00:48:12.674 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 1 more lines
```

R3 show bgp ipv4 unicast

```
  BGP table version is 146, local router ID is 172.16.3.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.1.1/32     172.20.0.1               0             0 65001 i
   *>   10.20.2.1/32     172.20.0.2                             0 65001 65002 i
   *>   10.20.3.1/32     0.0.0.0                  0         32768 i
   *>   10.30.1.0/24     172.20.0.1               0             0 65001 i
   *>   10.30.2.0/24     172.20.0.2                             0 65001 65002 i
  ... 4 more lines
```

R3 show bgp ipv4 unicast summary

```
  BGP router identifier 172.16.3.1, local AS number 65003
  BGP table version is 146, main routing table version 146
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 64 bytes of memory
  6 BGP community entries using 144 bytes of memory
  0 BGP route-map cache entries using 0 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5736 total bytes of memory
  BGP activity 72/63 prefixes, 77/68 paths, scan interval 60 secs
  9 networks peaked at 22:15:22 Sep 7 2026 UTC (01:07:32.746 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 1 more lines
```

PASS Capture Crypto State From Every Router (0.3s, 6 commands)

R1 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
     current_peer 100.64.0.3 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 604, #pkts encrypt: 604, #pkts digest: 604
      #pkts decaps: 594, #pkts decrypt: 594, #pkts verify: 594
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
```

R1 show crypto ikev2 sa

```
  IPv4 Crypto IKEv2  SA

  Tunnel-id Local                 Remote                fvrf/ivrf            Status
  1         100.64.0.1/500        100.64.0.2/500        none/none            READY
        Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
        Life/Active Time: 86400/100 sec
        CE id: 1029, Session-id: 26
        Local spi: 674CC240C9A38803       Remote spi: 6B960B9A3952A45C
```

```
  Tunnel-id Local                 Remote                fvrf/ivrf            Status
  2         100.64.0.1/500        100.64.0.3/500        none/none            READY
        Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
        Life/Active Time: 86400/100 sec
        CE id: 1030, Session-id: 27
  ... 3 more lines
```

R2 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     current_peer 100.64.0.1 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 1135, #pkts encrypt: 1135, #pkts digest: 1135
      #pkts decaps: 1133, #pkts decrypt: 1133, #pkts verify: 1133
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 33 more lines
```

R2 show crypto ikev2 sa

```
  IPv4 Crypto IKEv2  SA

  Tunnel-id Local                 Remote                fvrf/ivrf            Status
  1         100.64.0.2/500        100.64.0.1/500        none/none            READY
        Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
        Life/Active Time: 86400/101 sec
        CE id: 1029, Session-id: 24
        Local spi: 6B960B9A3952A45C       Remote spi: 674CC240C9A38803

   IPv6 Crypto IKEv2  SA
```

R3 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.3

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     current_peer 100.64.0.1 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 9361, #pkts encrypt: 9361, #pkts digest: 9361
      #pkts decaps: 9395, #pkts decrypt: 9395, #pkts verify: 9395
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 33 more lines
```

R3 show crypto ikev2 sa

```
  IPv4 Crypto IKEv2  SA

  Tunnel-id Local                 Remote                fvrf/ivrf            Status
  1         100.64.0.3/500        100.64.0.1/500        none/none            READY
        Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
        Life/Active Time: 86400/101 sec
        CE id: 1026, Session-id: 26
        Local spi: 54006597FF55CAD2       Remote spi: C7ABC0CAC6503940

   IPv6 Crypto IKEv2  SA
```

PASS Capture NAT State From Every Router (0.5s, 6 commands)

R1 show ip nat translations

```
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.1.128           192.168.10.88         ---                   ---
  ---  10.30.1.129           192.168.10.85         ---                   ---
  ---  10.30.1.113           192.168.10.93         ---                   ---
  ---  10.30.1.114           192.168.10.69         ---                   ---
  ---  10.30.1.116           192.168.10.73         ---                   ---
  ---  10.30.1.119           192.168.10.71         ---                   ---
  ---  10.30.1.123           192.168.10.78         ---                   ---
  ---  10.30.1.120           192.168.10.82         ---                   ---
  ---  10.30.1.126           192.168.10.76         ---                   ---
  ---  10.30.1.125           192.168.10.84         ---                   ---
  ---  10.30.1.101           192.168.10.90         ---                   ---
  ---  10.30.1.102           192.168.10.89         ---                   ---
```

```
---  10.30.1.111           192.168.10.70         ---                   ---
... 28 more lines
```

R1 show ip nat statistics

```
Total active translations: 40 (10 static, 30 dynamic; 0 extended)
Outside interfaces:
  Tunnel0
Inside interfaces:
  GigabitEthernet3
Hits: 457  Misses: 123
 Reserved port setting disabled provisioned no
 Dynamic overload mapping configured: 0
Expired translations: 123
Dynamic mappings:
-- Inside Source
[Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 30
 pool SITE-POOL: id 1, netmask 255.255.255.0
        start 10.30.1.100 end 10.30.1.129
... 9 more lines
```

R2 show ip nat translations

```
Pro  Inside global         Inside local          Outside local         Outside global
---  10.30.2.128           192.168.20.89         ---                   ---
---  10.30.2.129           192.168.20.84         ---                   ---
---  10.30.2.106           192.168.20.68         ---                   ---
---  10.30.2.105           192.168.20.88         ---                   ---
---  10.30.2.111           192.168.20.92         ---                   ---
---  10.30.2.108           192.168.20.80         ---                   ---
---  10.30.2.101           192.168.20.64         ---                   ---
---  10.30.2.102           192.168.20.65         ---                   ---
---  10.30.2.126           192.168.20.77         ---                   ---
---  10.30.2.125           192.168.20.86         ---                   ---
---  10.30.2.123           192.168.20.79         ---                   ---
---  10.30.2.120           192.168.20.74         ---                   ---
---  10.30.2.116           192.168.20.82         ---                   ---
... 28 more lines
```

R2 show ip nat statistics

```
Total active translations: 40 (10 static, 30 dynamic; 0 extended)
Outside interfaces:
  Tunnel0
Inside interfaces:
  GigabitEthernet3
Hits: 337  Misses: 83
 Reserved port setting disabled provisioned no
 Dynamic overload mapping configured: 0
Expired translations: 83
Dynamic mappings:
-- Inside Source
[Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 30
 pool SITE-POOL: id 1, netmask 255.255.255.0
        start 10.30.2.100 end 10.30.2.129
... 9 more lines
```

R3 show ip nat translations

```
Pro  Inside global         Inside local          Outside local         Outside global
---  10.30.3.104           192.168.30.84         ---                   ---
---  10.30.3.107           192.168.30.93         ---                   ---
---  10.30.3.109           192.168.30.92         ---                   ---
---  10.30.3.110           192.168.30.89         ---                   ---
---  10.30.3.103           192.168.30.85         ---                   ---
---  10.30.3.100           192.168.30.83         ---                   ---
---  10.30.3.124           192.168.30.90         ---                   ---
---  10.30.3.127           192.168.30.81         ---                   ---
---  10.30.3.121           192.168.30.80         ---                   ---
---  10.30.3.122           192.168.30.77         ---                   ---
---  10.30.3.118           192.168.30.86         ---                   ---
---  10.30.3.117           192.168.30.75         ---                   ---
---  10.30.3.115           192.168.30.82         ---                   ---
... 28 more lines
```

R3 show ip nat statistics

```
Total active translations: 40 (10 static, 30 dynamic; 0 extended)
Outside interfaces:
  Tunnel0
Inside interfaces:
  GigabitEthernet3
Hits: 120  Misses: 40
 Reserved port setting disabled provisioned no
 Dynamic overload mapping configured: 0
Expired translations: 40
Dynamic mappings:
-- Inside Source
[Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 30
```

```
 pool SITE-POOL: id 1, netmask 255.255.255.0
        start 10.30.3.100 end 10.30.3.129
... 9 more lines
```

PASS Capture NTP State From Every Router (0.1s, 6 commands)

R1 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0022 Hz, precision is 2**10
ntp uptime is 410100 (1/100 of seconds), resolution is 4000
reference time is EE49C50C.33B64630 (23:19:40.202 UTC Mon Sep 7 2026)
clock offset is 1.1201 msec, root delay is 50.71 msec
root dispersion is 10.94 msec, peer dispersion is 5.58 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008787 s/s
system poll interval is 128, last update was 195 sec ago.
```

R1 show ntp associations

```
address         ref clock       st   when   poll reach  delay  offset   disp
*~192.168.99.10   68.183.147.240   3     61    128   377  0.928   1.120  5.584
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R2 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0017 Hz, precision is 2**10
ntp uptime is 410100 (1/100 of seconds), resolution is 4000
reference time is EE49C517.28B439C8 (23:19:51.159 UTC Mon Sep 7 2026)
clock offset is -0.2035 msec, root delay is 49.85 msec
root dispersion is 69.46 msec, peer dispersion is 3.79 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000007002 s/s
system poll interval is 64, last update was 184 sec ago.
```

R2 show ntp associations

```
address         ref clock       st   when   poll reach  delay  offset   disp
*~192.168.99.10   68.183.147.240   3     24     64    17  0.062  -0.203  3.798
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R3 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0021 Hz, precision is 2**10
ntp uptime is 410100 (1/100 of seconds), resolution is 4000
reference time is EE49C439.2A7EFA50 (23:16:09.166 UTC Mon Sep 7 2026)
clock offset is 0.5161 msec, root delay is 47.91 msec
root dispersion is 13.66 msec, peer dispersion is 4.91 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008467 s/s
system poll interval is 128, last update was 406 sec ago.
```

R3 show ntp associations

```
address         ref clock       st   when   poll reach  delay  offset   disp
*~192.168.99.10   68.183.147.240   3      2    128   377  0.058   0.516  4.914
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

PASS Capture Logging State From Every Router (0.2s, 3 commands)

R1 show logging | include Trap logging|Logging to|Syslog logging

```
Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 0 flushes, 0 overruns, xml disabled,
filtering disabled)
    Trap logging: level informational, 1046 message lines logged
        Logging to 192.168.99.10  (MGMT) (udp port 514, audit disabled,
000142: *Sep  7 22:14:37.628 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 0 CLI
Request Triggered
000144: *Sep  7 22:14:37.632 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 514
(MGMT) started - CLI initiated
```

R2 show logging | include Trap logging|Logging to|Syslog logging

```
Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 0 flushes, 0 overruns, xml disabled,
filtering disabled)
    Trap logging: level informational, 1336 message lines logged
        Logging to 192.168.99.10  (MGMT) (udp port 514, audit disabled,
000718: .Sep  7 22:47:06.797 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 514
(MGMT) started - reconnection
000721: .Sep  7 22:47:20.338 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 514
(MGMT) started - reconnection
001203: .Sep  7 23:17:12.492 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 514
(MGMT) started - reconnection
001206: .Sep  7 23:17:30.372 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 514
(MGMT) started - reconnection
```

R3 show logging | include Trap logging|Logging to|Syslog logging

```
Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 0 flushes, 0 overruns, xml disabled,
filtering disabled)
```

```
    Trap logging: level informational, 873 message lines logged
        Logging to 192.168.99.10  (MGMT) (udp port 514, audit disabled,
000142: *Sep  7 22:14:37.619 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 0 CLI
Request Triggered
000143: *Sep  7 22:14:37.620 UTC: %SYS-6-LOGGINGHOST_STARTSTOP: Logging to host 192.168.99.10 port 514
(MGMT) started - CLI initiated
```

PASS Capture SNMP State From Every Router (0.2s, 9 commands)

R1 show snmp user

```
User name: labmon
Engine ID: 800000090300525400C80101
storage-type: nonvolatile        active
Authentication Protocol: SHA
Privacy Protocol: AES128
Group-name: LABGRP
```

R1 show snmp host

```
Notification host: 192.168.99.10        udp-port: 1162  VRFName: MGMT   type: trap
user: labmon    security model: v3 priv

Notification host: 192.168.99.10        udp-port: 162   VRFName: MGMT   type: trap
user: labmon    security model: v3 priv
```

R1 show snmp engineID

```
Local SNMP engineID: 800000090300525400C80101
Remote Engine ID          IP-addr    Port
```

R2 show snmp user

```
User name: labmon
Engine ID: 800000090300525400C80201
storage-type: nonvolatile        active
Authentication Protocol: SHA
Privacy Protocol: AES128
Group-name: LABGRP
```

R2 show snmp host

```
Notification host: 192.168.99.10        udp-port: 1162  VRFName: MGMT   type: trap
user: labmon    security model: v3 priv

Notification host: 192.168.99.10        udp-port: 162   VRFName: MGMT   type: trap
user: labmon    security model: v3 priv
```

R2 show snmp engineID

```
Local SNMP engineID: 800000090300525400C80201
Remote Engine ID          IP-addr    Port
```

R3 show snmp user

```
User name: labmon
Engine ID: 800000090300525400C80301
storage-type: nonvolatile        active
Authentication Protocol: SHA
Privacy Protocol: AES128
Group-name: LABGRP
```

R3 show snmp host

```
Notification host: 192.168.99.10        udp-port: 1162  VRFName: MGMT   type: trap
user: labmon    security model: v3 priv

Notification host: 192.168.99.10        udp-port: 162   VRFName: MGMT   type: trap
user: labmon    security model: v3 priv
```

R3 show snmp engineID

```
Local SNMP engineID: 800000090300525400C80301
Remote Engine ID          IP-addr    Port
```

PASS Capture The NMS View Of Every Router (0.5s, 16 commands)

The same system group, but seen over SNMPv3 from the NMS rather than read off the console. Captured next to the CLI output so the two can be compared in the evidence PDF.

NMS ip -br addr; ip route

```
lo               UNKNOWN        127.0.0.1/8 ::1/128
ens3             UP             10.0.2.15/24 metric 100 fec0::5054:ff:febb:101/64 fe80::5054:ff:febb:101/64
ens4             UP             192.168.10.20/24 fe80::5054:ff:febb:102/64
ens5             UP             192.168.99.10/24 fe80::5054:ff:febb:103/64
default via 10.0.2.2 dev ens3 proto dhcp src 10.0.2.15 metric 100
10.0.2.0/24 dev ens3 proto kernel scope link src 10.0.2.15 metric 100
10.0.2.2 dev ens3 proto dhcp scope link src 10.0.2.15 metric 100
10.0.2.3 dev ens3 proto dhcp scope link src 10.0.2.15 metric 100
```

```
  10.30.0.0/16 via 192.168.10.1 dev ens4
  192.168.10.0/24 dev ens4 proto kernel scope link src 192.168.10.20
  192.168.20.0/24 via 192.168.10.1 dev ens4
  192.168.30.0/24 via 192.168.10.1 dev ens4
  192.168.99.0/24 dev ens5 proto kernel scope link src 192.168.99.10
```

NMS ip -br addr; ip route

```
  lo               UNKNOWN        127.0.0.1/8 ::1/128
  ens3             UP             10.0.2.15/24 metric 100 fec0::5054:ff:febb:101/64 fe80::5054:ff:febb:101/64
  ens4             UP             192.168.10.20/24 fe80::5054:ff:febb:102/64
  ens5             UP             192.168.99.10/24 fe80::5054:ff:febb:103/64
  default via 10.0.2.2 dev ens3 proto dhcp src 10.0.2.15 metric 100
  10.0.2.0/24 dev ens3 proto kernel scope link src 10.0.2.15 metric 100
  10.0.2.2 dev ens3 proto dhcp scope link src 10.0.2.15 metric 100
  10.0.2.3 dev ens3 proto dhcp scope link src 10.0.2.15 metric 100
  10.30.0.0/16 via 192.168.10.1 dev ens4
  192.168.10.0/24 dev ens4 proto kernel scope link src 192.168.10.20
  192.168.20.0/24 via 192.168.10.1 dev ens4
  192.168.30.0/24 via 192.168.10.1 dev ens4
  192.168.99.0/24 dev ens5 proto kernel scope link src 192.168.99.10
```

NMS snmpget --version 2>&1 | head -1

```
  NET-SNMP version: 5.9.4.pre2
```

NMS snmpget --version 2>&1 | head -1

```
  NET-SNMP version: 5.9.4.pre2
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.10.1 1.3.6.1.2.1.1

```
  .1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
  UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
  Technical Support: http://www.cisco.com/techsupport
  Copyright (c) 1986-2026 by Cisco Systems, Inc.
  Compiled Wed 22-Jul-26 03:39 b"
  .1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
  .1.3.6.1.2.1.1.3.0 = Timeticks: (415000) 1:09:10.00
  .1.3.6.1.2.1.1.4.0 = ""
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
  .1.3.6.1.2.1.1.6.0 = ""
  .1.3.6.1.2.1.1.7.0 = INTEGER: 78
  .1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.10.1 1.3.6.1.2.1.1

```
  .1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
  UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
  Technical Support: http://www.cisco.com/techsupport
  Copyright (c) 1986-2026 by Cisco Systems, Inc.
  Compiled Wed 22-Jul-26 03:39 b"
  .1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
  .1.3.6.1.2.1.1.3.0 = Timeticks: (415000) 1:09:10.00
  .1.3.6.1.2.1.1.4.0 = ""
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
  .1.3.6.1.2.1.1.6.0 = ""
  .1.3.6.1.2.1.1.7.0 = INTEGER: 78
  .1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.10.1 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.10.1 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.20.1 1.3.6.1.2.1.1

```
  .1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
```

```
  UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
  Technical Support: http://www.cisco.com/techsupport
  Copyright (c) 1986-2026 by Cisco Systems, Inc.
  Compiled Wed 22-Jul-26 03:39 b"
  .1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
  .1.3.6.1.2.1.1.3.0 = Timeticks: (415086) 1:09:10.86
  .1.3.6.1.2.1.1.4.0 = ""
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
  .1.3.6.1.2.1.1.6.0 = ""
  .1.3.6.1.2.1.1.7.0 = INTEGER: 78
  .1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.20.1 1.3.6.1.2.1.1

```
  .1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
  UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
  Technical Support: http://www.cisco.com/techsupport
  Copyright (c) 1986-2026 by Cisco Systems, Inc.
  Compiled Wed 22-Jul-26 03:39 b"
  .1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
  .1.3.6.1.2.1.1.3.0 = Timeticks: (415086) 1:09:10.86
  .1.3.6.1.2.1.1.4.0 = ""
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
  .1.3.6.1.2.1.1.6.0 = ""
  .1.3.6.1.2.1.1.7.0 = INTEGER: 78
  .1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.20.1 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.20.1 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.30.1 1.3.6.1.2.1.1

```
  .1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
  UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
  Technical Support: http://www.cisco.com/techsupport
  Copyright (c) 1986-2026 by Cisco Systems, Inc.
  Compiled Wed 22-Jul-26 03:39 b"
  .1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
  .1.3.6.1.2.1.1.3.0 = Timeticks: (414990) 1:09:09.90
  .1.3.6.1.2.1.1.4.0 = ""
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
  .1.3.6.1.2.1.1.6.0 = ""
  .1.3.6.1.2.1.1.7.0 = INTEGER: 78
  .1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.30.1 1.3.6.1.2.1.1

```
  .1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
  UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
  Technical Support: http://www.cisco.com/techsupport
  Copyright (c) 1986-2026 by Cisco Systems, Inc.
  Compiled Wed 22-Jul-26 03:39 b"
  .1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
  .1.3.6.1.2.1.1.3.0 = Timeticks: (414990) 1:09:09.90
  .1.3.6.1.2.1.1.4.0 = ""
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
  .1.3.6.1.2.1.1.6.0 = ""
  .1.3.6.1.2.1.1.7.0 = INTEGER: 78
  .1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.30.1 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

```
NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 192.168.30.1
1.3.6.1.2.1.2.2.1.2
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

PASS Capture Collector State From The NMS (0.3s, 12 commands)

What the collectors actually hold: the tail of each router's syslog file and of snmptrapd's decrypted log. This is the management-plane evidence that used to come off h1.

```
NMS systemctl is-active rsyslog snmptrapd lab-trapcap
  active
  active
  active
```

```
NMS systemctl is-active rsyslog snmptrapd lab-trapcap
  active
  active
  active
```

```
NMS sudo ls -l /var/log/lab
  total 2660
  -rw-r--r-- 1 syslog syslog  128123 Sep  7 23:22 192.168.99.1.log
  -rw-r--r-- 1 syslog syslog  159924 Sep  7 23:22 192.168.99.2.log
  -rw-r--r-- 1 syslog syslog  105045 Sep  7 23:22 192.168.99.3.log
  -rw-r--r-- 1 root   root    881546 Sep  7 23:22 snmptrapd.log
  -rw-r--r-- 1 root   root   1416130 Sep  7 23:22 traps-raw.log
```

```
NMS sudo ls -l /var/log/lab
  total 2660
  -rw-r--r-- 1 syslog syslog  128123 Sep  7 23:22 192.168.99.1.log
  -rw-r--r-- 1 syslog syslog  159924 Sep  7 23:22 192.168.99.2.log
  -rw-r--r-- 1 syslog syslog  105045 Sep  7 23:22 192.168.99.3.log
  -rw-r--r-- 1 root   root    881546 Sep  7 23:22 snmptrapd.log
  -rw-r--r-- 1 root   root   1416130 Sep  7 23:22 traps-raw.log
```

```
NMS sudo tail -40 /var/log/lab/192.168.10.1.log
  tail: cannot open '/var/log/lab/192.168.10.1.log' for reading: No such file or directory
```

```
NMS sudo tail -40 /var/log/lab/192.168.10.1.log
  tail: cannot open '/var/log/lab/192.168.10.1.log' for reading: No such file or directory
```

```
NMS sudo tail -40 /var/log/lab/192.168.20.1.log
  tail: cannot open '/var/log/lab/192.168.20.1.log' for reading: No such file or directory
```

```
NMS sudo tail -40 /var/log/lab/192.168.20.1.log
  tail: cannot open '/var/log/lab/192.168.20.1.log' for reading: No such file or directory
```

```
NMS sudo tail -40 /var/log/lab/192.168.30.1.log
  tail: cannot open '/var/log/lab/192.168.30.1.log' for reading: No such file or directory
```

```
NMS sudo tail -40 /var/log/lab/192.168.30.1.log
  tail: cannot open '/var/log/lab/192.168.30.1.log' for reading: No such file or directory
```

```
NMS sudo tail -40 /var/log/lab/snmptrapd.log
  2026-09-07 23:22:26 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:39.57        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.7
  iso.3.6.1.4.1.9.9.171.1.3.2.1.9.29 3600 iso.3.6.1.4.1.9.9.171.1.3.2.1.8.29 4608000
  iso.3.6.1.4.1.9.9.171.1.3.3.1.3.29.1 1  iso.3.6.1.4.1.9.9.171.1.3.3.1.4.29.1 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.5.29.1 "64 40 00 03 "     iso.3.6.1.4.1.9.9.171.1.3.3.1.9.29.1 1
  iso.3.6.1.4.1.9.9.171.1.3.3.1.10.29.1 "64 40 00 02 "    iso.3.6.1.4.1.9.9.171.1.3.3.1.11.29.1 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.6.29.1 47 iso.3.6.1.4.1.9.9.171.1.3.3.1.7.29.1 0
  2026-09-07 23:22:26 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:40.66        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.7
  iso.3.6.1.4.1.9.9.171.1.3.2.1.9.29 3600 iso.3.6.1.4.1.9.9.171.1.3.2.1.8.29 4608000
  iso.3.6.1.4.1.9.9.171.1.3.3.1.3.29.1 1  iso.3.6.1.4.1.9.9.171.1.3.3.1.4.29.1 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.5.29.1 "64 40 00 02 "     iso.3.6.1.4.1.9.9.171.1.3.3.1.9.29.1 1
```

```
  iso.3.6.1.4.1.9.9.171.1.3.3.1.10.29.1 "64 40 00 03 "    iso.3.6.1.4.1.9.9.171.1.3.3.1.11.29.1 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.6.29.1 47 iso.3.6.1.4.1.9.9.171.1.3.3.1.7.29.1 0
  2026-09-07 23:22:27 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:40.41        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.1
  iso.3.6.1.4.1.9.10.137.1.2.1.8.1708049 0        iso.3.6.1.4.1.9.10.137.1.2.1.8.1708049 0
  iso.3.6.1.2.1.2.2.1.1.8 8
  2026-09-07 23:22:27 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:41.50        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.1
  iso.3.6.1.4.1.9.10.137.1.2.1.8.1708035 0        iso.3.6.1.4.1.9.10.137.1.2.1.8.1708035 0
  iso.3.6.1.2.1.2.2.1.1.8 8
  2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:42.80        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.62.2.0.4
  iso.3.6.1.4.1.9.10.62.1.2.3.1.1.2.14.84.117.110.110.101.108.48.45.104.101.97.100.45.48 3
  2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:41.71        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.2
  iso.3.6.1.4.1.9.9.171.1.2.2.1.6.1.4.100.64.0.3.1.4.100.64.0.2.29 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.2.2.1.7.1.4.100.64.0.3.1.4.100.64.0.2.29 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.2.3.1.16.29 2   iso.3.6.1.4.1.9.9.171.1.4.2.1.1.2.29 4
  2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:42.80        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.8
  iso.3.6.1.4.1.9.9.171.1.3.2.1.10.29 213 iso.3.6.1.4.1.9.9.171.1.4.3.1.1.12.28 213
  iso.3.6.1.4.1.9.9.171.1.4.3.1.1.10.28 3600      iso.3.6.1.4.1.9.9.171.1.4.3.1.1.9.28 4608000
  iso.3.6.1.4.1.9.9.171.1.4.3.1.1.2.28 1  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.5.28 1
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.11.28 1 iso.3.6.1.4.1.9.9.171.1.4.3.2.1.6.28 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.7.28 "64 40 00 02 "     iso.3.6.1.4.1.9.9.171.1.4.3.2.1.12.28 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.13.28 "64 40 00 03 "    iso.3.6.1.4.1.9.9.171.1.4.3.2.1.8.28 47
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.9.28 0
  ... 26 more lines
NMS sudo tail -40 /var/log/lab/snmptrapd.log
  2026-09-07 23:22:26 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:39.57        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.7
  iso.3.6.1.4.1.9.9.171.1.3.2.1.9.29 3600 iso.3.6.1.4.1.9.9.171.1.3.2.1.8.29 4608000
  iso.3.6.1.4.1.9.9.171.1.3.3.1.3.29.1 1  iso.3.6.1.4.1.9.9.171.1.3.3.1.4.29.1 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.5.29.1 "64 40 00 03 "     iso.3.6.1.4.1.9.9.171.1.3.3.1.9.29.1 1
  iso.3.6.1.4.1.9.9.171.1.3.3.1.10.29.1 "64 40 00 02 "    iso.3.6.1.4.1.9.9.171.1.3.3.1.11.29.1 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.6.29.1 47 iso.3.6.1.4.1.9.9.171.1.3.3.1.7.29.1 0
  2026-09-07 23:22:26 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:40.66        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.7
  iso.3.6.1.4.1.9.9.171.1.3.2.1.9.29 3600 iso.3.6.1.4.1.9.9.171.1.3.2.1.8.29 4608000
  iso.3.6.1.4.1.9.9.171.1.3.3.1.3.29.1 1  iso.3.6.1.4.1.9.9.171.1.3.3.1.4.29.1 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.5.29.1 "64 40 00 02 "     iso.3.6.1.4.1.9.9.171.1.3.3.1.9.29.1 1
  iso.3.6.1.4.1.9.9.171.1.3.3.1.10.29.1 "64 40 00 03 "    iso.3.6.1.4.1.9.9.171.1.3.3.1.11.29.1 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.3.3.1.6.29.1 47 iso.3.6.1.4.1.9.9.171.1.3.3.1.7.29.1 0
  2026-09-07 23:22:27 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:40.41        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.1
  iso.3.6.1.4.1.9.10.137.1.2.1.8.1708049 0        iso.3.6.1.4.1.9.10.137.1.2.1.8.1708049 0
  iso.3.6.1.2.1.2.2.1.1.8 8
  2026-09-07 23:22:27 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:41.50        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.1
  iso.3.6.1.4.1.9.10.137.1.2.1.8.1708035 0        iso.3.6.1.4.1.9.10.137.1.2.1.8.1708035 0
  iso.3.6.1.2.1.2.2.1.1.8 8
  2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:42.80        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.62.2.0.4
  iso.3.6.1.4.1.9.10.62.1.2.3.1.1.2.14.84.117.110.110.101.108.48.45.104.101.97.100.45.48 3
  2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:41.71        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.2
  iso.3.6.1.4.1.9.9.171.1.2.2.1.6.1.4.100.64.0.3.1.4.100.64.0.2.29 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.2.2.1.7.1.4.100.64.0.3.1.4.100.64.0.2.29 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.2.3.1.16.29 2   iso.3.6.1.4.1.9.9.171.1.4.2.1.1.2.29 4
  2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:1:08:42.80        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.8
  iso.3.6.1.4.1.9.9.171.1.3.2.1.10.29 213 iso.3.6.1.4.1.9.9.171.1.4.3.1.1.12.28 213
  iso.3.6.1.4.1.9.9.171.1.4.3.1.1.10.28 3600      iso.3.6.1.4.1.9.9.171.1.4.3.1.1.9.28 4608000
  iso.3.6.1.4.1.9.9.171.1.4.3.1.1.2.28 1  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.5.28 1
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.11.28 1 iso.3.6.1.4.1.9.9.171.1.4.3.2.1.6.28 "64 40 00 02 "
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.7.28 "64 40 00 02 "     iso.3.6.1.4.1.9.9.171.1.4.3.2.1.12.28 "64 40 00 03 "
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.13.28 "64 40 00 03 "    iso.3.6.1.4.1.9.9.171.1.4.3.2.1.8.28 47
  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.9.28 0
  ... 26 more lines
```

PASS Capture Config And Routing Table From Every Host (0.1s, 6 commands)

```
H1 ip addr
  1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue qlen 1000
      link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
      inet 127.0.0.1/8 scope host lo
         valid_lft forever preferred_lft forever
      inet6 ::1/128 scope host
         valid_lft forever preferred_lft forever
```

```
  2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
      link/ether 52:54:00:aa:01:01 brd ff:ff:ff:ff:ff:ff
      inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute eth0
         valid_lft 82334sec preferred_lft 71534sec
      inet6 fec0::5054:ff:feaa:101/64 scope site dynamic noprefixroute flags 100
         valid_lft 86212sec preferred_lft 14212sec
      inet6 fe80::5054:ff:feaa:101/64 scope link
         valid_lft forever preferred_lft forever
  ... 84 more lines
```

H1 ip route

```
  default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
  10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
  10.30.0.0/16 via 192.168.10.1 dev eth1
  169.254.0.0/16 dev eth1 scope link  src 169.254.229.55  metric 1003
  192.168.10.0/24 dev eth1 scope link  src 192.168.10.10
  192.168.20.0/24 via 192.168.10.1 dev eth1
  192.168.30.0/24 via 192.168.10.1 dev eth1
```

H2 ip addr

```
  1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue qlen 1000
      link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
      inet 127.0.0.1/8 scope host lo
         valid_lft forever preferred_lft forever
      inet6 ::1/128 scope host
         valid_lft forever preferred_lft forever
  2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
      link/ether 52:54:00:aa:02:01 brd ff:ff:ff:ff:ff:ff
      inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute eth0
         valid_lft 82337sec preferred_lft 71537sec
      inet6 fec0::5054:ff:feaa:201/64 scope site dynamic noprefixroute flags 100
         valid_lft 86083sec preferred_lft 14083sec
      inet6 fe80::5054:ff:feaa:201/64 scope link
         valid_lft forever preferred_lft forever
  ... 84 more lines
```

H2 ip route

```
  default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
  10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
  10.30.0.0/16 via 192.168.20.1 dev eth1
  192.168.30.10 via 192.168.20.1 dev eth1
  169.254.0.0/16 dev eth1 scope link  src 169.254.199.41  metric 1003
  192.168.10.0/24 via 192.168.20.1 dev eth1
  192.168.30.10 via 192.168.20.1 dev eth1
  192.168.20.0/24 dev eth1 scope link  src 192.168.20.10
  192.168.30.0/24 via 192.168.20.1 dev eth1
  192.168.30.10 via 192.168.20.1 dev eth1
```

H3 ip addr

```
  1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue qlen 1000
      link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
      inet 127.0.0.1/8 scope host lo
         valid_lft forever preferred_lft forever
      inet6 ::1/128 scope host
         valid_lft forever preferred_lft forever
  2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
      link/ether 52:54:00:aa:03:01 brd ff:ff:ff:ff:ff:ff
      inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute eth0
         valid_lft 82336sec preferred_lft 71536sec
      inet6 fec0::5054:ff:feaa:301/64 scope site dynamic noprefixroute flags 100
         valid_lft 86292sec preferred_lft 14292sec
      inet6 fe80::5054:ff:feaa:301/64 scope link
         valid_lft forever preferred_lft forever
  ... 84 more lines
```

H3 ip route

```
  default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
  10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
  10.30.0.0/16 via 192.168.30.1 dev eth1
  169.254.0.0/16 dev eth1 scope link  src 169.254.207.242  metric 1003
  192.168.10.0/24 via 192.168.30.1 dev eth1
  192.168.20.0/24 via 192.168.30.1 dev eth1
  192.168.30.0/24 dev eth1 scope link  src 192.168.30.10
```

PASS Every Router Routing Table Holds All Three LANs (0.2s, 3 commands)

A content check on what was just captured: in a working hub-and-spoke every router reaches every LAN, the spokes reaching each other's through the hub.

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, m - OMP
        n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
        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
        H - NHRP, G - NHRP registered, g - NHRP registration summary
        o - ODR, P - periodic downloaded static route, l - LISP
        a - application route
        + - replicated route, % - next hop override, p - overrides from PfR
        & - replicated local route overrides by connected

  Gateway of last resort is 10.0.2.2 to network 0.0.0.0
  ... 24 more lines
```

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, m - OMP
        n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
        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
        H - NHRP, G - NHRP registered, g - NHRP registration summary
        o - ODR, P - periodic downloaded static route, l - LISP
        a - application route
        + - replicated route, % - next hop override, p - overrides from PfR
        & - replicated local route overrides by connected

  Gateway of last resort is 10.0.2.2 to network 0.0.0.0
  ... 24 more lines
```

R3 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, m - OMP
        n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
        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
        H - NHRP, G - NHRP registered, g - NHRP registration summary
        o - ODR, P - periodic downloaded static route, l - LISP
        a - application route
        + - replicated route, % - next hop override, p - overrides from PfR
        & - replicated local route overrides by connected

  Gateway of last resort is 10.0.2.2 to network 0.0.0.0
  ... 24 more lines
```

06 Wire Encryption

PASS Protected Traffic Appears On The Link As ESP (15.7s, 9 commands)

```
R1 no monitor capture ROBOTCAP
  Capture does not exist
R1 monitor capture ROBOTCAP interface GigabitEthernet2 both
  ${output} =
R1 monitor capture ROBOTCAP match ipv4 any any
  ${output} =
R1 monitor capture ROBOTCAP buffer size 5
  ${output} =
R1 monitor capture ROBOTCAP start
  Started capture point : ROBOTCAP
R1 ping 172.16.2.1 source Loopback0 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 172.16.2.1, timeout is 2 seconds:
  Packet sent with a source address of 172.16.1.1
  .....
  Success rate is 0 percent (0/5)
R1 monitor capture ROBOTCAP stop
  Stopped capture point : ROBOTCAP
R1 show monitor capture ROBOTCAP buffer brief
  ----------------------------------------------------------------------------
   #   size   timestamp     source             destination      dscp    protocol
   ----------------------------------------------------------------------------
     0  138    0.000000   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
     1  138    0.000992   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     2  138    0.123986   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     3  138    0.123986   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     4  138    0.137993   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     5  138    0.333982   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     6  138    0.369036   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     7  138    0.369036   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     8  138    0.412033   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     9  138    0.412033   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
    10  138    0.421035   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
  ... 275 more lines
R1 no monitor capture ROBOTCAP
  ${output} =
```

PASS Protected Endpoint Addresses Never Appear In Cleartext On The Link (15.7s, 9 commands)

The strongest statement this lab can make about encryption: traffic between the loopbacks crosses the wire without either loopback address being visible, and with no cleartext ICMP.

```
R1 no monitor capture ROBOTCAP
  Capture does not exist
R1 monitor capture ROBOTCAP interface GigabitEthernet2 both
  ${output} =
R1 monitor capture ROBOTCAP match ipv4 any any
  ${output} =
R1 monitor capture ROBOTCAP buffer size 5
  ${output} =
R1 monitor capture ROBOTCAP start
  Started capture point : ROBOTCAP
R1 ping 172.16.2.1 source Loopback0 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 172.16.2.1, timeout is 2 seconds:
  Packet sent with a source address of 172.16.1.1
  .....
  Success rate is 0 percent (0/5)
R1 monitor capture ROBOTCAP stop
  Stopped capture point : ROBOTCAP
R1 show monitor capture ROBOTCAP buffer brief
  ----------------------------------------------------------------------------
   #   size   timestamp     source             destination      dscp    protocol
   ----------------------------------------------------------------------------
     0  138    0.000000   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
```

```
    1  138    0.000000   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
    2  138    0.016998   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
    3  138    0.026000   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
    4  138    0.026992   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
    5  138    0.159996   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
    6  138    0.160988   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
    7  138    0.279985   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
    8  138    0.279985   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
    9  138    0.331984   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
   10  138    0.391978   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
  ... 269 more lines
```

R1 no monitor capture ROBOTCAP

```
  ${output} =
```

PASS Unprotected Link Traffic Is Visible As Cleartext ICMP (2.5s, 9 commands)

Positive control for the capture itself. Without this, the absence asserted above could just mean the capture was broken.

R1 no monitor capture ROBOTCAP

```
  Capture does not exist
```

R1 monitor capture ROBOTCAP interface GigabitEthernet2 both

```
  ${output} =
```

R1 monitor capture ROBOTCAP match ipv4 any any

```
  ${output} =
```

R1 monitor capture ROBOTCAP buffer size 5

```
  ${output} =
```

R1 monitor capture ROBOTCAP start

```
  Started capture point : ROBOTCAP
```

R1 ping 100.64.0.2 repeat 5

```
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 100.64.0.2, timeout is 2 seconds:
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

R1 monitor capture ROBOTCAP stop

```
  Stopped capture point : ROBOTCAP
```

R1 show monitor capture ROBOTCAP buffer brief

```
  ----------------------------------------------------------------------------
   #   size   timestamp     source             destination      dscp    protocol
   ----------------------------------------------------------------------------
    0  138    0.000000   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
    1  138    0.000000   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
    2  114    0.020995   100.64.0.1       ->  100.64.0.2       0  BE   ICMP
    3  114    0.020995   100.64.0.2       ->  100.64.0.1       0  BE   ICMP
    4  114    0.021987   100.64.0.1       ->  100.64.0.2       0  BE   ICMP
    5  114    0.022994   100.64.0.2       ->  100.64.0.1       0  BE   ICMP
    6  114    0.023986   100.64.0.1       ->  100.64.0.2       0  BE   ICMP
    7  114    0.023986   100.64.0.2       ->  100.64.0.1       0  BE   ICMP
    8  114    0.023986   100.64.0.1       ->  100.64.0.2       0  BE   ICMP
    9  114    0.024993   100.64.0.2       ->  100.64.0.1       0  BE   ICMP
   10  114    0.024993   100.64.0.1       ->  100.64.0.2       0  BE   ICMP
  ... 54 more lines
```

R1 no monitor capture ROBOTCAP

```
  ${output} =
```

07 Ipsec Negative

PASS IKEv2 Refuses To Establish With A Mismatched Pre-Shared Key (13.3s, 13 commands)

Proves authentication is actually enforced. Without this, a tunnel that accepted any peer would still pass suite 04.

```
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 crypto ikev2 keyring LAB-KR
  ${output} =
R2 peer ANY
  ${output} =
R2 pre-shared-key WrongKeyOnPurpose999
  ${output} =
R2 end
  ${output} =
R1 clear crypto sa
  ${output} =
R1 clear crypto ikev2 sa
  ${output} =
R2 clear crypto sa
  ${output} =
R2 clear crypto ikev2 sa
  ${output} =
R3 clear crypto sa
  ${output} =
R3 clear crypto ikev2 sa
  ${output} =
R1 ping 172.16.2.1 source Loopback0 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 172.16.2.1, timeout is 2 seconds:
  Packet sent with a source address of 172.16.1.1
  .....
  Success rate is 0 percent (0/5)
R2 show crypto ikev2 sa
  ${output} =
```

PASS Tunnel Recovers Once The Correct Key Is Restored (14.3s, 13 commands)

Also guarantees the previous test cannot leave the lab broken.

```
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 crypto ikev2 keyring LAB-KR
  ${output} =
R2 peer ANY
  ${output} =
R2 pre-shared-key LabPreSharedKey123
  ${output} =
R2 end
  ${output} =
R1 clear crypto sa
  ${output} =
R1 clear crypto ikev2 sa
  ${output} =
R2 clear crypto sa
  ${output} =
R2 clear crypto ikev2 sa
  ${output} =
R3 clear crypto sa
  ${output} =
R3 clear crypto ikev2 sa
  ${output} =
R1 ping 10.20.2.1 source Loopback1 repeat 5
  Type escape sequence to abort.
```

```
  Sending 5, 100-byte ICMP Echos to 10.20.2.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.1.1
  ...!!
  Success rate is 40 percent (2/5), round-trip min/avg/max = 1/1/1 ms
R1 ping 10.20.2.1 source Loopback1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 10.20.2.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.1.1
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

PASS IPsec Rekeys And Traffic Still Flows Afterwards (96.1s, 37 commands)

Drops the SA lifetime to the 120s platform minimum, waits for the outbound SPI to rotate, then re-checks connectivity. Rekey is where real tunnels break.

```
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 crypto ipsec security-association lifetime seconds 120
  Warning! Lifetime value of 120 sec is lower than the recommended optimum value of 900 sec
R1 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 crypto ipsec security-association lifetime seconds 120
  Warning! Lifetime value of 120 sec is lower than the recommended optimum value of 900 sec
R2 end
  ${output} =
R3 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R3 crypto ipsec security-association lifetime seconds 120
  Warning! Lifetime value of 120 sec is lower than the recommended optimum value of 900 sec
R3 end
  ${output} =
R1 clear crypto sa
  ${output} =
R1 clear crypto ikev2 sa
  ${output} =
R2 clear crypto sa
  ${output} =
R2 clear crypto ikev2 sa
  ${output} =
R3 clear crypto sa
  ${output} =
R3 clear crypto ikev2 sa
  ${output} =
R1 ping 10.20.2.1 source Loopback1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 10.20.2.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.1.1
  ...!!
  Success rate is 40 percent (2/5), round-trip min/avg/max = 1/1/1 ms
R1 ping 10.20.2.1 source Loopback1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 10.20.2.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.1.1
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 68, #pkts encrypt: 68, #pkts digest: 68
      #pkts decaps: 69, #pkts decrypt: 69, #pkts verify: 69
      #pkts compressed: 0, #pkts decompressed: 0
```

```
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 68, #pkts encrypt: 68, #pkts digest: 68
    #pkts decaps: 69, #pkts decrypt: 69, #pkts verify: 69
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 133, #pkts encrypt: 133, #pkts digest: 133
    #pkts decaps: 131, #pkts decrypt: 131, #pkts verify: 131
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 192, #pkts encrypt: 192, #pkts digest: 192
    #pkts decaps: 191, #pkts decrypt: 191, #pkts verify: 191
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 251, #pkts encrypt: 251, #pkts digest: 251
    #pkts decaps: 249, #pkts decrypt: 249, #pkts verify: 249
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 309, #pkts encrypt: 309, #pkts digest: 309
    #pkts decaps: 309, #pkts decrypt: 309, #pkts verify: 309
```

```
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
 ... 78 more lines
```

R1 show crypto ipsec sa

```
 interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 369, #pkts encrypt: 369, #pkts digest: 369
    #pkts decaps: 373, #pkts decrypt: 373, #pkts verify: 373
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
 ... 78 more lines
```

R1 show crypto ipsec sa

```
 interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 436, #pkts encrypt: 436, #pkts digest: 436
    #pkts decaps: 434, #pkts decrypt: 434, #pkts verify: 434
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
 ... 78 more lines
```

R1 show crypto ipsec sa

```
 interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 495, #pkts encrypt: 495, #pkts digest: 495
    #pkts decaps: 494, #pkts decrypt: 494, #pkts verify: 494
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
 ... 78 more lines
```

R1 show crypto ipsec sa

```
 interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 550, #pkts encrypt: 550, #pkts digest: 550
    #pkts decaps: 548, #pkts decrypt: 548, #pkts verify: 548
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
 ... 78 more lines
```

R1 ping 10.20.2.1 source Loopback1 repeat 5

```
 Type escape sequence to abort.
 Sending 5, 100-byte ICMP Echos to 10.20.2.1, timeout is 2 seconds:
 Packet sent with a source address of 10.20.1.1
 !!!!!
 Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/3 ms
```

R1 configure terminal

```
 Enter configuration commands, one per line.  End with CNTL/Z.
```

R1 no crypto ipsec security-association lifetime seconds 120

```
  ${output} =
R1 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no crypto ipsec security-association lifetime seconds 120
  ${output} =
R2 end
  ${output} =
R3 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R3 no crypto ipsec security-association lifetime seconds 120
  ${output} =
R3 end
  ${output} =
```

08 Management Api

PASS RESTCONF Reports The Same Hostname As The CLI (0.4s, 3 commands)

```
R1 show running-config | include ^hostname
  hostname c8000v-r1
R2 show running-config | include ^hostname
  hostname c8000v-r2
R3 show running-config | include ^hostname
  hostname c8000v-r3
```

PASS RESTCONF Interface State Agrees With The CLI (0.1s, 1 commands)

```
R1 show ip interface brief GigabitEthernet2
  Interface              IP-Address      OK? Method Status                Protocol
  GigabitEthernet2       100.64.0.1      YES TFTP   up                    up
```

PASS Config Pushed Over RESTCONF Appears In The CLI (0.3s, 1 commands)

Write path plus cross-check: RESTCONF and the CLI must be two views of one datastore, not two datastores.

```
R1 show running-config interface Loopback200
  Building configuration...

  Current configuration : 68 bytes
  !
  interface Loopback200
   ip address 198.51.100.1 255.255.255.0
  end
```

PASS Config Deleted Over RESTCONF Disappears From The CLI (0.8s, 1 commands)

Runs after the PUT test, which creates the interface; a 404 here would mean the create silently failed.

```
R1 show ip interface brief Loopback200
  ^
  % Invalid input detected at '^' marker.
```

PASS NETCONF Reports The Same Hostname As The CLI (0.8s, 1 commands)

```
R1 show running-config | include ^hostname
  hostname c8000v-r1
```

PASS NETCONF Advertises The Expected Base Capabilities (0.5s, 0 commands)

IOS-XE does not list per-module URIs such as Cisco-IOS-XE-native in the hello; modules are exposed via yang-library. That the native model is usable is proven by the hostname test above, which queries the native namespace directly.

No device commands (assertion used earlier output).

09 Bgp

PASS BGP Sessions Are Established With The Expected Peer AS (0.1s, 4 commands)

The hub holds one session per spoke; each spoke holds exactly one.

```
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 40, main routing table version 40
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  6 BGP community entries using 144 bytes of memory
  3 BGP route-map cache entries using 216 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5936 total bytes of memory
  BGP activity 139/130 prefixes, 145/136 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:51:43.657 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 40, main routing table version 40
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  6 BGP community entries using 144 bytes of memory
  3 BGP route-map cache entries using 216 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5936 total bytes of memory
  BGP activity 139/130 prefixes, 145/136 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:51:43.692 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
R2 show bgp ipv4 unicast summary
  BGP router identifier 172.16.2.1, local AS number 65002
  BGP table version is 70, main routing table version 70
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 64 bytes of memory
  6 BGP community entries using 144 bytes of memory
  6 BGP route-map cache entries using 432 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 6168 total bytes of memory
  BGP activity 172/163 prefixes, 174/165 paths, scan interval 60 secs
  31 networks peaked at 22:34:42 Sep 7 2026 UTC (00:51:00.728 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 1 more lines
R3 show bgp ipv4 unicast summary
  BGP router identifier 172.16.3.1, local AS number 65003
  BGP table version is 152, main routing table version 152
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 64 bytes of memory
  6 BGP community entries using 144 bytes of memory
  3 BGP route-map cache entries using 216 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5952 total bytes of memory
  BGP activity 75/66 prefixes, 80/71 paths, scan interval 60 secs
  9 networks peaked at 22:15:22 Sep 7 2026 UTC (01:10:20.761 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 1 more lines
```

PASS Each Spoke Learns The Other Spoke Prefix Through The Hub (0.1s, 2 commands)

The defining property of this topology: spokes never peer with each other, so R3's prefix can only reach R2 via the hub, and its AS path must show both hops.

```
R2 show bgp ipv4 unicast 10.20.3.1
  BGP routing table entry for 10.20.3.1/32, version 67
  Paths: (1 available, best #1, table default)
    Not advertised to any peer
    Refresh Epoch 1
    65001 65003
      172.20.0.3 from 172.20.0.1 (172.16.1.1)
        Origin IGP, localpref 100, valid, external, best
        Community: 65003:1
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:24:08 UTC
R3 show bgp ipv4 unicast 10.20.2.1
  BGP routing table entry for 10.20.2.1/32, version 150
  Paths: (1 available, best #1, table default)
    Not advertised to any peer
    Refresh Epoch 1
    65001 65002
      172.20.0.2 from 172.20.0.1 (172.16.1.1)
        Origin IGP, localpref 100, valid, external, best
        Community: 65002:1
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:24:34 UTC
```

PASS Every Peer Is Configured With MD5 Authentication (0.4s, 3 commands)

The negative test below proves a wrong password is rejected; this proves no peer was left without one in the first place.

```
R1 show running-config | include ^ neighbor .* remote-as|^ neighbor .* password
  neighbor 172.20.0.2 remote-as 65002
   neighbor 172.20.0.2 password LabBgpSecret
   neighbor 172.20.0.3 remote-as 65003
   neighbor 172.20.0.3 password LabBgpSecret
R2 show running-config | include ^ neighbor .* remote-as|^ neighbor .* password
  neighbor 172.20.0.1 remote-as 65001
   neighbor 172.20.0.1 password LabBgpSecret
R3 show running-config | include ^ neighbor .* remote-as|^ neighbor .* password
  neighbor 172.20.0.1 remote-as 65001
   neighbor 172.20.0.1 password LabBgpSecret
```

PASS A BFD Session Is Up For Every BGP Peer (0.1s, 3 commands)

One BFD session per peer, on the tunnel the peer address lives on -- the hub therefore holds two.

```
R1 show bfd neighbors
  IPv4 Sessions
  NeighAddr                              LD/RD         RH/RS     State     Int
  172.20.0.2                           4097/4102       Up        Up        Tu0
  172.20.0.3                           4098/4097       Up        Up        Tu0
R2 show bfd neighbors
  IPv4 Sessions
  NeighAddr                              LD/RD         RH/RS     State     Int
  172.20.0.1                           4102/4097       Up        Up        Tu0
R3 show bfd neighbors
  IPv4 Sessions
  NeighAddr                              LD/RD         RH/RS     State     Int
  172.20.0.1                           4097/4098       Up        Up        Tu0
```

PASS BGP Uses BFD For Fall-over On Every Peer (0.4s, 6 commands)

A BFD session that no protocol consumes would detect failures and change nothing, so this checks BGP is the registered client rather than just that BFD is running.

```
R1 show running-config | include ^ neighbor .* remote-as|fall-over bfd
  neighbor 172.20.0.2 remote-as 65002
   neighbor 172.20.0.2 fall-over bfd
   neighbor 172.20.0.3 remote-as 65003
   neighbor 172.20.0.3 fall-over bfd
R1 show bfd neighbors client bgp
  IPv4 Sessions
  NeighAddr                              LD/RD         RH/RS     State     Int
  172.20.0.2                           4097/4102       Up        Up        Tu0
```

```
  172.20.0.3                          4098/4097       Up        Up        Tu0
R2 show running-config | include ^ neighbor .* remote-as|fall-over bfd
  neighbor 172.20.0.1 remote-as 65001
   neighbor 172.20.0.1 fall-over bfd
R2 show bfd neighbors client bgp
  IPv4 Sessions
  NeighAddr                             LD/RD         RH/RS     State     Int
  172.20.0.1                          4102/4097       Up        Up        Tu0
R3 show running-config | include ^ neighbor .* remote-as|fall-over bfd
  neighbor 172.20.0.1 remote-as 65001
   neighbor 172.20.0.1 fall-over bfd
R3 show bfd neighbors client bgp
  IPv4 Sessions
  NeighAddr                             LD/RD         RH/RS     State     Int
  172.20.0.1                          4097/4098       Up        Up        Tu0
```

PASS BFD Tears The Session Down Long Before The Hold Time (42.8s, 32 commands)

The test that makes BFD more than configuration. An ACL on the hub's tunnel drops only BFD control packets (UDP 3784 and 3785) and leaves BGP's TCP session untouched, so ordinary BGP liveness is unaffected. Without fall-over the session would survive until the 30s hold time expires; with it, BFD declares the peer down in about a second and BGP follows.

```
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 40, main routing table version 40
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  6 BGP community entries using 144 bytes of memory
  3 BGP route-map cache entries using 216 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5936 total bytes of memory
  BGP activity 139/130 prefixes, 145/136 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:51:44.666 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 ip access-list extended BLOCK-BFD
  ${output} =
R1 deny udp any any eq 3784
  ${output} =
R1 deny udp any any eq 3785
  ${output} =
R1 permit ip any any
  ${output} =
R1 end
  ${output} =
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 interface Tunnel0
  ${output} =
R1 ip access-group BLOCK-BFD in
  ${output} =
R1 end
  ${output} =
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      17      19       40    0    0 00:01:35        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      17      20       40    0    0 00:01:36        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002       0       0        1    0    0 00:00:00 Idle
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 interface Tunnel0
  ${output} =
```

R1 no ip access-group BLOCK-BFD in

```
${output} =
```

R1 end

```
${output} =
```

R1 configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

R1 no ip access-list extended BLOCK-BFD

```
${output} =
```

R1 end

```
${output} =
```

R1 show bgp ipv4 unicast summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 46, main routing table version 46
3 network entries using 744 bytes of memory
3 path entries using 408 bytes of memory
1/1 BGP path/bestpath attribute entries using 296 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1448 total bytes of memory
BGP activity 139/136 prefixes, 145/142 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:51:47.175 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
172.20.0.2      4        65002       0       0        1    0    0 00:00:01 Idle
172.20.0.3      4        65003       0       0        1    0    0 00:00:00 Idle
```

R1 show bgp ipv4 unicast summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 49, main routing table version 49
6 network entries using 1488 bytes of memory
6 path entries using 816 bytes of memory
4/4 BGP path/bestpath attribute entries using 1184 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
3 BGP community entries using 72 bytes of memory
3 BGP route-map cache entries using 216 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3800 total bytes of memory
BGP activity 142/136 prefixes, 148/142 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:51:52.214 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
... 2 more lines
```

R1 show bgp ipv4 unicast summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 52, main routing table version 52
9 network entries using 2232 bytes of memory
9 path entries using 1224 bytes of memory
7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
6 BGP community entries using 144 bytes of memory
6 BGP route-map cache entries using 432 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 6152 total bytes of memory
BGP activity 145/136 prefixes, 151/142 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:51:57.255 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
... 2 more lines
```

R1 show ip route 10.20.2.1

```
Routing entry for 10.20.2.1/32
  Known via "bgp 65001", distance 20, metric 0
  Tag 65002, type external
  Last update from 172.20.0.2 00:00:05 ago
  Routing Descriptor Blocks:
  * 172.20.0.2, from 172.20.0.2, 00:00:05 ago
      opaque_ptr 0x747B4EAD51F8
      Route metric is 0, traffic share count is 1
      AS Hops 1
      Route tag 65002
      MPLS label: none
```

R3 show ip route 10.20.2.1

```
% Subnet not in table
```

R3 show ip route 10.20.2.1

```
% Subnet not in table
```

R3 show ip route 10.20.2.1

```
% Subnet not in table
```

```
R3 show ip route 10.20.2.1
  % Subnet not in table
R3 show ip route 10.20.2.1
  % Subnet not in table
R3 show ip route 10.20.2.1
  % Subnet not in table
R3 show ip route 10.20.2.1
  Routing entry for 10.20.2.1/32
    Known via "bgp 65003", distance 20, metric 0
    Tag 65001, type external
    Last update from 172.20.0.2 00:00:05 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.1, 00:00:05 ago
        opaque_ptr 0x75671E6AB998
        Route metric is 0, traffic share count is 1
        AS Hops 2
        Route tag 65001
        MPLS label: none
```

PASS Every Peer Has An Outbound Route-map Over Per-class Prefix-lists (0.6s, 13 commands)

One prefix-list per prefix class, and a route-map clause per class so each can carry its own community. The clauses are the whitelist: the route-map's implicit deny is what stops anything unnamed being advertised.

```
R2 show running-config | include route-map RM-OUT-R2 out
  neighbor 172.20.0.2 route-map RM-OUT-R2 out
R3 show running-config | include route-map RM-OUT-R3 out
  neighbor 172.20.0.3 route-map RM-OUT-R3 out
R1 show ip prefix-list PL-OWN-LO
  ip prefix-list PL-OWN-LO: 1 entries
     seq 5 permit 10.20.1.1/32
R1 show ip prefix-list PL-OWN-NAT
  ip prefix-list PL-OWN-NAT: 1 entries
     seq 5 permit 10.30.1.0/24
R1 show ip prefix-list PL-OWN-LAN
  ip prefix-list PL-OWN-LAN: 1 entries
     seq 5 permit 192.168.10.0/24
R1 show running-config | include route-map RM-OUT-R1 out
  neighbor 172.20.0.1 route-map RM-OUT-R1 out
R2 show ip prefix-list PL-OWN-LO
  ip prefix-list PL-OWN-LO: 1 entries
     seq 5 permit 10.20.2.1/32
R2 show ip prefix-list PL-OWN-NAT
  ip prefix-list PL-OWN-NAT: 1 entries
     seq 5 permit 10.30.2.0/24
R2 show ip prefix-list PL-OWN-LAN
  ip prefix-list PL-OWN-LAN: 1 entries
     seq 5 permit 192.168.20.0/24
R1 show running-config | include route-map RM-OUT-R1 out
  neighbor 172.20.0.1 route-map RM-OUT-R1 out
R3 show ip prefix-list PL-OWN-LO
  ip prefix-list PL-OWN-LO: 1 entries
     seq 5 permit 10.20.3.1/32
R3 show ip prefix-list PL-OWN-NAT
  ip prefix-list PL-OWN-NAT: 1 entries
     seq 5 permit 10.30.3.0/24
R3 show ip prefix-list PL-OWN-LAN
  ip prefix-list PL-OWN-LAN: 1 entries
     seq 5 permit 192.168.30.0/24
```

PASS Every Peer Has An Inbound Policy Matching Community And AS Path (0.6s, 11 commands)

*Both matches sit in one permit clause, so they are ANDed and the clause's implicit deny is the drop: a prefix with an unknown community *or* an unexpected AS path falls through.*

```
R2 show running-config | include route-map RM-IN-R2 in
  neighbor 172.20.0.2 route-map RM-IN-R2 in
R2 show route-map RM-IN-R2
```

```
  route-map RM-IN-R2, permit, sequence 10
    Match clauses:
      as-path (as-path filter): 10
      community (community-list filter): CL-VALID
    Set clauses:
    Policy routing matches: 0 packets, 0 bytes
```

R3 show running-config | include route-map RM-IN-R3 in

```
  neighbor 172.20.0.3 route-map RM-IN-R3 in
```

R3 show route-map RM-IN-R3

```
  route-map RM-IN-R3, permit, sequence 10
    Match clauses:
      as-path (as-path filter): 20
      community (community-list filter): CL-VALID
    Set clauses:
    Policy routing matches: 0 packets, 0 bytes
```

R1 show ip community-list CL-VALID

```
  Named Community standard list CL-VALID
      permit 65001:1
      permit 65001:2
      permit 65001:3
      permit 65002:1
      permit 65002:2
      permit 65002:3
      permit 65003:1
      permit 65003:2
      permit 65003:3
```

R1 show running-config | include route-map RM-IN-R1 in

```
  neighbor 172.20.0.1 route-map RM-IN-R1 in
```

R1 show route-map RM-IN-R1

```
  route-map RM-IN-R1, permit, sequence 10
    Match clauses:
      as-path (as-path filter): 10
      community (community-list filter): CL-VALID
    Set clauses:
    Policy routing matches: 0 packets, 0 bytes
```

R2 show ip community-list CL-VALID

```
  Named Community standard list CL-VALID
      permit 65001:1
      permit 65001:2
      permit 65001:3
      permit 65002:1
      permit 65002:2
      permit 65002:3
      permit 65003:1
      permit 65003:2
      permit 65003:3
```

R1 show running-config | include route-map RM-IN-R1 in

```
  neighbor 172.20.0.1 route-map RM-IN-R1 in
```

R1 show route-map RM-IN-R1

```
  route-map RM-IN-R1, permit, sequence 10
    Match clauses:
      as-path (as-path filter): 10
      community (community-list filter): CL-VALID
    Set clauses:
    Policy routing matches: 0 packets, 0 bytes
```

R3 show ip community-list CL-VALID

```
  Named Community standard list CL-VALID
      permit 65001:1
      permit 65001:2
      permit 65001:3
      permit 65002:1
      permit 65002:2
      permit 65002:3
      permit 65003:1
      permit 65003:2
      permit 65003:3
```

PASS Every Received Prefix Carries The Community Of Its Origin (0.6s, 18 commands)

A prefix is tagged by the router that owns it, so the community identifies both the origin AS and the kind of prefix. Checked on the receiver, which is the only place it proves the tag survived the wire.

R1 show bgp ipv4 unicast 10.20.2.1/32

```
  BGP routing table entry for 10.20.2.1/32, version 52
```

```
  Paths: (1 available, best #1, table default)
    Advertised to update-groups:
       33
    Refresh Epoch 1
    65002
      172.20.0.2 from 172.20.0.2 (172.16.2.1)
        Origin IGP, metric 0, localpref 100, valid, external, best
        Community: 65002:1
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:25:51 UTC
```

R1 show bgp ipv4 unicast 10.20.3.1/32

```
  BGP routing table entry for 10.20.3.1/32, version 49
  Paths: (1 available, best #1, table default)
    Advertised to update-groups:
       34
    Refresh Epoch 1
    65003
      172.20.0.3 from 172.20.0.3 (172.16.3.1)
        Origin IGP, metric 0, localpref 100, valid, external, best
        Community: 65003:1
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:25:50 UTC
```

R1 show bgp ipv4 unicast 10.30.2.0/24

```
  BGP routing table entry for 10.30.2.0/24, version 51
  Paths: (1 available, best #1, table default)
    Advertised to update-groups:
       33
    Refresh Epoch 1
    65002
      172.20.0.2 from 172.20.0.2 (172.16.2.1)
        Origin IGP, metric 0, localpref 100, valid, external, best
        Community: 65002:2
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:25:51 UTC
```

R1 show bgp ipv4 unicast 10.30.3.0/24

```
  BGP routing table entry for 10.30.3.0/24, version 48
  Paths: (1 available, best #1, table default)
    Advertised to update-groups:
       34
    Refresh Epoch 1
    65003
      172.20.0.3 from 172.20.0.3 (172.16.3.1)
        Origin IGP, metric 0, localpref 100, valid, external, best
        Community: 65003:2
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:25:50 UTC
```

R1 show bgp ipv4 unicast 192.168.20.0/24

```
  BGP routing table entry for 192.168.20.0/24, version 50
  Paths: (1 available, best #1, table default)
    Advertised to update-groups:
       33
    Refresh Epoch 1
    65002
      172.20.0.2 from 172.20.0.2 (172.16.2.1)
        Origin IGP, metric 0, localpref 100, valid, external, best
        Community: 65002:3
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:25:51 UTC
```

R1 show bgp ipv4 unicast 192.168.30.0/24

```
  BGP routing table entry for 192.168.30.0/24, version 47
  Paths: (1 available, best #1, table default)
    Advertised to update-groups:
       34
    Refresh Epoch 1
    65003
      172.20.0.3 from 172.20.0.3 (172.16.3.1)
        Origin IGP, metric 0, localpref 100, valid, external, best
        Community: 65003:3
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:25:50 UTC
```

R2 show bgp ipv4 unicast 10.20.1.1/32

```
  BGP routing table entry for 10.20.1.1/32, version 79
  Paths: (1 available, best #1, table default)
    Not advertised to any peer
    Refresh Epoch 1
    65001
      172.20.0.1 from 172.20.0.1 (172.16.1.1)
        Origin IGP, metric 0, localpref 100, valid, external, best
```

```
      Community: 65001:1
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:51 UTC
```

R2 show bgp ipv4 unicast 10.20.3.1/32

```
BGP routing table entry for 10.20.3.1/32, version 80
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001 65003
    172.20.0.3 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65003:1
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:51 UTC
```

R2 show bgp ipv4 unicast 10.30.1.0/24

```
BGP routing table entry for 10.30.1.0/24, version 78
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001
    172.20.0.1 from 172.20.0.1 (172.16.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 65001:2
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:51 UTC
```

R2 show bgp ipv4 unicast 10.30.3.0/24

```
BGP routing table entry for 10.30.3.0/24, version 81
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001 65003
    172.20.0.3 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65003:2
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:51 UTC
```

R2 show bgp ipv4 unicast 192.168.10.0/24

```
BGP routing table entry for 192.168.10.0/24, version 77
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001
    172.20.0.1 from 172.20.0.1 (172.16.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 65001:3
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:51 UTC
```

R2 show bgp ipv4 unicast 192.168.30.0/24

```
BGP routing table entry for 192.168.30.0/24, version 82
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001 65003
    172.20.0.3 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65003:3
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:51 UTC
```

R3 show bgp ipv4 unicast 10.20.1.1/32

```
BGP routing table entry for 10.20.1.1/32, version 161
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001
    172.20.0.1 from 172.20.0.1 (172.16.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 65001:1
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:50 UTC
```

R3 show bgp ipv4 unicast 10.20.2.1/32

```
BGP routing table entry for 10.20.2.1/32, version 162
Paths: (1 available, best #1, table default)
  Flag: 0x8100
  Not advertised to any peer
  Refresh Epoch 1
  65001 65002
    172.20.0.2 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
```

```
      Community: 65002:1
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:26:21 UTC
```

R3 show bgp ipv4 unicast 10.30.1.0/24

```
BGP routing table entry for 10.30.1.0/24, version 160
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001
    172.20.0.1 from 172.20.0.1 (172.16.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 65001:2
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:50 UTC
```

R3 show bgp ipv4 unicast 10.30.2.0/24

```
BGP routing table entry for 10.30.2.0/24, version 163
Paths: (1 available, best #1, table default)
  Flag: 0x8100
  Not advertised to any peer
  Refresh Epoch 1
  65001 65002
    172.20.0.2 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65002:2
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:26:21 UTC
```

R3 show bgp ipv4 unicast 192.168.10.0/24

```
BGP routing table entry for 192.168.10.0/24, version 159
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001
    172.20.0.1 from 172.20.0.1 (172.16.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 65001:3
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:50 UTC
```

R3 show bgp ipv4 unicast 192.168.20.0/24

```
BGP routing table entry for 192.168.20.0/24, version 164
Paths: (1 available, best #1, table default)
  Flag: 0x8100
  Not advertised to any peer
  Refresh Epoch 1
  65001 65002
    172.20.0.2 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65002:3
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:26:21 UTC
```

PASS Re-advertised Prefixes Keep Their Origin Community Through The Hub (0.1s, 4 commands)

A spoke-to-spoke prefix crosses the hub, which re-advertises it. If the hub re-tagged it the community would say 65001 and the origin would be lost, so this asserts the far spoke's own community survives the hop.

R2 show bgp ipv4 unicast 10.20.3.1/32

```
BGP routing table entry for 10.20.3.1/32, version 80
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001 65003
    172.20.0.3 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65003:1
      rx pathid: 0, tx pathid: 0x0
      Updated on Sep 7 2026 23:25:51 UTC
```

R2 show bgp ipv4 unicast 192.168.30.0/24

```
BGP routing table entry for 192.168.30.0/24, version 82
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  65001 65003
    172.20.0.3 from 172.20.0.1 (172.16.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 65003:3
      rx pathid: 0, tx pathid: 0x0
```

```
      Updated on Sep 7 2026 23:25:51 UTC
R3 show bgp ipv4 unicast 10.20.2.1/32
  BGP routing table entry for 10.20.2.1/32, version 162
  Paths: (1 available, best #1, table default)
    Flag: 0x8100
    Not advertised to any peer
    Refresh Epoch 1
    65001 65002
      172.20.0.2 from 172.20.0.1 (172.16.1.1)
        Origin IGP, localpref 100, valid, external, best
        Community: 65002:1
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:26:21 UTC
R3 show bgp ipv4 unicast 192.168.20.0/24
  BGP routing table entry for 192.168.20.0/24, version 164
  Paths: (1 available, best #1, table default)
    Flag: 0x8100
    Not advertised to any peer
    Refresh Epoch 1
    65001 65002
      172.20.0.2 from 172.20.0.1 (172.16.1.1)
        Origin IGP, localpref 100, valid, external, best
        Community: 65002:3
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:26:21 UTC
```

PASS A Prefix With An Unknown Community Is Rejected Inbound (26.0s, 40 commands)

*The prefix is explicitly permitted *outbound* by a temporary clause, so the outbound whitelist cannot be what stops it -- only the inbound community match can. The test asserts R2 really did advertise it before asserting R1 refused it, otherwise it would pass whenever the advertisement failed.*

```
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface Loopback98
  ${output} =
R2 ip address 10.88.88.88 255.255.255.255
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip prefix-list PL-TEST seq 5 permit 10.88.88.88/32
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 route-map RM-OUT-R1 permit 5
  ${output} =
R2 match ip address prefix-list PL-TEST
  ${output} =
R2 set community 65500:9
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.88.88.88 mask 255.255.255.255
  ${output} =
R2 end
  ${output} =
R2 clear ip bgp * soft out
  ${output} =
```

```
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 82, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 83, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 83, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 83, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 83, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 83, local router ID is 172.16.2.1
  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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.2.1/32     0.0.0.0                  0         32768 i
 *>   10.30.2.0/24     0.0.0.0                  0         32768 i
 *>   10.88.88.88/32   0.0.0.0                  0         32768 i
 *>   192.168.20.0     0.0.0.0                  0         32768 i

... 1 more lines
```

R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes

```
BGP table version is 83, local router ID is 172.16.2.1
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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.2.1/32     0.0.0.0                  0         32768 i
 *>   10.30.2.0/24     0.0.0.0                  0         32768 i
 *>   10.88.88.88/32   0.0.0.0                  0         32768 i
 *>   192.168.20.0     0.0.0.0                  0         32768 i

... 1 more lines
```

R1 show bgp ipv4 unicast 10.88.88.88

```
% Network not in table
```

R2 configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 router bgp 65002

```
${output} =
```

R2 address-family ipv4 unicast

```
${output} =
```

R2 no network 10.88.88.88 mask 255.255.255.255

```
${output} =
```

R2 end

```
${output} =
```

R2 configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 no route-map RM-OUT-R1 permit 5

```
${output} =
```

R2 end

```
${output} =
```

R2 configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 no ip prefix-list PL-TEST

```
${output} =
```

R2 end

```
${output} =
```

R2 configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 no interface Loopback98

```
${output} =
```

R2 end

```
${output} =
```

PASS Every Peer Has A Maximum-prefix Limit With Headroom (0.5s, 6 commands)

Filtering controls what a peer may send; this controls how much. The limit must sit above normal load or it would trip in steady state -- a hub holds 3 prefixes per spoke, a spoke 6 -- and far below anything that could exhaust memory.

R1 show running-config | include ^ neighbor .* remote-as|maximum-prefix

```
neighbor 172.20.0.2 remote-as 65002
 neighbor 172.20.0.3 remote-as 65003
  neighbor 172.20.0.2 maximum-prefix 15 80
  neighbor 172.20.0.3 maximum-prefix 15 80
```

R1 show bgp ipv4 unicast summary | begin Neighbor

```
  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  172.20.0.2      4        65002      18      16       52    0    0 00:01:02        3
  172.20.0.3      4        65003      13      16       52    0    0 00:01:03        3
R2 show running-config | include ^ neighbor .* remote-as|maximum-prefix
  neighbor 172.20.0.1 remote-as 65001
    neighbor 172.20.0.1 maximum-prefix 15 80
R2 show bgp ipv4 unicast summary | begin Neighbor
  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  172.20.0.1      4        65001      16      18       83    0    0 00:01:02        6
R3 show running-config | include ^ neighbor .* remote-as|maximum-prefix
  neighbor 172.20.0.1 remote-as 65001
    neighbor 172.20.0.1 maximum-prefix 15 80
R3 show bgp ipv4 unicast summary | begin Neighbor
  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  172.20.0.1      4        65001      16      13      164    0    0 00:01:03        6
```

PASS A Peer That Floods Prefixes Is Torn Down Rather Than Absorbed (37.0s, 344 commands)

R2 originates 20 extra prefixes, tagged with a valid community and carrying a valid AS path, and explicitly permitted outbound -- so neither the whitelist, the community match nor the AS-path filter can be what stops them. Only the prefix count is left. The hub must drop the session instead of accepting an unbounded table.

```
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip prefix-list PL-FLOOD seq 5 permit 10.99.0.0/16 le 32
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 route-map RM-OUT-R1 permit 7
  ${output} =
R2 match ip address prefix-list PL-FLOOD
  ${output} =
R2 set community 65002:1
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.0.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.1.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.2.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.3.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.4.0 255.255.255.0 Null0
  ${output} =
```

```
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.5.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.6.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.7.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.8.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.9.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.10.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.11.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.12.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.13.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.14.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.15.0 255.255.255.0 Null0
```

```
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.16.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.17.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.18.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip route 10.99.19.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.0.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.1.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.2.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.3.0 mask 255.255.255.0
  ${output} =
```

```
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.4.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.5.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.6.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.7.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.8.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.9.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
```

```
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.10.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.11.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.12.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.13.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.14.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.15.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.16.0 mask 255.255.255.0
  ${output} =
```

```
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.17.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.18.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.99.19.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      18      17       52    0    0 00:01:06        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      19      17       52    0    0 00:01:11        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      19      18       52    0    0 00:01:16        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      20      18       52    0    0 00:01:21        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      20      19       52    0    0 00:01:26        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002      21      19       52    0    0 00:01:31        3
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002       0       0        1    0    0 00:00:04 Idle (PfxCt)
R1 show bgp ipv4 unicast summary | include 172.20.0.2
  172.20.0.2      4        65002       0       0        1    0    0 00:00:04 Idle (PfxCt)
R1 show logging | include MAXPFXEXCEED
  000408: Sep  7 22:33:59.581 UTC: %BGP-3-MAXPFXEXCEED: Number of prefixes received from 172.20.0.2 1/1
  (afi/safi): 16 exceeds limit 15
  000748: Sep  7 23:03:35.410 UTC: %BGP-3-MAXPFXEXCEED: Number of prefixes received from 172.20.0.2 1/1
  (afi/safi): 16 exceeds limit 15
  001152: Sep  7 23:27:24.049 UTC: %BGP-3-MAXPFXEXCEED: Number of prefixes received from 172.20.0.2 1/1
  (afi/safi): 16 exceeds limit 15
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.0.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
```

```
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.0.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.1.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.1.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.2.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.2.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.3.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.3.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.4.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
```

```
R2 no ip route 10.99.4.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.5.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.5.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.6.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.6.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.7.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.7.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.8.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.8.0 255.255.255.0 Null0
```

```
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.9.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.9.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.10.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.10.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.11.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.11.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.12.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.12.0 255.255.255.0 Null0
  ${output} =
```

```
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.13.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.13.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.14.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.14.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.15.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.15.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.16.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.16.0 255.255.255.0 Null0
  ${output} =
R2 end
```

```
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.17.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.17.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.18.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.18.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.99.19.0 mask 255.255.255.0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip route 10.99.19.0 255.255.255.0 Null0
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no route-map RM-OUT-R1 permit 7
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip prefix-list PL-FLOOD
  ${output} =
R2 end
  ${output} =
R1 clear ip bgp 172.20.0.2
  ${output} =
```

PASS The Session Recovers Once The Flood Stops (25.2s, 8 commands)

A maximum-prefix teardown is deliberately sticky -- no "restart" is configured -- so recovery takes an operator clearing it. This asserts the lab returns to a converged state rather than leaving the next suite a broken topology.

```
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 79, main routing table version 79
  6 network entries using 1488 bytes of memory
  6 path entries using 816 bytes of memory
  8/4 BGP path/bestpath attribute entries using 2368 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  7 BGP community entries using 168 bytes of memory
  7 BGP route-map cache entries using 504 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5392 total bytes of memory
  BGP activity 158/152 prefixes, 164/158 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:53:32.901 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 82, main routing table version 82
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  8/7 BGP path/bestpath attribute entries using 2368 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  7 BGP community entries using 168 bytes of memory
  7 BGP route-map cache entries using 504 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 6544 total bytes of memory
  BGP activity 161/152 prefixes, 167/158 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:53:37.936 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
R1 show ip route 10.20.2.1
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:00:00 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:00:00 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
R3 show ip route 10.20.2.1
  % Subnet not in table
R3 show ip route 10.20.2.1
  % Subnet not in table
R3 show ip route 10.20.2.1
  % Subnet not in table
R3 show ip route 10.20.2.1
  % Subnet not in table
R3 show ip route 10.20.2.1
  Routing entry for 10.20.2.1/32
    Known via "bgp 65003", distance 20, metric 0
    Tag 65001, type external
    Last update from 172.20.0.2 00:00:03 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.1, 00:00:03 ago
        opaque_ptr 0x75671E6AB998
        Route metric is 0, traffic share count is 1
        AS Hops 2
        Route tag 65001
        MPLS label: none
```

PASS A Prefix With An Invalid AS Path Is Rejected Inbound (10.8s, 38 commands)

Same prefix, this time with a valid community but an AS path this topology cannot produce. Only the AS-path match differs, so a rejection here isolates that filter.

```
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface Loopback98
  ${output} =
R2 ip address 10.88.88.88 255.255.255.255
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 ip prefix-list PL-TEST seq 5 permit 10.88.88.88/32
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 route-map RM-OUT-R1 permit 5
  ${output} =
R2 match ip address prefix-list PL-TEST
  ${output} =
R2 set community 65002:1
  ${output} =
R2 set as-path prepend 65099
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.88.88.88 mask 255.255.255.255
  ${output} =
R2 end
  ${output} =
R2 clear ip bgp * soft out
  ${output} =
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 136, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 137, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 137, local router ID is 172.16.2.1
```

```
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   10.88.88.88/32   0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  ... 1 more lines
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 137, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   10.88.88.88/32   0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  ... 1 more lines
R1 show bgp ipv4 unicast 10.88.88.88
  % Network not in table
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.88.88.88 mask 255.255.255.255
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no route-map RM-OUT-R1 permit 5
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no ip prefix-list PL-TEST
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no interface Loopback98
  ${output} =
R2 end
  ${output} =
```

PASS Each Peer Is Advertised Exactly Its Whitelisted Prefixes (0.3s, 4 commands)

Not "at least" -- exactly. A whitelist that permits more than intended still passes a containment check, so the advertised set is compared for equality against what the peer should get: a spoke sends only its own prefixes, the hub sends its own plus the far spoke's.

```
R2 show bgp ipv4 unicast neighbors 172.20.0.2 advertised-routes
  BGP table version is 82, local router ID is 172.16.1.1
  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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.1.1/32     0.0.0.0                  0         32768 i
 *>   10.20.3.1/32     172.20.0.3               0             0 65003 i
 *>   10.30.1.0/24     0.0.0.0                  0         32768 i
 *>   10.30.3.0/24     172.20.0.3               0             0 65003 i
 *>   192.168.10.0     0.0.0.0                  0         32768 i
... 3 more lines
```

```
R3 show bgp ipv4 unicast neighbors 172.20.0.3 advertised-routes
BGP table version is 82, local router ID is 172.16.1.1
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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.1.1/32     0.0.0.0                  0         32768 i
 *>   10.20.2.1/32     172.20.0.2               0             0 65002 i
 *>   10.30.1.0/24     0.0.0.0                  0         32768 i
 *>   10.30.2.0/24     172.20.0.2               0             0 65002 i
 *>   192.168.10.0     0.0.0.0                  0         32768 i
... 3 more lines
```

```
R1 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
BGP table version is 138, local router ID is 172.16.2.1
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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.2.1/32     0.0.0.0                  0         32768 i
 *>   10.30.2.0/24     0.0.0.0                  0         32768 i
 *>   192.168.20.0     0.0.0.0                  0         32768 i

Total number of prefixes 3
```

```
R1 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
BGP table version is 170, local router ID is 172.16.3.1
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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.3.1/32     0.0.0.0                  0         32768 i
 *>   10.30.3.0/24     0.0.0.0                  0         32768 i
 *>   192.168.30.0     0.0.0.0                  0         32768 i

Total number of prefixes 3
```

PASS A Prefix Outside The Whitelist Is Not Advertised (10.5s, 20 commands)

The point of a whitelist. A spoke originates a prefix nobody authorised; it appears in that spoke's own BGP table, so the origination worked, and must still never reach the hub.

```
R2 configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface Loopback99
${output} =
R2 ip address 10.77.77.77 255.255.255.255
${output} =
R2 end
${output} =
R2 configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

```
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 network 10.77.77.77 mask 255.255.255.255
  ${output} =
R2 end
  ${output} =
R2 show bgp ipv4 unicast 10.77.77.77
  BGP routing table entry for 10.77.77.77/32, version 139
  Paths: (1 available, best #1, table default)
    Flag: 0x8100
    Not advertised to any peer
    Refresh Epoch 1
    Local
      0.0.0.0 from 0.0.0.0 (172.16.2.1)
        Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local, best
        rx pathid: 0, tx pathid: 0x0
        Updated on Sep 7 2026 23:28:10 UTC
R2 show bgp ipv4 unicast neighbors 172.20.0.1 advertised-routes
  BGP table version is 139, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
   *>   192.168.20.0     0.0.0.0                  0         32768 i

  Total number of prefixes 3
R1 show bgp ipv4 unicast 10.77.77.77
  % Network not in table
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 router bgp 65002
  ${output} =
R2 address-family ipv4 unicast
  ${output} =
R2 no network 10.77.77.77 mask 255.255.255.255
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no interface Loopback99
  ${output} =
R2 end
  ${output} =
```

PASS Each Router Receives The Peer Prefix (0.1s, 2 commands)

```
R1 show bgp ipv4 unicast
  BGP table version is 82, local router ID is 172.16.1.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.1.1/32     0.0.0.0                  0         32768 i
   *>   10.20.2.1/32     172.20.0.2               0             0 65002 i
   *>   10.20.3.1/32     172.20.0.3               0             0 65003 i
   *>   10.30.1.0/24     0.0.0.0                  0         32768 i
   *>   10.30.2.0/24     172.20.0.2               0             0 65002 i
  ... 4 more lines
```

```
R2 show bgp ipv4 unicast
  BGP table version is 140, local router ID is 172.16.2.1
  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,
                t secondary path, L long-lived-stale,
  Origin codes: i - IGP, e - EGP, ? - incomplete
  RPKI validation codes: V valid, I invalid, N Not found

       Network          Next Hop            Metric LocPrf Weight Path
   *>   10.20.1.1/32     172.20.0.1               0             0 65001 i
   *>   10.20.2.1/32     0.0.0.0                  0         32768 i
   *>   10.20.3.1/32     172.20.0.3                             0 65001 65003 i
   *>   10.30.1.0/24     172.20.0.1               0             0 65001 i
   *>   10.30.2.0/24     0.0.0.0                  0         32768 i
  ... 4 more lines
```

PASS Peer Prefix Is Learned Via BGP And Not A Static Route (0.0s, 1 commands)

Distinguishes a genuinely BGP-installed route from one that merely happens to exist. eBGP is distance 20; a static is 1.

```
R1 show ip route 10.20.2.1
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:00:42 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:00:42 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

PASS BGP Route Resolves Out The Encrypted Tunnel (0.0s, 1 commands)

The next hop is a tunnel address, so the forwarding path must recurse to Tunnel0 rather than the cleartext link.

```
R1 show ip cef 10.20.2.1
  10.20.2.1/32
    nexthop 172.20.0.2 Tunnel0
```

PASS Traffic Over The BGP-Learned Route Reaches The Peer (0.0s, 1 commands)

End to end: this only succeeds because BGP installed the route.

```
R1 ping 10.20.2.1 source Loopback1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 10.20.2.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.1.1
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

PASS BGP-Routed Traffic Is Encrypted (5.7s, 7 commands)

```
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 968, #pkts encrypt: 968, #pkts digest: 968
      #pkts decaps: 966, #pkts decrypt: 966, #pkts verify: 966
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
R2 show crypto ipsec sa
```

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     current_peer 100.64.0.1 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 2105, #pkts encrypt: 2105, #pkts digest: 2105
      #pkts decaps: 2100, #pkts decrypt: 2100, #pkts verify: 2100
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 33 more lines
```

R1 ping 10.20.2.1 source Loopback1 repeat 20

```
  Type escape sequence to abort.
  Sending 20, 100-byte ICMP Echos to 10.20.2.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.1.1
  !!!!!!!!!!!!!!!!!!!!
  Success rate is 100 percent (20/20), round-trip min/avg/max = 1/1/2 ms
```

R1 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 968, #pkts encrypt: 968, #pkts digest: 968
      #pkts decaps: 978, #pkts decrypt: 978, #pkts verify: 978
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
```

R2 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     current_peer 100.64.0.1 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 2105, #pkts encrypt: 2105, #pkts digest: 2105
      #pkts decaps: 2100, #pkts decrypt: 2100, #pkts verify: 2100
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 33 more lines
```

R1 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 1024, #pkts encrypt: 1024, #pkts digest: 1024
      #pkts decaps: 1027, #pkts decrypt: 1027, #pkts verify: 1027
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
```

R2 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     current_peer 100.64.0.1 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 2160, #pkts encrypt: 2160, #pkts digest: 2160
```

```
    #pkts decaps: 2159, #pkts decrypt: 2159, #pkts verify: 2159
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 33 more lines
```

PASS BGP Control Plane Traffic Is Encrypted On The Wire (18.8s, 8 commands)

The reason for peering over the tunnel. Captures a keepalive window and asserts the session is invisible: no TCP, no peering addresses, no advertised prefixes -- only ESP.

```
R1 no monitor capture BGPCAP
  Capture does not exist
R1 monitor capture BGPCAP interface GigabitEthernet2 both
  ${output} =
R1 monitor capture BGPCAP match ipv4 any any
  ${output} =
R1 monitor capture BGPCAP buffer size 5
  ${output} =
R1 monitor capture BGPCAP start
  Started capture point : BGPCAP
R1 monitor capture BGPCAP stop
  Stopped capture point : BGPCAP
R1 show monitor capture BGPCAP buffer brief
  ----------------------------------------------------------------------------
   #   size   timestamp     source             destination      dscp    protocol
   ----------------------------------------------------------------------------
     0  138    0.000000   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     1  138    0.000000   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
     2  138    0.063992   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
     3  138    0.224994   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
     4  138    0.224994   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     5  138    0.248980   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     6  138    0.248980   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     7  138    0.350040   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     8  138    0.426025   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     9  138    0.426025   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
    10  138    0.445036   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
  ... 319 more lines
R1 no monitor capture BGPCAP
  ${output} =
```

PASS Withdrawing A Prefix Removes It From The Peer (60.5s, 23 commands)

Shuts the advertised interface on R2 and requires R1 to lose both the BGP path and the route, then restores it.

```
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface Loopback1
  ${output} =
R2 shutdown
  ${output} =
R2 end
  ${output} =
R1 show ip route 10.20.2.1
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:01:07 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:01:07 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
R1 show ip route 10.20.2.1
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
```

```
    Tag 65002, type external
    Last update from 172.20.0.2 00:01:12 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:01:12 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

R1 show ip route 10.20.2.1

```
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:01:17 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:01:17 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

R1 show ip route 10.20.2.1

```
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:01:22 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:01:22 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

R1 show ip route 10.20.2.1

```
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:01:27 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:01:27 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

R1 show ip route 10.20.2.1

```
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:01:32 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:01:32 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

R1 show ip route 10.20.2.1

```
  % Subnet not in table
```

R2 configure terminal

```
  Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 interface Loopback1

```
  ${output} =
```

R2 no shutdown

```
  ${output} =
```

R2 end

```
  ${output} =
```

R1 show ip route 10.20.2.1

```
  % Subnet not in table
```

R1 show ip route 10.20.2.1

```
  % Subnet not in table
```

R1 show ip route 10.20.2.1

```
  % Subnet not in table
```

R1 show ip route 10.20.2.1

```
  % Subnet not in table
```

```
R1 show ip route 10.20.2.1
  % Subnet not in table
```

```
R1 show ip route 10.20.2.1
  % Subnet not in table
```

```
R1 show ip route 10.20.2.1
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:00:04 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:00:04 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

```
R2 show ip route 10.20.1.1
  Routing entry for 10.20.1.1/32
    Known via "bgp 65002", distance 20, metric 0
    Tag 65001, type external
    Last update from 172.20.0.1 00:02:07 ago
    Routing Descriptor Blocks:
    * 172.20.0.1, from 172.20.0.1, 00:02:07 ago
        opaque_ptr 0x7E32CED11C60
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65001
        MPLS label: none
```

PASS Session Recovers After A Hard Clear (10.2s, 5 commands)

```
R1 clear ip bgp *
  ${output} =
```

```
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 1, main routing table version 1
  3 network entries using 744 bytes of memory
  3 path entries using 408 bytes of memory
  2/0 BGP path/bestpath attribute entries using 592 bytes of memory
  1 BGP AS-PATH entries using 24 bytes of memory
  1 BGP community entries using 24 bytes of memory
  1 BGP route-map cache entries using 72 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 1864 total bytes of memory
  BGP activity 165/162 prefixes, 171/168 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:55:44.780 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
```

```
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 1, main routing table version 1
  3 network entries using 744 bytes of memory
  3 path entries using 408 bytes of memory
  2/0 BGP path/bestpath attribute entries using 592 bytes of memory
  1 BGP AS-PATH entries using 24 bytes of memory
  1 BGP community entries using 24 bytes of memory
  1 BGP route-map cache entries using 72 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 1864 total bytes of memory
  BGP activity 165/162 prefixes, 171/168 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:55:49.814 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
```

```
R1 show bgp ipv4 unicast summary
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 10, main routing table version 10
  9 network entries using 2232 bytes of memory
  9 path entries using 1224 bytes of memory
  7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  6 BGP community entries using 144 bytes of memory
  6 BGP route-map cache entries using 432 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 6152 total bytes of memory
```

```
  BGP activity 171/162 prefixes, 177/168 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:55:54.853 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
```

R1 show ip route 10.20.2.1

```
  Routing entry for 10.20.2.1/32
    Known via "bgp 65001", distance 20, metric 0
    Tag 65002, type external
    Last update from 172.20.0.2 00:00:01 ago
    Routing Descriptor Blocks:
    * 172.20.0.2, from 172.20.0.2, 00:00:01 ago
        opaque_ptr 0x747B4EAD51F8
        Route metric is 0, traffic share count is 1
        AS Hops 1
        Route tag 65002
        MPLS label: none
```

PASS Mismatched MD5 Password Prevents The Session Coming Up (50.4s, 19 commands)

Negative control on BGP authentication, mirroring the IPsec wrong-PSK test: without it, a session that accepted any peer would still pass everything above.

R2 configure terminal

```
  Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 router bgp 65002

```
  ${output} =
```

R2 neighbor 172.20.0.1 password WrongBgpSecret999

```
  ${output} =
```

R2 end

```
  ${output} =
```

R1 clear ip bgp *

```
  ${output} =
```

R2 clear ip bgp *

```
  ${output} =
```

R1 show bgp ipv4 unicast summary

```
  BGP router identifier 172.16.1.1, local AS number 65001
  BGP table version is 1, main routing table version 1
  6 network entries using 1488 bytes of memory
  6 path entries using 816 bytes of memory
  7/0 BGP path/bestpath attribute entries using 2072 bytes of memory
  2 BGP AS-PATH entries using 48 bytes of memory
  6 BGP community entries using 144 bytes of memory
  6 BGP route-map cache entries using 432 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 5000 total bytes of memory
  BGP activity 177/171 prefixes, 183/177 paths, scan interval 60 secs
  22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:56:40.023 ago)

  Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
  ... 2 more lines
```

R2 configure terminal

```
  Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 router bgp 65002

```
  ${output} =
```

R2 neighbor 172.20.0.1 password LabBgpSecret

```
  ${output} =
```

R2 end

```
  ${output} =
```

R2 configure terminal

```
  Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 interface Loopback1

```
  ${output} =
```

R2 no shutdown

```
  ${output} =
```

R2 end

```
  ${output} =
```

R1 clear ip bgp *

```
  ${output} =
```

R2 clear ip bgp *

```
${output} =
```

R1 show bgp ipv4 unicast summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 1, main routing table version 1
3 network entries using 744 bytes of memory
3 path entries using 408 bytes of memory
7/0 BGP path/bestpath attribute entries using 2072 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
6 BGP community entries using 144 bytes of memory
6 BGP route-map cache entries using 432 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3848 total bytes of memory
BGP activity 180/177 prefixes, 186/183 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:56:40.214 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
... 2 more lines
```

R1 show bgp ipv4 unicast summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 1, main routing table version 1
3 network entries using 744 bytes of memory
3 path entries using 408 bytes of memory
7/0 BGP path/bestpath attribute entries using 2072 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
6 BGP community entries using 144 bytes of memory
6 BGP route-map cache entries using 432 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3848 total bytes of memory
BGP activity 180/177 prefixes, 186/183 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:56:45.249 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
... 2 more lines
```

10 Host To Host

PASS Every Host Holds Its LAN Address (0.1s, 3 commands)

H1 ip addr show eth1

```
  3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
      link/ether 52:54:00:aa:01:02 brd ff:ff:ff:ff:ff:ff
      inet 192.168.10.10/24 scope global eth1
         valid_lft forever preferred_lft forever
      inet 169.254.229.55/16 brd 169.254.255.255 scope global noprefixroute eth1
         valid_lft forever preferred_lft forever
      inet 192.168.10.11/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.10.12/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.10.13/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.10.14/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
  ... 70 more lines
```

H2 ip addr show eth1

```
  3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
      link/ether 52:54:00:aa:02:02 brd ff:ff:ff:ff:ff:ff
      inet 192.168.20.10/24 scope global eth1
         valid_lft forever preferred_lft forever
      inet 169.254.199.41/16 brd 169.254.255.255 scope global noprefixroute eth1
         valid_lft forever preferred_lft forever
      inet 192.168.20.11/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.20.12/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.20.13/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.20.14/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
  ... 70 more lines
```

H3 ip addr show eth1

```
  3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
      link/ether 52:54:00:aa:03:02 brd ff:ff:ff:ff:ff:ff
      inet 192.168.30.10/24 scope global eth1
         valid_lft forever preferred_lft forever
      inet 169.254.207.242/16 brd 169.254.255.255 scope global noprefixroute eth1
         valid_lft forever preferred_lft forever
      inet 192.168.30.11/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.30.12/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.30.13/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
      inet 192.168.30.14/24 scope global secondary eth1
         valid_lft forever preferred_lft forever
  ... 70 more lines
```

PASS Every Host Routes The Other Two LANs Via Its Own Router (0.0s, 3 commands)

H1 ip route

```
  default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
  10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
  10.30.0.0/16 via 192.168.10.1 dev eth1
  169.254.0.0/16 dev eth1 scope link  src 169.254.229.55  metric 1003
  192.168.10.0/24 dev eth1 scope link  src 192.168.10.10
  192.168.20.0/24 via 192.168.10.1 dev eth1
  192.168.30.0/24 via 192.168.10.1 dev eth1
```

H2 ip route

```
  default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
  10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
  10.30.0.0/16 via 192.168.20.1 dev eth1
  169.254.0.0/16 dev eth1 scope link  src 169.254.199.41  metric 1003
  192.168.10.0/24 via 192.168.20.1 dev eth1
  192.168.20.0/24 dev eth1 scope link  src 192.168.20.10
  192.168.30.0/24 via 192.168.20.1 dev eth1
```

H3 ip route

```
  default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
  10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
  10.30.0.0/16 via 192.168.30.1 dev eth1
```

```
169.254.0.0/16 dev eth1 scope link  src 169.254.207.242  metric 1003
192.168.10.0/24 via 192.168.30.1 dev eth1
192.168.20.0/24 via 192.168.30.1 dev eth1
192.168.30.0/24 dev eth1 scope link  src 192.168.30.10
```

PASS Every Host Can Reach Its Default Gateway (12.3s, 3 commands)

Isolates the host-to-router leg so a failure further along is not misread as a broken LAN.

H1 ping -c 5 192.168.10.1

```
PING 192.168.10.1 (192.168.10.1) 56(84) bytes of data.
64 bytes from 192.168.10.1: icmp_seq=1 ttl=255 time=0.442 ms
64 bytes from 192.168.10.1: icmp_seq=2 ttl=255 time=0.385 ms
64 bytes from 192.168.10.1: icmp_seq=3 ttl=255 time=0.359 ms
64 bytes from 192.168.10.1: icmp_seq=4 ttl=255 time=0.436 ms
64 bytes from 192.168.10.1: icmp_seq=5 ttl=255 time=0.377 ms

--- 192.168.10.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4103ms
rtt min/avg/max/mdev = 0.359/0.399/0.442/0.033 ms
```

H2 ping -c 5 192.168.20.1

```
PING 192.168.20.1 (192.168.20.1) 56(84) bytes of data.
64 bytes from 192.168.20.1: icmp_seq=1 ttl=255 time=0.543 ms
64 bytes from 192.168.20.1: icmp_seq=2 ttl=255 time=0.411 ms
64 bytes from 192.168.20.1: icmp_seq=3 ttl=255 time=0.396 ms
64 bytes from 192.168.20.1: icmp_seq=4 ttl=255 time=0.389 ms
64 bytes from 192.168.20.1: icmp_seq=5 ttl=255 time=0.375 ms

--- 192.168.20.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4103ms
rtt min/avg/max/mdev = 0.375/0.422/0.543/0.061 ms
```

H3 ping -c 5 192.168.30.1

```
PING 192.168.30.1 (192.168.30.1) 56(84) bytes of data.
64 bytes from 192.168.30.1: icmp_seq=1 ttl=255 time=0.393 ms
64 bytes from 192.168.30.1: icmp_seq=2 ttl=255 time=0.446 ms
64 bytes from 192.168.30.1: icmp_seq=3 ttl=255 time=0.381 ms
64 bytes from 192.168.30.1: icmp_seq=4 ttl=255 time=0.333 ms
64 bytes from 192.168.30.1: icmp_seq=5 ttl=255 time=0.325 ms

--- 192.168.30.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4100ms
rtt min/avg/max/mdev = 0.325/0.375/0.446/0.043 ms
```

PASS Every Host Can Reach Every Other Host (24.1s, 6 commands)

The full mesh, including h2 <-> h3 which never touches a direct link and can only work if the hub re-advertises between spokes.

H2 ping -c 5 192.168.20.10

```
PING 192.168.20.10 (192.168.20.10) 56(84) bytes of data.
64 bytes from 192.168.20.10: icmp_seq=1 ttl=62 time=1.09 ms
64 bytes from 192.168.20.10: icmp_seq=2 ttl=62 time=1.21 ms
64 bytes from 192.168.20.10: icmp_seq=3 ttl=62 time=1.15 ms
64 bytes from 192.168.20.10: icmp_seq=4 ttl=62 time=1.16 ms
64 bytes from 192.168.20.10: icmp_seq=5 ttl=62 time=1.22 ms

--- 192.168.20.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4006ms
rtt min/avg/max/mdev = 1.094/1.165/1.221/0.045 ms
```

H3 ping -c 5 192.168.30.10

```
PING 192.168.30.10 (192.168.30.10) 56(84) bytes of data.
64 bytes from 192.168.30.10: icmp_seq=1 ttl=62 time=1.18 ms
64 bytes from 192.168.30.10: icmp_seq=2 ttl=62 time=1.24 ms
64 bytes from 192.168.30.10: icmp_seq=3 ttl=62 time=1.19 ms
64 bytes from 192.168.30.10: icmp_seq=4 ttl=62 time=1.26 ms
64 bytes from 192.168.30.10: icmp_seq=5 ttl=62 time=1.35 ms

--- 192.168.30.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4006ms
rtt min/avg/max/mdev = 1.179/1.242/1.346/0.059 ms
```

H1 ping -c 5 192.168.10.10

```
PING 192.168.10.10 (192.168.10.10) 56(84) bytes of data.
64 bytes from 192.168.10.10: icmp_seq=1 ttl=62 time=1.32 ms
64 bytes from 192.168.10.10: icmp_seq=2 ttl=62 time=1.05 ms
64 bytes from 192.168.10.10: icmp_seq=3 ttl=62 time=1.25 ms
64 bytes from 192.168.10.10: icmp_seq=4 ttl=62 time=1.18 ms
```

```
  64 bytes from 192.168.10.10: icmp_seq=5 ttl=62 time=1.18 ms

  --- 192.168.10.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4005ms
  rtt min/avg/max/mdev = 1.053/1.195/1.318/0.088 ms
```

H3 ping -c 5 192.168.30.10

```
  PING 192.168.30.10 (192.168.30.10) 56(84) bytes of data.
  64 bytes from 192.168.30.10: icmp_seq=1 ttl=62 time=1.15 ms
  64 bytes from 192.168.30.10: icmp_seq=2 ttl=62 time=1.15 ms
  64 bytes from 192.168.30.10: icmp_seq=3 ttl=62 time=1.13 ms
  64 bytes from 192.168.30.10: icmp_seq=4 ttl=62 time=1.20 ms
  64 bytes from 192.168.30.10: icmp_seq=5 ttl=62 time=1.09 ms

  --- 192.168.30.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4005ms
  rtt min/avg/max/mdev = 1.089/1.143/1.198/0.035 ms
```

H1 ping -c 5 192.168.10.10

```
  PING 192.168.10.10 (192.168.10.10) 56(84) bytes of data.
  64 bytes from 192.168.10.10: icmp_seq=1 ttl=62 time=1.27 ms
  64 bytes from 192.168.10.10: icmp_seq=2 ttl=62 time=1.45 ms
  64 bytes from 192.168.10.10: icmp_seq=3 ttl=62 time=1.23 ms
  64 bytes from 192.168.10.10: icmp_seq=4 ttl=62 time=1.12 ms
  64 bytes from 192.168.10.10: icmp_seq=5 ttl=62 time=1.13 ms

  --- 192.168.10.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.121/1.239/1.445/0.117 ms
```

H2 ping -c 5 192.168.20.10

```
  PING 192.168.20.10 (192.168.20.10) 56(84) bytes of data.
  64 bytes from 192.168.20.10: icmp_seq=1 ttl=62 time=1.24 ms
  64 bytes from 192.168.20.10: icmp_seq=2 ttl=62 time=1.30 ms
  64 bytes from 192.168.20.10: icmp_seq=3 ttl=62 time=1.15 ms
  64 bytes from 192.168.20.10: icmp_seq=4 ttl=62 time=1.11 ms
  64 bytes from 192.168.20.10: icmp_seq=5 ttl=62 time=1.20 ms

  --- 192.168.20.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.111/1.201/1.296/0.065 ms
```

PASS Spoke To Spoke Traffic Is Routed Through The Hub (0.1s, 3 commands)

R2 must reach R3's LAN via the hub's tunnel address, not by any direct path -- there is no spoke-to-spoke link.

R2 show ip route 192.168.30.0

```
  Routing entry for 192.168.30.0/24
    Known via "bgp 65002", distance 20, metric 0
    Tag 65001, type external
    Last update from 172.20.0.3 00:01:29 ago
    Routing Descriptor Blocks:
    * 172.20.0.3, from 172.20.0.1, 00:01:29 ago
        opaque_ptr 0x7E32CED11C60
        Route metric is 0, traffic share count is 1
        AS Hops 2
        Route tag 65001
        MPLS label: none
```

R2 show ip cef 192.168.30.10

```
  192.168.30.0/24
    nexthop 172.20.0.3 Tunnel0
```

R3 show ip cef 192.168.20.10

```
  192.168.20.0/24
    nexthop 172.20.0.2 Tunnel0
```

PASS Hub Reaches Both Spoke LANs On Separate Tunnels (0.0s, 2 commands)

R1 show ip cef 192.168.20.10

```
  192.168.20.0/24
    nexthop 172.20.0.2 Tunnel0
```

R1 show ip cef 192.168.30.10

```
  192.168.30.0/24
    nexthop 172.20.0.3 Tunnel0
```

PASS Host Traffic Is Encrypted In Transit (19.6s, 5 commands)

No host runs crypto: the routers encrypt for them, so the ESP counters must move by the traffic the hosts generated.

```
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 2544, #pkts encrypt: 2544, #pkts digest: 2544
      #pkts decaps: 2546, #pkts decrypt: 2546, #pkts verify: 2546
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
R2 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
     current_peer 100.64.0.3 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 260, #pkts encrypt: 260, #pkts digest: 260
      #pkts decaps: 264, #pkts decrypt: 264, #pkts verify: 264
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
H1 ping -c 20 192.168.20.10
  PING 192.168.20.10 (192.168.20.10) 56(84) bytes of data.
  64 bytes from 192.168.20.10: icmp_seq=1 ttl=62 time=1.70 ms
  64 bytes from 192.168.20.10: icmp_seq=2 ttl=62 time=1.24 ms
  64 bytes from 192.168.20.10: icmp_seq=3 ttl=62 time=1.24 ms
  64 bytes from 192.168.20.10: icmp_seq=4 ttl=62 time=1.24 ms
  64 bytes from 192.168.20.10: icmp_seq=5 ttl=62 time=1.28 ms
  64 bytes from 192.168.20.10: icmp_seq=6 ttl=62 time=1.14 ms
  64 bytes from 192.168.20.10: icmp_seq=7 ttl=62 time=1.22 ms
  64 bytes from 192.168.20.10: icmp_seq=8 ttl=62 time=1.25 ms
  64 bytes from 192.168.20.10: icmp_seq=9 ttl=62 time=1.11 ms
  64 bytes from 192.168.20.10: icmp_seq=10 ttl=62 time=1.05 ms
  64 bytes from 192.168.20.10: icmp_seq=11 ttl=62 time=1.14 ms
  64 bytes from 192.168.20.10: icmp_seq=12 ttl=62 time=1.28 ms
  64 bytes from 192.168.20.10: icmp_seq=13 ttl=62 time=1.21 ms
  ... 11 more lines
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 2673, #pkts encrypt: 2673, #pkts digest: 2673
      #pkts decaps: 2683, #pkts decrypt: 2683, #pkts verify: 2683
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
R2 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
     current_peer 100.64.0.3 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 369, #pkts encrypt: 369, #pkts digest: 369
      #pkts decaps: 373, #pkts decrypt: 373, #pkts verify: 373
```

```
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

PASS Host Addresses Never Appear In Cleartext On The Spoke Link (11.7s, 9 commands)

Capture the R1<->R2 link while the hosts talk: only ESP between the link addresses should be visible.

```
R1 no monitor capture HOSTCAP
  Capture does not exist
R1 monitor capture HOSTCAP interface GigabitEthernet2 both
  ${output} =
R1 monitor capture HOSTCAP match ipv4 any any
  ${output} =
R1 monitor capture HOSTCAP buffer size 5
  ${output} =
R1 monitor capture HOSTCAP start
  Started capture point : HOSTCAP
H1 ping -c 10 192.168.20.10
  PING 192.168.20.10 (192.168.20.10) 56(84) bytes of data.
  64 bytes from 192.168.20.10: icmp_seq=1 ttl=62 time=2.04 ms
  64 bytes from 192.168.20.10: icmp_seq=2 ttl=62 time=1.15 ms
  64 bytes from 192.168.20.10: icmp_seq=3 ttl=62 time=1.28 ms
  64 bytes from 192.168.20.10: icmp_seq=4 ttl=62 time=1.12 ms
  64 bytes from 192.168.20.10: icmp_seq=5 ttl=62 time=1.24 ms
  64 bytes from 192.168.20.10: icmp_seq=6 ttl=62 time=1.24 ms
  64 bytes from 192.168.20.10: icmp_seq=7 ttl=62 time=1.18 ms
  64 bytes from 192.168.20.10: icmp_seq=8 ttl=62 time=1.44 ms
  64 bytes from 192.168.20.10: icmp_seq=9 ttl=62 time=1.14 ms
  64 bytes from 192.168.20.10: icmp_seq=10 ttl=62 time=1.06 ms

  --- 192.168.20.10 ping statistics ---
  10 packets transmitted, 10 received, 0% packet loss, time 9012ms
  ... 1 more lines
R1 monitor capture HOSTCAP stop
  Stopped capture point : HOSTCAP
R1 show monitor capture HOSTCAP buffer brief
  ----------------------------------------------------------------------------
   #   size   timestamp     source             destination      dscp    protocol
   ----------------------------------------------------------------------------
     0  138    0.000000   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     1  138    0.000000   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     2  170    0.002990   100.64.0.1       ->  100.64.0.2       0  BE   ESP
     3  170    0.004989   100.64.0.2       ->  100.64.0.1       0  BE   ESP
     4  138    0.037992   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     5  138    0.077983   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     6  138    0.077983   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
     7  138    0.086986   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     8  138    0.086986   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     9  138    0.199986   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
    10  138    0.199986   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
  ... 230 more lines
R1 no monitor capture HOSTCAP
  ${output} =
```

PASS Spoke To Spoke Traffic Is Encrypted On The Direct Path (11.5s, 11 commands)

The VTI lab this mirrors captured the hub's second link, because h2 to h3 crossed two tunnels and was decrypted and re-encrypted in between. Under DMVPN there is no second leg to capture: once the shortcut forms the hub is not on the path at all, so the capture moves to the spoke's own WAN interface -- the only place that traffic now appears. It should be ESP there, with neither host address visible.

```
R2 ping 10.20.3.1 source Loopback1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R2 show ip nhrp 172.20.0.3
```

```
172.20.0.3/32 via 172.20.0.3
   Tunnel0 created 00:01:15, expire 00:03:44
   Type: dynamic, Flags: router nhop bfd
   NBMA address: 100.64.0.3
```

R2 no monitor capture HOSTCAP

```
Capture does not exist
```

R2 monitor capture HOSTCAP interface GigabitEthernet2 both

```
${output} =
```

R2 monitor capture HOSTCAP match ipv4 any any

```
${output} =
```

R2 monitor capture HOSTCAP buffer size 5

```
${output} =
```

R2 monitor capture HOSTCAP start

```
Started capture point : HOSTCAP
```

H2 ping -c 10 192.168.30.10

```
PING 192.168.30.10 (192.168.30.10) 56(84) bytes of data.
64 bytes from 192.168.30.10: icmp_seq=1 ttl=62 time=1.24 ms
64 bytes from 192.168.30.10: icmp_seq=2 ttl=62 time=1.19 ms
64 bytes from 192.168.30.10: icmp_seq=3 ttl=62 time=1.19 ms
64 bytes from 192.168.30.10: icmp_seq=4 ttl=62 time=1.27 ms
64 bytes from 192.168.30.10: icmp_seq=5 ttl=62 time=1.25 ms
64 bytes from 192.168.30.10: icmp_seq=6 ttl=62 time=1.23 ms
64 bytes from 192.168.30.10: icmp_seq=7 ttl=62 time=1.25 ms
64 bytes from 192.168.30.10: icmp_seq=8 ttl=62 time=1.27 ms
64 bytes from 192.168.30.10: icmp_seq=9 ttl=62 time=1.18 ms
64 bytes from 192.168.30.10: icmp_seq=10 ttl=62 time=1.32 ms

--- 192.168.30.10 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9013ms
... 1 more lines
```

R2 monitor capture HOSTCAP stop

```
Stopped capture point : HOSTCAP
```

R2 show monitor capture HOSTCAP buffer brief

```
-----------------------------------------------------------------------------
 #   size   timestamp     source             destination      dscp    protocol
 -----------------------------------------------------------------------------
   0  170    0.000000   100.64.0.2       ->  100.64.0.3       0  BE   ESP
   1  170    0.001007   100.64.0.3       ->  100.64.0.2       0  BE   ESP
   2  138    0.057996   100.64.0.3       ->  100.64.0.2       48 CS6  ESP
   3  138    0.057996   100.64.0.2       ->  100.64.0.3       48 CS6  ESP
   4  138    0.189993   100.64.0.2       ->  100.64.0.3       48 CS6  ESP
   5  138    0.244982   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
   6  138    0.244982   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
   7  138    0.269990   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
   8  138    0.270982   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
   9  138    0.312987   100.64.0.2       ->  100.64.0.3       48 CS6  ESP
  10  138    0.312987   100.64.0.3       ->  100.64.0.2       48 CS6  ESP
... 215 more lines
```

R2 no monitor capture HOSTCAP

```
${output} =
```

PASS The Hub Is Not On The Spoke To Spoke Path (0.0s, 2 commands)

The routing consequence of the shortcut, from the hosts' point of view rather than the routers'.

R2 show ip nhrp 172.20.0.3

```
172.20.0.3/32 via 172.20.0.3
   Tunnel0 created 00:01:26, expire 00:03:33
   Type: dynamic, Flags: router nhop bfd
   NBMA address: 100.64.0.3
```

H2 traceroute -n -q 1 -w 1 192.168.30.10

```
traceroute to 192.168.30.10 (192.168.30.10), 30 hops max, 60 byte packets
 1  192.168.20.1  1.112 ms
 2  172.20.0.3  1.089 ms
 3  192.168.30.10  2.095 ms
```

11 Throughput

PASS Hub To Spoke Hosts Sustain The Target Throughput (32.0s, 2 commands)

h1 -> h2 crosses one tunnel.

```
H1 nc -l -p 5001 > /dev/null 2>&1 &
  ${output} =
H1 S=$(date +%s); dd if=/dev/zero bs=64k count=1024 2>/dev/null | nc -w 1 192.168.20.10 5001; echo SECS=$(( $(date +%s) - S ))
  SECS=31
```

PASS Spoke To Spoke Hosts Sustain The Target Throughput (31.9s, 2 commands)

h2 -> h3 crosses two tunnels, being decrypted and re-encrypted at the hub, so it is the more demanding path.

```
H2 nc -l -p 5001 > /dev/null 2>&1 &
  ${output} =
H2 S=$(date +%s); dd if=/dev/zero bs=64k count=1024 2>/dev/null | nc -w 1 192.168.30.10 5001; echo SECS=$(( $(date +%s) - S ))
  SECS=31
```

PASS Bulk Throughput Traffic Is Encrypted (17.5s, 6 commands)

Rate alone says nothing about protection. A transfer of this size must move thousands of packets through ESP, so assert the counters rose in proportion to the bytes actually sent.

```
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 53004, #pkts encrypt: 53004, #pkts digest: 53004
      #pkts decaps: 28767, #pkts decrypt: 28767, #pkts verify: 28767
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
R2 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
     current_peer 100.64.0.3 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 50699, #pkts encrypt: 50699, #pkts digest: 50699
      #pkts decaps: 26301, #pkts decrypt: 26301, #pkts verify: 26301
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
H1 nc -l -p 5001 > /dev/null 2>&1 &
  [1]+  Stopped (tty input)        nc -l -p 5001 1>/dev/null 2>&1
H1 S=$(date +%s); dd if=/dev/zero bs=64k count=512 2>/dev/null | nc -w 1 192.168.20.10 5001; echo SECS=$(( $(date +%s) - S ))
  SECS=15
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
```

```
    current_peer 100.64.0.2 port 500
      PERMIT, flags={origin_is_acl,}
     #pkts encaps: 78000, #pkts encrypt: 78000, #pkts digest: 78000
     #pkts decaps: 41206, #pkts decrypt: 41206, #pkts verify: 41206
     #pkts compressed: 0, #pkts decompressed: 0
     #pkts not compressed: 0, #pkts compr. failed: 0
     #pkts not decompressed: 0, #pkts decompress failed: 0
     #send errors 0, #recv errors 0
 ... 78 more lines
```

R1 show crypto ipsec sa

```
 interface: Tunnel0
     Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

    protected vrf: (none)
    local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
    remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
    current_peer 100.64.0.3 port 500
      PERMIT, flags={origin_is_acl,}
     #pkts encaps: 50797, #pkts encrypt: 50797, #pkts digest: 50797
     #pkts decaps: 26398, #pkts decrypt: 26398, #pkts verify: 26398
     #pkts compressed: 0, #pkts decompressed: 0
     #pkts not compressed: 0, #pkts compr. failed: 0
     #pkts not decompressed: 0, #pkts decompress failed: 0
     #send errors 0, #recv errors 0
 ... 78 more lines
```

12 Nat

PASS Every Router Has A Static Source NAT Mapping For Its Host (0.3s, 3 commands)

H1 show running-config | include ip nat inside source

```
ip nat inside source static 192.168.10.10 10.30.1.10 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.11 10.30.1.11 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.12 10.30.1.12 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.13 10.30.1.13 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.14 10.30.1.14 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.15 10.30.1.15 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.16 10.30.1.16 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.17 10.30.1.17 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.18 10.30.1.18 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.19 10.30.1.19 route-map NAT-TO-DOMAIN
ip nat inside source list NAT-POOL-SRC pool SITE-POOL
```

H2 show running-config | include ip nat inside source

```
ip nat inside source static 192.168.20.10 10.30.2.10 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.11 10.30.2.11 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.12 10.30.2.12 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.13 10.30.2.13 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.14 10.30.2.14 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.15 10.30.2.15 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.16 10.30.2.16 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.17 10.30.2.17 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.18 10.30.2.18 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.19 10.30.2.19 route-map NAT-TO-DOMAIN
ip nat inside source list NAT-POOL-SRC pool SITE-POOL
```

H3 show running-config | include ip nat inside source

```
ip nat inside source static 192.168.30.10 10.30.3.10 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.11 10.30.3.11 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.12 10.30.3.12 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.13 10.30.3.13 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.14 10.30.3.14 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.15 10.30.3.15 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.16 10.30.3.16 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.17 10.30.3.17 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.18 10.30.3.18 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.19 10.30.3.19 route-map NAT-TO-DOMAIN
ip nat inside source list NAT-POOL-SRC pool SITE-POOL
```

PASS NAT Inside And Outside Interfaces Are Marked Correctly (0.3s, 7 commands)

The LAN faces inside, the tunnels face outside. Getting this backwards silently disables translation rather than erroring.

R1 show running-config interface GigabitEthernet3

```
Building configuration...

Current configuration : 145 bytes
!
interface GigabitEthernet3
 description LAN toward the local host
 ip address 192.168.10.1 255.255.255.0
 ip nat inside
 negotiation auto
end
```

R1 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 399 bytes
!
interface Tunnel0
 description DMVPN hub
 ip address 172.20.0.1 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp redirect
 ip tcp adjust-mss 1360
... 6 more lines
```

R2 show running-config interface GigabitEthernet3

```
Building configuration...
Current configuration : 145 bytes
```

```
!
interface GigabitEthernet3
 description LAN toward the local host
 ip address 192.168.20.1 255.255.255.0
 ip nat inside
 negotiation auto
end
```

R2 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 433 bytes
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.2 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
... 6 more lines
```

R3 show running-config interface GigabitEthernet3

```
Building configuration...

Current configuration : 145 bytes
!
interface GigabitEthernet3
 description LAN toward the local host
 ip address 192.168.30.1 255.255.255.0
 ip nat inside
 negotiation auto
end
```

R3 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 433 bytes
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.3 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
... 6 more lines
```

R1 show running-config interface Tunnel0

```
Building configuration...

Current configuration : 399 bytes
!
interface Tunnel0
 description DMVPN hub
 ip address 172.20.0.1 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp redirect
 ip tcp adjust-mss 1360
... 6 more lines
```

PASS Mapped Prefixes Are Advertised Across The Fabric (0.1s, 3 commands)

Return traffic can only find its way home if each site's NAT range is reachable, so the mapped prefixes ride BGP like the real ones.

R2 show ip route 10.30.1.0

```
Routing entry for 10.30.1.0/24
  Known via "bgp 65002", distance 20, metric 0
  Tag 65001, type external
  Last update from 172.20.0.1 00:03:47 ago
  Routing Descriptor Blocks:
```

```
  * 172.20.0.1, from 172.20.0.1, 00:03:47 ago
      opaque_ptr 0x7E32CED118A0
      Route metric is 0, traffic share count is 1
      AS Hops 1
      Route tag 65001
      MPLS label: none
```

R2 show ip route 10.30.3.0

```
Routing entry for 10.30.3.0/24
  Known via "bgp 65002", distance 20, metric 0
  Tag 65001, type external
  Last update from 172.20.0.3 00:03:47 ago
  Routing Descriptor Blocks:
  * 172.20.0.3, from 172.20.0.1, 00:03:47 ago
      opaque_ptr 0x7E32CED119E0
      Route metric is 0, traffic share count is 1
      AS Hops 2
      Route tag 65001
      MPLS label: none
```

R3 show ip route 10.30.1.0

```
Routing entry for 10.30.1.0/24
  Known via "bgp 65003", distance 20, metric 0
  Tag 65001, type external
  Last update from 172.20.0.1 00:03:48 ago
  Routing Descriptor Blocks:
  * 172.20.0.1, from 172.20.0.1, 00:03:48 ago
      opaque_ptr 0x75671E6ABAD8
      Route metric is 0, traffic share count is 1
      AS Hops 1
      Route tag 65001
      MPLS label: none
```

PASS Every Host Reaches Every Other Host At Its Mapped Address (24.1s, 6 commands)

H2 ping -c 5 10.30.2.10

```
PING 10.30.2.10 (10.30.2.10) 56(84) bytes of data.
64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.35 ms
64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.17 ms
64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.20 ms
64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.11 ms
64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.39 ms

--- 10.30.2.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4005ms
rtt min/avg/max/mdev = 1.110/1.244/1.394/0.107 ms
```

H3 ping -c 5 10.30.3.10

```
PING 10.30.3.10 (10.30.3.10) 56(84) bytes of data.
64 bytes from 10.30.3.10: icmp_seq=1 ttl=62 time=1.08 ms
64 bytes from 10.30.3.10: icmp_seq=2 ttl=62 time=1.21 ms
64 bytes from 10.30.3.10: icmp_seq=3 ttl=62 time=1.10 ms
64 bytes from 10.30.3.10: icmp_seq=4 ttl=62 time=1.20 ms
64 bytes from 10.30.3.10: icmp_seq=5 ttl=62 time=1.21 ms

--- 10.30.3.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4005ms
rtt min/avg/max/mdev = 1.076/1.157/1.210/0.057 ms
```

H1 ping -c 5 10.30.1.10

```
PING 10.30.1.10 (10.30.1.10) 56(84) bytes of data.
64 bytes from 10.30.1.10: icmp_seq=1 ttl=62 time=1.29 ms
64 bytes from 10.30.1.10: icmp_seq=2 ttl=62 time=1.58 ms
64 bytes from 10.30.1.10: icmp_seq=3 ttl=62 time=1.09 ms
64 bytes from 10.30.1.10: icmp_seq=4 ttl=62 time=1.10 ms
64 bytes from 10.30.1.10: icmp_seq=5 ttl=62 time=1.11 ms

--- 10.30.1.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4006ms
rtt min/avg/max/mdev = 1.091/1.233/1.579/0.187 ms
```

H3 ping -c 5 10.30.3.10

```
PING 10.30.3.10 (10.30.3.10) 56(84) bytes of data.
64 bytes from 10.30.3.10: icmp_seq=1 ttl=62 time=1.16 ms
64 bytes from 10.30.3.10: icmp_seq=2 ttl=62 time=1.27 ms
64 bytes from 10.30.3.10: icmp_seq=3 ttl=62 time=1.24 ms
64 bytes from 10.30.3.10: icmp_seq=4 ttl=62 time=1.17 ms
64 bytes from 10.30.3.10: icmp_seq=5 ttl=62 time=1.14 ms

--- 10.30.3.10 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4005ms
rtt min/avg/max/mdev = 1.135/1.194/1.265/0.049 ms
```

```
H1 ping -c 5 10.30.1.10
  PING 10.30.1.10 (10.30.1.10) 56(84) bytes of data.
  64 bytes from 10.30.1.10: icmp_seq=1 ttl=62 time=1.27 ms
  64 bytes from 10.30.1.10: icmp_seq=2 ttl=62 time=1.23 ms
  64 bytes from 10.30.1.10: icmp_seq=3 ttl=62 time=1.29 ms
  64 bytes from 10.30.1.10: icmp_seq=4 ttl=62 time=1.16 ms
  64 bytes from 10.30.1.10: icmp_seq=5 ttl=62 time=1.10 ms

  --- 10.30.1.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.097/1.209/1.287/0.071 ms
H2 ping -c 5 10.30.2.10
  PING 10.30.2.10 (10.30.2.10) 56(84) bytes of data.
  64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.35 ms
  64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.26 ms
  64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.33 ms
  64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.02 ms
  64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.21 ms

  --- 10.30.2.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.018/1.232/1.352/0.118 ms
```

PASS Translations Show The Host Rewritten To Its Mapped Address (4.2s, 2 commands)

The inside-local / inside-global pair is the direct evidence that the source address was rewritten.

```
H1 ping -c 5 10.30.2.10
  PING 10.30.2.10 (10.30.2.10) 56(84) bytes of data.
  64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.17 ms
  64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.28 ms
  64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.15 ms
  64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.19 ms
  64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.16 ms

  --- 10.30.2.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.147/1.188/1.284/0.049 ms
R1 show ip nat translations
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.1.128           192.168.10.88         ---                   ---
  ---  10.30.1.129           192.168.10.85         ---                   ---
  ---  10.30.1.113           192.168.10.93         ---                   ---
  ---  10.30.1.114           192.168.10.69         ---                   ---
  ---  10.30.1.116           192.168.10.73         ---                   ---
  ---  10.30.1.119           192.168.10.71         ---                   ---
  ---  10.30.1.123           192.168.10.78         ---                   ---
  ---  10.30.1.120           192.168.10.82         ---                   ---
  ---  10.30.1.126           192.168.10.76         ---                   ---
  ---  10.30.1.125           192.168.10.84         ---                   ---
  ---  10.30.1.101           192.168.10.90         ---                   ---
  ---  10.30.1.102           192.168.10.89         ---                   ---
  ---  10.30.1.111           192.168.10.70         ---                   ---
  ... 35 more lines
```

PASS The Far Host Sees The Mapped Source Not The Real One (4.2s, 2 commands)

On the receiving router the peer appears as the sender's mapped address, which is the whole point of source NAT.

```
H1 ping -c 5 10.30.2.10
  PING 10.30.2.10 (10.30.2.10) 56(84) bytes of data.
  64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.27 ms
  64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.11 ms
  64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.58 ms
  64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.25 ms
  64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.17 ms

  --- 10.30.2.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.112/1.276/1.583/0.163 ms
R2 show ip nat translations
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.2.128           192.168.20.89         ---                   ---
  ---  10.30.2.129           192.168.20.84         ---                   ---
  ---  10.30.2.106           192.168.20.68         ---                   ---
```

```
  ---  10.30.2.105           192.168.20.88         ---                   ---
  ---  10.30.2.111           192.168.20.92         ---                   ---
  ---  10.30.2.108           192.168.20.80         ---                   ---
  ---  10.30.2.101           192.168.20.64         ---                   ---
  ---  10.30.2.102           192.168.20.65         ---                   ---
  ---  10.30.2.126           192.168.20.77         ---                   ---
  ---  10.30.2.125           192.168.20.86         ---                   ---
  ---  10.30.2.123           192.168.20.79         ---                   ---
  ---  10.30.2.120           192.168.20.74         ---                   ---
  ---  10.30.2.116           192.168.20.82         ---                   ---
  ... 36 more lines
```

PASS Spoke To Spoke NAT Works Through The Hub (4.4s, 3 commands)

h2 -> h3 by mapped address crosses two tunnels and two translations, with no direct spoke-to-spoke path.

```
H2 ping -c 5 10.30.3.10
  PING 10.30.3.10 (10.30.3.10) 56(84) bytes of data.
  64 bytes from 10.30.3.10: icmp_seq=1 ttl=62 time=1.19 ms
  64 bytes from 10.30.3.10: icmp_seq=2 ttl=62 time=1.23 ms
  64 bytes from 10.30.3.10: icmp_seq=3 ttl=62 time=1.24 ms
  64 bytes from 10.30.3.10: icmp_seq=4 ttl=62 time=1.21 ms
  64 bytes from 10.30.3.10: icmp_seq=5 ttl=62 time=1.18 ms

  --- 10.30.3.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.179/1.208/1.241/0.023 ms
R2 show ip nat translations
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.2.128           192.168.20.89         ---                   ---
  ---  10.30.2.129           192.168.20.84         ---                   ---
  ---  10.30.2.106           192.168.20.68         ---                   ---
  ---  10.30.2.105           192.168.20.88         ---                   ---
  ---  10.30.2.111           192.168.20.92         ---                   ---
  ---  10.30.2.108           192.168.20.80         ---                   ---
  ---  10.30.2.101           192.168.20.64         ---                   ---
  ---  10.30.2.102           192.168.20.65         ---                   ---
  ---  10.30.2.126           192.168.20.77         ---                   ---
  ---  10.30.2.125           192.168.20.86         ---                   ---
  ---  10.30.2.123           192.168.20.79         ---                   ---
  ---  10.30.2.120           192.168.20.74         ---                   ---
  ---  10.30.2.116           192.168.20.82         ---                   ---
  ... 37 more lines
R3 show ip nat translations
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.3.104           192.168.30.84         ---                   ---
  ---  10.30.3.107           192.168.30.93         ---                   ---
  ---  10.30.3.109           192.168.30.92         ---                   ---
  ---  10.30.3.110           192.168.30.89         ---                   ---
  ---  10.30.3.103           192.168.30.85         ---                   ---
  ---  10.30.3.100           192.168.30.83         ---                   ---
  ---  10.30.3.124           192.168.30.90         ---                   ---
  ---  10.30.3.127           192.168.30.81         ---                   ---
  ---  10.30.3.121           192.168.30.80         ---                   ---
  ---  10.30.3.122           192.168.30.77         ---                   ---
  ---  10.30.3.118           192.168.30.86         ---                   ---
  ---  10.30.3.117           192.168.30.75         ---                   ---
  ---  10.30.3.115           192.168.30.82         ---                   ---
  ... 38 more lines
```

PASS NATted Traffic Is Still Encrypted (19.6s, 5 commands)

Translation happens before encryption, so NATted traffic must still raise the ESP counters.

```
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 78330, #pkts encrypt: 78330, #pkts digest: 78330
      #pkts decaps: 41533, #pkts decrypt: 41533, #pkts verify: 41533
      #pkts compressed: 0, #pkts decompressed: 0
```

```
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R2 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
   current_peer 100.64.0.3 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 51108, #pkts encrypt: 51108, #pkts digest: 51108
    #pkts decaps: 26710, #pkts decrypt: 26710, #pkts verify: 26710
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

H1 ping -c 20 10.30.2.10

```
PING 10.30.2.10 (10.30.2.10) 56(84) bytes of data.
64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.29 ms
64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.08 ms
64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.23 ms
64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.22 ms
64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.36 ms
64 bytes from 10.30.2.10: icmp_seq=6 ttl=62 time=1.26 ms
64 bytes from 10.30.2.10: icmp_seq=7 ttl=62 time=1.24 ms
64 bytes from 10.30.2.10: icmp_seq=8 ttl=62 time=1.15 ms
64 bytes from 10.30.2.10: icmp_seq=9 ttl=62 time=1.07 ms
64 bytes from 10.30.2.10: icmp_seq=10 ttl=62 time=1.22 ms
64 bytes from 10.30.2.10: icmp_seq=11 ttl=62 time=1.10 ms
64 bytes from 10.30.2.10: icmp_seq=12 ttl=62 time=1.28 ms
64 bytes from 10.30.2.10: icmp_seq=13 ttl=62 time=1.13 ms
... 11 more lines
```

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 78460, #pkts encrypt: 78460, #pkts digest: 78460
    #pkts decaps: 41665, #pkts decrypt: 41665, #pkts verify: 41665
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R2 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
   current_peer 100.64.0.3 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 51217, #pkts encrypt: 51217, #pkts digest: 51217
    #pkts decaps: 26818, #pkts decrypt: 26818, #pkts verify: 26818
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

PASS Mapped Addresses Never Appear In Cleartext On The WAN (14.0s, 18 commands)

R1 no monitor capture NATCAP

```
Capture does not exist
```

R1 monitor capture NATCAP interface GigabitEthernet2 both

```
${output} =
```

R1 monitor capture NATCAP match ipv4 any any

```
  ${output} =
R1 monitor capture NATCAP buffer size 5
  ${output} =
R1 monitor capture NATCAP start
  Started capture point : NATCAP
R1 ping 100.64.0.2 repeat 2
  Type escape sequence to abort.
  Sending 2, 100-byte ICMP Echos to 100.64.0.2, timeout is 2 seconds:
  !!
  Success rate is 100 percent (2/2), round-trip min/avg/max = 1/1/2 ms
R1 monitor capture NATCAP stop
  Stopped capture point : NATCAP
R1 show monitor capture NATCAP buffer brief
  ----------------------------------------------------------------------------
   #   size   timestamp     source             destination      dscp    protocol
   ----------------------------------------------------------------------------
     0  114    0.000000   100.64.0.1       ->  100.64.0.2       0  BE   ICMP
     1  114    0.000000   100.64.0.2       ->  100.64.0.1       0  BE   ICMP
     2  114    0.001007   100.64.0.1       ->  100.64.0.2       0  BE   ICMP
     3  114    0.001998   100.64.0.2       ->  100.64.0.1       0  BE   ICMP
     4  138    0.049008   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
     5  138    0.050000   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     6  138    0.133995   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     7  138    0.135002   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     8  138    0.161994   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     9  138    0.161994   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
    10  138    0.387040   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
  ... 39 more lines
R1 no monitor capture NATCAP
  ${output} =
R1 no monitor capture NATCAP
  Capture does not exist
R1 monitor capture NATCAP interface GigabitEthernet2 both
  ${output} =
R1 monitor capture NATCAP match ipv4 any any
  ${output} =
R1 monitor capture NATCAP buffer size 5
  ${output} =
R1 monitor capture NATCAP start
  Started capture point : NATCAP
H1 ping -c 10 10.30.2.10
  PING 10.30.2.10 (10.30.2.10) 56(84) bytes of data.
  64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.20 ms
  64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.19 ms
  64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.15 ms
  64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.21 ms
  64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.19 ms
  64 bytes from 10.30.2.10: icmp_seq=6 ttl=62 time=1.65 ms
  64 bytes from 10.30.2.10: icmp_seq=7 ttl=62 time=1.23 ms
  64 bytes from 10.30.2.10: icmp_seq=8 ttl=62 time=1.12 ms
  64 bytes from 10.30.2.10: icmp_seq=9 ttl=62 time=1.34 ms
  64 bytes from 10.30.2.10: icmp_seq=10 ttl=62 time=1.25 ms

  --- 10.30.2.10 ping statistics ---
  10 packets transmitted, 10 received, 0% packet loss, time 9013ms
  ... 1 more lines
R1 monitor capture NATCAP stop
  Stopped capture point : NATCAP
R1 show monitor capture NATCAP buffer brief
  ----------------------------------------------------------------------------
   #   size   timestamp     source             destination      dscp    protocol
   ----------------------------------------------------------------------------
     0  170    0.000000   100.64.0.1       ->  100.64.0.2       0  BE   ESP
     1  170    0.000992   100.64.0.2       ->  100.64.0.1       0  BE   ESP
     2  138    0.005997   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     3  138    0.005997   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
     4  138    0.035994   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     5  138    0.035994   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     6  138    0.130990   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
     7  138    0.148995   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
     8  138    0.248980   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
     9  138    0.248980   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
    10  138    0.403971   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
  ... 226 more lines
```

```
R1 no monitor capture NATCAP
  ${output} =
```

PASS The Untranslated LAN Path Still Works (8.0s, 2 commands)

Guards the route-map scoping. If translation ever widened to all traffic, replies on this path would arrive from a mapped address the sender never contacted, and this would fail.

```
H1 ping -c 5 192.168.20.10
  PING 192.168.20.10 (192.168.20.10) 56(84) bytes of data.
  64 bytes from 192.168.20.10: icmp_seq=1 ttl=62 time=1.19 ms
  64 bytes from 192.168.20.10: icmp_seq=2 ttl=62 time=1.34 ms
  64 bytes from 192.168.20.10: icmp_seq=3 ttl=62 time=1.34 ms
  64 bytes from 192.168.20.10: icmp_seq=4 ttl=62 time=1.10 ms
  64 bytes from 192.168.20.10: icmp_seq=5 ttl=62 time=1.09 ms

  --- 192.168.20.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.093/1.210/1.337/0.107 ms
H2 ping -c 5 192.168.30.10
  PING 192.168.30.10 (192.168.30.10) 56(84) bytes of data.
  64 bytes from 192.168.30.10: icmp_seq=1 ttl=62 time=1.20 ms
  64 bytes from 192.168.30.10: icmp_seq=2 ttl=62 time=1.19 ms
  64 bytes from 192.168.30.10: icmp_seq=3 ttl=62 time=1.18 ms
  64 bytes from 192.168.30.10: icmp_seq=4 ttl=62 time=1.28 ms
  64 bytes from 192.168.30.10: icmp_seq=5 ttl=62 time=1.22 ms

  --- 192.168.30.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4005ms
  rtt min/avg/max/mdev = 1.180/1.213/1.275/0.033 ms
```

13 Nat Pool

PASS Every Host Carries Its Full Block Of Addresses (0.1s, 6 commands)

10 statically mapped plus 30 pool-eligible, on one interface.

H1 ip addr show eth1

```
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:01:02 brd ff:ff:ff:ff:ff:ff
    inet 192.168.10.10/24 scope global eth1
       valid_lft forever preferred_lft forever
    inet 169.254.229.55/16 brd 169.254.255.255 scope global noprefixroute eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.11/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.12/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.13/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.14/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
... 70 more lines
```

H1 ip addr show eth1 | grep -c 'inet 192.168.10.'

```
40
```

H2 ip addr show eth1

```
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:02:02 brd ff:ff:ff:ff:ff:ff
    inet 192.168.20.10/24 scope global eth1
       valid_lft forever preferred_lft forever
    inet 169.254.199.41/16 brd 169.254.255.255 scope global noprefixroute eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.11/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.12/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.13/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.14/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
... 70 more lines
```

H2 ip addr show eth1 | grep -c 'inet 192.168.20.'

```
40
```

H3 ip addr show eth1

```
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:03:02 brd ff:ff:ff:ff:ff:ff
    inet 192.168.30.10/24 scope global eth1
       valid_lft forever preferred_lft forever
    inet 169.254.207.242/16 brd 169.254.255.255 scope global noprefixroute eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.11/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.12/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.13/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.14/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
... 70 more lines
```

H3 ip addr show eth1 | grep -c 'inet 192.168.30.'

```
40
```

PASS Every Router Configures Ten Static Mappings And A Thirty Address Pool (0.4s, 6 commands)

H1 show running-config | count ^ip nat inside source static

```
Number of lines which match regexp = 10
```

H1 show ip nat statistics

```
Total active translations: 10 (10 static, 0 dynamic; 0 extended)
Outside interfaces:
  Tunnel0
Inside interfaces:
  GigabitEthernet3
Hits: 0  Misses: 0
```

```
  Reserved port setting disabled provisioned no
  Dynamic overload mapping configured: 0
 Expired translations: 0
 Dynamic mappings:
 -- Inside Source
 [Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 0
  pool SITE-POOL: id 1, netmask 255.255.255.0
         start 10.30.1.100 end 10.30.1.129
 ... 9 more lines
```

H2 show running-config | count ^ip nat inside source static

```
 Number of lines which match regexp = 10
```

H2 show ip nat statistics

```
 Total active translations: 10 (10 static, 0 dynamic; 0 extended)
 Outside interfaces:
   Tunnel0
 Inside interfaces:
   GigabitEthernet3
 Hits: 0  Misses: 0
  Reserved port setting disabled provisioned no
  Dynamic overload mapping configured: 0
 Expired translations: 0
 Dynamic mappings:
 -- Inside Source
 [Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 0
  pool SITE-POOL: id 1, netmask 255.255.255.0
         start 10.30.2.100 end 10.30.2.129
 ... 9 more lines
```

H3 show running-config | count ^ip nat inside source static

```
 Number of lines which match regexp = 10
```

H3 show ip nat statistics

```
 Total active translations: 10 (10 static, 0 dynamic; 0 extended)
 Outside interfaces:
   Tunnel0
 Inside interfaces:
   GigabitEthernet3
 Hits: 0  Misses: 0
  Reserved port setting disabled provisioned no
  Dynamic overload mapping configured: 0
 Expired translations: 0
 Dynamic mappings:
 -- Inside Source
 [Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 0
  pool SITE-POOL: id 1, netmask 255.255.255.0
         start 10.30.3.100 end 10.30.3.129
 ... 9 more lines
```

PASS The Pool Access List Is One Range And Excludes The Static Block (0.1s, 3 commands)

A single /27 range rather than thirty host entries, and it must not overlap the statically mapped addresses -- otherwise which rule wins depends on evaluation order.

H1 show ip access-lists NAT-POOL-SRC

```
 Extended IP access list NAT-POOL-SRC
     10 permit ip 192.168.10.64 0.0.0.31 10.30.0.0 0.0.255.255
```

H2 show ip access-lists NAT-POOL-SRC

```
 Extended IP access list NAT-POOL-SRC
     10 permit ip 192.168.20.64 0.0.0.31 10.30.0.0 0.0.255.255
```

H3 show ip access-lists NAT-POOL-SRC

```
 Extended IP access list NAT-POOL-SRC
     10 permit ip 192.168.30.64 0.0.0.31 10.30.0.0 0.0.255.255
```

PASS All Ten Static Addresses Translate To Their Own Fixed Mapping (9.5s, 2 commands)

Static NAT is one-to-one and deterministic: inside .10-.19 must appear outside as .10-.19, each to its own.

H1 for i in $(seq 10 19) $(seq 64 93); do ping -c 2 -W 2 -I 192.168.10.$i 10.30.2.10 >/dev/null 2>&1 & done; wait; echo SENT

```
 SENT
 [40]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
 [39]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
 [38]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
 [37]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
 [36]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
```

```
[35]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
[34]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
[33]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
[32]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
[31]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
[30]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
[29]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
[28]+  Done                    ping -c 2 -W 2 -I 192.168.10.${i} 10.30.2.10 1>/dev/null 2>&1
... 27 more lines
```

R1 show ip nat translations

```
Pro  Inside global         Inside local          Outside local         Outside global
---  10.30.1.128           192.168.10.89         ---                   ---
---  10.30.1.129           192.168.10.82         ---                   ---
---  10.30.1.113           192.168.10.77         ---                   ---
---  10.30.1.114           192.168.10.66         ---                   ---
---  10.30.1.116           192.168.10.69         ---                   ---
---  10.30.1.119           192.168.10.86         ---                   ---
---  10.30.1.123           192.168.10.93         ---                   ---
---  10.30.1.120           192.168.10.76         ---                   ---
---  10.30.1.126           192.168.10.71         ---                   ---
---  10.30.1.125           192.168.10.72         ---                   ---
---  10.30.1.101           192.168.10.84         ---                   ---
---  10.30.1.102           192.168.10.83         ---                   ---
---  10.30.1.111           192.168.10.67         ---                   ---
... 68 more lines
```

PASS All Thirty Pool Addresses Translate Into The Pool And Are Distinct (0.5s, 1 commands)

Without overload each client takes its own pool address, so 30 clients must yield 30 different outside addresses.

R1 show ip nat translations

```
Pro  Inside global         Inside local          Outside local         Outside global
---  10.30.1.128           192.168.10.89         ---                   ---
---  10.30.1.129           192.168.10.82         ---                   ---
---  10.30.1.113           192.168.10.77         ---                   ---
---  10.30.1.114           192.168.10.66         ---                   ---
---  10.30.1.116           192.168.10.69         ---                   ---
---  10.30.1.119           192.168.10.86         ---                   ---
---  10.30.1.123           192.168.10.93         ---                   ---
---  10.30.1.120           192.168.10.76         ---                   ---
---  10.30.1.126           192.168.10.71         ---                   ---
---  10.30.1.125           192.168.10.72         ---                   ---
---  10.30.1.101           192.168.10.84         ---                   ---
---  10.30.1.102           192.168.10.83         ---                   ---
---  10.30.1.111           192.168.10.67         ---                   ---
... 68 more lines
```

PASS The Pool Is Exactly Consumed With No Misses (0.0s, 1 commands)

30 clients against a 30 address pool: full allocation and no misses is the evidence that none of them shared or failed.

R1 show ip nat statistics

```
Total active translations: 80 (10 static, 70 dynamic; 40 extended)
Outside interfaces:
  Tunnel0
Inside interfaces:
  GigabitEthernet3
Hits: 120  Misses: 40
 Reserved port setting disabled provisioned no
 Dynamic overload mapping configured: 0
Expired translations: 0
Dynamic mappings:
-- Inside Source
[Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 60
 pool SITE-POOL: id 1, netmask 255.255.255.0
        start 10.30.1.100 end 10.30.1.129
... 9 more lines
```

PASS A Thirty-first Client Gets No Translation Once The Pool Is Exhausted (7.3s, 8 commands)

The boundary the pool sizing never otherwise reaches. The pool holds exactly as many addresses as there are clients, which means the exhaustion path is never exercised by a normal run -- and an off-by-one in pool bounds would look identical to a correct configuration. So bring up one more client inside the pool ACL and require the router to refuse it: no translation, no borrowing of another client's address, and the miss counted. Without "overload" there is nothing to share, so silently reusing an address would be a correctness bug, not graceful degradation. Run against R1/H1, because it is R1's pool that the tests above fill: the suite drives traffic from H1 first and only reaches the other routers later. Asserting exhaustion on a router whose pool is still empty would test nothing.

```
R1 show ip nat statistics | include allocated
  type generic, total addresses 30, allocated 30 (100%), misses 0
R1 show ip nat statistics
  Total active translations: 80 (10 static, 70 dynamic; 40 extended)
  Outside interfaces:
    Tunnel0
  Inside interfaces:
    GigabitEthernet3
  Hits: 120  Misses: 40
   Reserved port setting disabled provisioned no
   Dynamic overload mapping configured: 0
  Expired translations: 0
  Dynamic mappings:
  -- Inside Source
  [Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 60
   pool SITE-POOL: id 1, netmask 255.255.255.0
          start 10.30.1.100 end 10.30.1.129
  ... 9 more lines
H1 sudo ip addr add 192.168.10.94/24 dev eth1
  ${output} =
H1 ping -c 3 -W 2 -I 192.168.10.94 10.30.2.10
  PING 10.30.2.10 (10.30.2.10) from 192.168.10.94 : 56(84) bytes of data.
  From 192.168.10.1 icmp_seq=1 Destination Host Unreachable
  From 192.168.10.1 icmp_seq=2 Destination Host Unreachable
  From 192.168.10.1 icmp_seq=3 Destination Host Unreachable

  --- 10.30.2.10 ping statistics ---
  3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2049ms
R1 show ip nat translations | include 192.168.10.94
  ${output} =
R1 show ip nat statistics
  Total active translations: 80 (10 static, 70 dynamic; 40 extended)
  Outside interfaces:
    Tunnel0
  Inside interfaces:
    GigabitEthernet3
  Hits: 120  Misses: 40
   Reserved port setting disabled provisioned no
   Dynamic overload mapping configured: 0
  Expired translations: 0
  Dynamic mappings:
  -- Inside Source
  [Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 60
   pool SITE-POOL: id 1, netmask 255.255.255.0
          start 10.30.1.100 end 10.30.1.129
  ... 9 more lines
R1 show ip nat statistics
  Total active translations: 80 (10 static, 70 dynamic; 40 extended)
  Outside interfaces:
    Tunnel0
  Inside interfaces:
    GigabitEthernet3
  Hits: 120  Misses: 40
   Reserved port setting disabled provisioned no
   Dynamic overload mapping configured: 0
  Expired translations: 0
  Dynamic mappings:
  -- Inside Source
  [Id: 1] access-list NAT-POOL-SRC pool SITE-POOL refcount 60
   pool SITE-POOL: id 1, netmask 255.255.255.0
          start 10.30.1.100 end 10.30.1.129
  ... 9 more lines
H1 sudo ip addr del 192.168.10.94/24 dev eth1
  ${output} =
```

PASS The Pool Is Still Intact After The Exhaustion Attempt (0.5s, 2 commands)

The refusal must cost nothing: the thirty legitimate clients keep the addresses they held, and none was evicted to make room for the one that was turned away.

```
R1 show ip nat statistics | include allocated
  type generic, total addresses 30, allocated 30 (100%), misses 3
R1 show ip nat translations
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.1.128           192.168.10.89         ---                   ---
  ---  10.30.1.129           192.168.10.82         ---                   ---
  ---  10.30.1.113           192.168.10.77         ---                   ---
  ---  10.30.1.114           192.168.10.66         ---                   ---
  ---  10.30.1.116           192.168.10.69         ---                   ---
  ---  10.30.1.119           192.168.10.86         ---                   ---
  ---  10.30.1.123           192.168.10.93         ---                   ---
  ---  10.30.1.120           192.168.10.76         ---                   ---
  ---  10.30.1.126           192.168.10.71         ---                   ---
  ---  10.30.1.125           192.168.10.72         ---                   ---
  ---  10.30.1.101           192.168.10.84         ---                   ---
  ---  10.30.1.102           192.168.10.83         ---                   ---
  ---  10.30.1.111           192.168.10.67         ---                   ---
  ... 68 more lines
```

PASS Static And Pool Translations Coexist Across The Whole Block (0.5s, 1 commands)

All 40 of a host's addresses in flight, translated by two different mechanisms, with no outside address reused.

```
R1 show ip nat translations
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.1.128           192.168.10.89         ---                   ---
  ---  10.30.1.129           192.168.10.82         ---                   ---
  ---  10.30.1.113           192.168.10.77         ---                   ---
  ---  10.30.1.114           192.168.10.66         ---                   ---
  ---  10.30.1.116           192.168.10.69         ---                   ---
  ---  10.30.1.119           192.168.10.86         ---                   ---
  ---  10.30.1.123           192.168.10.93         ---                   ---
  ---  10.30.1.120           192.168.10.76         ---                   ---
  ---  10.30.1.126           192.168.10.71         ---                   ---
  ---  10.30.1.125           192.168.10.72         ---                   ---
  ---  10.30.1.101           192.168.10.84         ---                   ---
  ---  10.30.1.102           192.168.10.83         ---                   ---
  ---  10.30.1.111           192.168.10.67         ---                   ---
  ... 68 more lines
```

PASS Both Mechanisms Work On Every Router (19.5s, 4 commands)

The spokes carry the same scheme, not just the hub.

```
H2 for i in $(seq 10 19) $(seq 64 93); do ping -c 2 -W 2 -I 192.168.20.$i 10.30.1.10 >/dev/null 2>&1 & done; wait;
echo SENT
  SENT
  [40]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [39]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [38]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [37]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [36]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [35]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [34]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [33]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [32]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [31]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [30]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [29]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  [28]+  Done                    ping -c 2 -W 2 -I 192.168.20.${i} 10.30.1.10 1>/dev/null 2>&1
  ... 27 more lines
H2 show ip nat translations
  Pro  Inside global         Inside local          Outside local         Outside global
  ---  10.30.2.128           192.168.20.87         ---                   ---
  ---  10.30.2.129           192.168.20.82         ---                   ---
  ---  10.30.2.106           192.168.20.66         ---                   ---
  ---  10.30.2.105           192.168.20.84         ---                   ---
```

```
---  10.30.2.111          192.168.20.77        ---                  ---
---  10.30.2.108          192.168.20.75        ---                  ---
---  10.30.2.101          192.168.20.91        ---                  ---
---  10.30.2.102          192.168.20.64        ---                  ---
---  10.30.2.126          192.168.20.72        ---                  ---
---  10.30.2.125          192.168.20.74        ---                  ---
---  10.30.2.123          192.168.20.93        ---                  ---
---  10.30.2.120          192.168.20.83        ---                  ---
---  10.30.2.116          192.168.20.79        ---                  ---
... 108 more lines
```

H3 for i in $(seq 10 19) $(seq 64 93); do ping -c 2 -W 2 -I 192.168.30.$i 10.30.1.10 >/dev/null 2>&1 & done; wait; echo SENT

```
SENT
[40]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[39]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[38]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[37]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[36]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[35]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[34]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[33]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[32]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[31]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[30]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[29]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
[28]+  Done                    ping -c 2 -W 2 -I 192.168.30.${i} 10.30.1.10 1>/dev/null 2>&1
... 27 more lines
```

H3 show ip nat translations

```
Pro  Inside global         Inside local         Outside local        Outside global
---  10.30.3.104           192.168.30.75        ---                  ---
---  10.30.3.107           192.168.30.92        ---                  ---
---  10.30.3.109           192.168.30.93        ---                  ---
---  10.30.3.110           192.168.30.91        ---                  ---
---  10.30.3.103           192.168.30.88        ---                  ---
---  10.30.3.100           192.168.30.87        ---                  ---
---  10.30.3.124           192.168.30.90        ---                  ---
---  10.30.3.127           192.168.30.83        ---                  ---
---  10.30.3.121           192.168.30.86        ---                  ---
---  10.30.3.122           192.168.30.82        ---                  ---
---  10.30.3.118           192.168.30.89        ---                  ---
---  10.30.3.117           192.168.30.84        ---                  ---
---  10.30.3.115           192.168.30.77        ---                  ---
... 68 more lines
```

PASS Only The Static Mappings Live In The Configuration (0.1s, 1 commands)

Static mappings are configuration and survive a reload; pool allocations are runtime state and do not. Confusing the two is how NAT surprises people after a reboot.

R1 show running-config | include ip nat inside source

```
ip nat inside source static 192.168.10.10 10.30.1.10 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.11 10.30.1.11 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.12 10.30.1.12 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.13 10.30.1.13 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.14 10.30.1.14 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.15 10.30.1.15 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.16 10.30.1.16 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.17 10.30.1.17 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.18 10.30.1.18 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.19 10.30.1.19 route-map NAT-TO-DOMAIN
ip nat inside source list NAT-POOL-SRC pool SITE-POOL
```

PASS Traffic From Both Mechanisms Is Encrypted (38.6s, 6 commands)

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 79005, #pkts encrypt: 79005, #pkts digest: 79005
    #pkts decaps: 42201, #pkts decrypt: 42201, #pkts verify: 42201
```

```
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R2 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
   current_peer 100.64.0.3 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 51572, #pkts encrypt: 51572, #pkts digest: 51572
    #pkts decaps: 27172, #pkts decrypt: 27172, #pkts verify: 27172
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

H1 ping -c 20 -I 192.168.10.10 10.30.2.10

```
PING 10.30.2.10 (10.30.2.10) from 192.168.10.10 : 56(84) bytes of data.
64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.31 ms
64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.13 ms
64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.19 ms
64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.12 ms
64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.18 ms
64 bytes from 10.30.2.10: icmp_seq=6 ttl=62 time=1.13 ms
64 bytes from 10.30.2.10: icmp_seq=7 ttl=62 time=1.21 ms
64 bytes from 10.30.2.10: icmp_seq=8 ttl=62 time=1.22 ms
64 bytes from 10.30.2.10: icmp_seq=9 ttl=62 time=1.04 ms
64 bytes from 10.30.2.10: icmp_seq=10 ttl=62 time=1.22 ms
64 bytes from 10.30.2.10: icmp_seq=11 ttl=62 time=1.08 ms
64 bytes from 10.30.2.10: icmp_seq=12 ttl=62 time=1.07 ms
64 bytes from 10.30.2.10: icmp_seq=13 ttl=62 time=1.30 ms
... 11 more lines
```

H1 ping -c 20 -I 192.168.10.64 10.30.2.10

```
PING 10.30.2.10 (10.30.2.10) from 192.168.10.64 : 56(84) bytes of data.
64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.15 ms
64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.14 ms
64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.15 ms
64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.18 ms
64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.25 ms
64 bytes from 10.30.2.10: icmp_seq=6 ttl=62 time=1.30 ms
64 bytes from 10.30.2.10: icmp_seq=7 ttl=62 time=1.40 ms
64 bytes from 10.30.2.10: icmp_seq=8 ttl=62 time=1.12 ms
64 bytes from 10.30.2.10: icmp_seq=9 ttl=62 time=1.12 ms
64 bytes from 10.30.2.10: icmp_seq=10 ttl=62 time=1.10 ms
64 bytes from 10.30.2.10: icmp_seq=11 ttl=62 time=1.22 ms
64 bytes from 10.30.2.10: icmp_seq=12 ttl=62 time=1.16 ms
64 bytes from 10.30.2.10: icmp_seq=13 ttl=62 time=1.20 ms
... 11 more lines
```

R1 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   current_peer 100.64.0.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 79269, #pkts encrypt: 79269, #pkts digest: 79269
    #pkts decaps: 42468, #pkts decrypt: 42468, #pkts verify: 42468
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

R2 show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
   current_peer 100.64.0.3 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 51793, #pkts encrypt: 51793, #pkts digest: 51793
```

```
    #pkts decaps: 27393, #pkts decrypt: 27393, #pkts verify: 27393
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
... 78 more lines
```

PASS Neither Real Nor Translated Addresses Appear In Cleartext (11.5s, 9 commands)

R1 no monitor capture POOLCAP

```
Capture does not exist
```

R1 monitor capture POOLCAP interface GigabitEthernet2 both

```
${output} =
```

R1 monitor capture POOLCAP match ipv4 any any

```
${output} =
```

R1 monitor capture POOLCAP buffer size 5

```
${output} =
```

R1 monitor capture POOLCAP start

```
Started capture point : POOLCAP
```

H1 ping -c 10 -I 192.168.10.64 10.30.2.10

```
PING 10.30.2.10 (10.30.2.10) from 192.168.10.64 : 56(84) bytes of data.
64 bytes from 10.30.2.10: icmp_seq=1 ttl=62 time=1.36 ms
64 bytes from 10.30.2.10: icmp_seq=2 ttl=62 time=1.14 ms
64 bytes from 10.30.2.10: icmp_seq=3 ttl=62 time=1.06 ms
64 bytes from 10.30.2.10: icmp_seq=4 ttl=62 time=1.23 ms
64 bytes from 10.30.2.10: icmp_seq=5 ttl=62 time=1.45 ms
64 bytes from 10.30.2.10: icmp_seq=6 ttl=62 time=1.21 ms
64 bytes from 10.30.2.10: icmp_seq=7 ttl=62 time=1.49 ms
64 bytes from 10.30.2.10: icmp_seq=8 ttl=62 time=1.17 ms
64 bytes from 10.30.2.10: icmp_seq=9 ttl=62 time=1.27 ms
64 bytes from 10.30.2.10: icmp_seq=10 ttl=62 time=1.55 ms

--- 10.30.2.10 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9013ms
... 1 more lines
```

R1 monitor capture POOLCAP stop

```
Stopped capture point : POOLCAP
```

R1 show monitor capture POOLCAP buffer brief

```
-----------------------------------------------------------------------------
 #   size   timestamp     source             destination      dscp    protocol
 ----------------------------------------------------------------------------
   0  170    0.000000   100.64.0.1       ->  100.64.0.2       0  BE   ESP
   1  170    0.000000   100.64.0.2       ->  100.64.0.1       0  BE   ESP
   2  138    0.148003   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
   3  138    0.148003   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
   4  138    0.264986   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
   5  138    0.264986   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
   6  138    0.309997   100.64.0.1       ->  100.64.0.3       48 CS6  ESP
   7  138    0.310989   100.64.0.3       ->  100.64.0.1       48 CS6  ESP
   8  138    0.325987   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
   9  138    0.326995   100.64.0.2       ->  100.64.0.1       48 CS6  ESP
  10  138    0.370983   100.64.0.1       ->  100.64.0.2       48 CS6  ESP
... 218 more lines
```

R1 no monitor capture POOLCAP

```
${output} =
```

14 Ntp

PASS Every Router Is An NTP Client Of The NMS Over The Management VRF (0.3s, 3 commands)

```
R1 show running-config | include ^ntp
  ntp source GigabitEthernet4
  ntp server vrf MGMT 192.168.99.10
R2 show running-config | include ^ntp
  ntp source GigabitEthernet4
  ntp server vrf MGMT 192.168.99.10
R3 show running-config | include ^ntp
  ntp source GigabitEthernet4
  ntp server vrf MGMT 192.168.99.10
```

PASS The NMS Itself Synchronises To The Public Pool (2.4s, 2 commands)

The precondition the rest of this suite rests on. chrony is configured "local stratum 10", so it serves time whether or not it has an upstream -- meaning the routers can agree perfectly on time that came from nowhere. This requires a real upstream: a reference that is not the local clock, and a stratum that proves it came from somewhere else.

```
NMS chronyc tracking
  Reference ID    : 44B793F0 (68.183.147.240)
  Stratum         : 3
  Ref time (UTC)  : Mon Sep 07 23:28:02 2026
  System time     : 0.000295948 seconds fast of NTP time
  Last offset     : -0.000096958 seconds
  RMS offset      : 0.000707182 seconds
  Frequency       : 8.692 ppm fast
  Residual freq   : -0.005 ppm
  Skew            : 0.229 ppm
  Root delay      : 0.047848970 seconds
  Root dispersion : 0.003390881 seconds
  Update interval : 520.1 seconds
  Leap status     : Normal
NMS chronyc -n sources
  MS Name/IP address         Stratum Poll Reach LastRx Last sample
  ===============================================================================
  ^+ 162.254.225.151               2  10   377   392  -3230us[-3230us] +/-   53ms
  ^* 68.183.147.240                2  10   377   582  +1658us[+1561us] +/-   28ms
  ^- 51.81.226.229                 2  10   377   514   +862us[ +862us] +/-  105ms
  ^+ 172.234.44.141                2  10   377   393   -401us[ -401us] +/-   70ms
  ^+ 69.164.213.136                2  10   377   461   +239us[ +239us] +/-   52ms
  ^+ 23.168.24.210                 2  10   377   641  -2175us[-2271us] +/-   37ms
```

PASS Every Router Appears As A Client Of The NMS (0.1s, 1 commands)

Seen from the server, which is where a missing client shows up as an absence rather than as a router quietly using something else.

```
NMS sudo chronyc clients
  Hostname                      NTP   Drop Int IntL Last     Cmd   Drop Int  Last
  ===============================================================================
  192.168.99.3                   74      0   7   -    88       0      0   -     -
  192.168.99.2                   82      0   7   -    37       0      0   -     -
  192.168.99.1                   75      0   7   -    22       0      0   -     -
  localhost                       0      0   -   -     -      24      0   7     0
```

PASS Every Router Forms Associations With Pool Servers (0.1s, 3 commands)

```
R1 show ntp associations
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     22    128   377  0.075   0.224  4.458
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
R2 show ntp associations
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     37    128   377  0.066  -1.229  5.509
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
R3 show ntp associations
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     88    128   377  0.072   0.066  4.738
```

```
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

PASS Associations Become Reachable (0.1s, 3 commands)

A non-zero reach register means packets are actually coming back, which distinguishes a working client from one that has merely been configured.

R1 show ntp associations

```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     22    128   377  0.075   0.224  4.458
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R2 show ntp associations

```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     37    128   377  0.066  -1.229  5.509
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R3 show ntp associations

```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     88    128   377  0.072   0.066  4.738
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

PASS Every Router Selects A System Peer (0.1s, 3 commands)

R1 show ntp associations

```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     22    128   377  0.075   0.224  4.458
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R2 show ntp associations

```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     38    128   377  0.066  -1.229  5.509
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R3 show ntp associations

```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     89    128   377  0.072   0.066  4.738
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

PASS Every Router Clock Is Synchronised (0.1s, 3 commands)

The end state: IOS declares the clock synchronised. This lags real accuracy by a long way. IOS holds the flag back until its loopfilter leaves the 'FREQ' drift-measurement phase, measured on this platform at about 17 minutes from a cold NTP start -- while the offset is already within milliseconds well before that. The wait below is bounded to cover a freshly provisioned lab; on a lab that has been up it returns on the first poll and costs nothing.

R1 show ntp status

```
  Clock is synchronized, stratum 4, reference is 192.168.99.10
  nominal freq is 250.0000 Hz, actual freq is 250.0022 Hz, precision is 2**10
  ntp uptime is 499000 (1/100 of seconds), resolution is 4000
  reference time is EE49C932.33B64630 (23:37:22.202 UTC Mon Sep 7 2026)
  clock offset is 0.2243 msec, root delay is 47.92 msec
  root dispersion is 9.37 msec, peer dispersion is 4.45 msec
  loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008782 s/s
  system poll interval is 128, last update was 23 sec ago.
```

R2 show ntp status

```
  Clock is synchronized, stratum 4, reference is 192.168.99.10
  nominal freq is 250.0000 Hz, actual freq is 250.0017 Hz, precision is 2**10
  ntp uptime is 499000 (1/100 of seconds), resolution is 4000
  reference time is EE49C7CF.28B439C8 (23:31:27.159 UTC Mon Sep 7 2026)
  clock offset is -1.2297 msec, root delay is 47.91 msec
  root dispersion is 13.09 msec, peer dispersion is 5.50 msec
  loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000007039 s/s
  system poll interval is 128, last update was 378 sec ago.
```

R3 show ntp status

```
  Clock is synchronized, stratum 4, reference is 192.168.99.10
  nominal freq is 250.0000 Hz, actual freq is 250.0021 Hz, precision is 2**10
  ntp uptime is 499000 (1/100 of seconds), resolution is 4000
  reference time is EE49C6D8.2AC08388 (23:27:20.167 UTC Mon Sep 7 2026)
  clock offset is 0.0665 msec, root delay is 50.63 msec
  root dispersion is 14.92 msec, peer dispersion is 4.73 msec
  loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008462 s/s
  system poll interval is 128, last update was 625 sec ago.
```

PASS Stratum Is Sane On Every Router (0.1s, 3 commands)

Stratum 16 means unsynchronised. A client of a stratum 1-2 pool server should land well below the limit.

R1 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0022 Hz, precision is 2**10
ntp uptime is 499100 (1/100 of seconds), resolution is 4000
reference time is EE49C932.33B64630 (23:37:22.202 UTC Mon Sep 7 2026)
clock offset is 0.2243 msec, root delay is 47.92 msec
root dispersion is 9.37 msec, peer dispersion is 4.45 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008782 s/s
system poll interval is 128, last update was 23 sec ago.
```

R2 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0017 Hz, precision is 2**10
ntp uptime is 499000 (1/100 of seconds), resolution is 4000
reference time is EE49C7CF.28B439C8 (23:31:27.159 UTC Mon Sep 7 2026)
clock offset is -1.2297 msec, root delay is 47.91 msec
root dispersion is 13.09 msec, peer dispersion is 5.50 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000007039 s/s
system poll interval is 128, last update was 378 sec ago.
```

R3 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0021 Hz, precision is 2**10
ntp uptime is 499000 (1/100 of seconds), resolution is 4000
reference time is EE49C6D8.2AC08388 (23:27:20.167 UTC Mon Sep 7 2026)
clock offset is 0.0665 msec, root delay is 50.63 msec
root dispersion is 14.92 msec, peer dispersion is 4.73 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008462 s/s
system poll interval is 128, last update was 625 sec ago.
```

PASS The Reference Is One Of The Peers The Router Actually Polls (0.1s, 6 commands)

Guards against a router calling itself synchronised to something that is not in its association list.

R1 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0022 Hz, precision is 2**10
ntp uptime is 499100 (1/100 of seconds), resolution is 4000
reference time is EE49C932.33B64630 (23:37:22.202 UTC Mon Sep 7 2026)
clock offset is 0.2243 msec, root delay is 47.92 msec
root dispersion is 9.37 msec, peer dispersion is 4.45 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008782 s/s
system poll interval is 128, last update was 23 sec ago.
```

R1 show ntp associations

```
address         ref clock       st   when   poll reach  delay  offset   disp
*~192.168.99.10   68.183.147.240   3     23    128   377  0.075   0.224  4.458
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R2 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0017 Hz, precision is 2**10
ntp uptime is 499000 (1/100 of seconds), resolution is 4000
reference time is EE49C7CF.28B439C8 (23:31:27.159 UTC Mon Sep 7 2026)
clock offset is -1.2297 msec, root delay is 47.91 msec
root dispersion is 13.09 msec, peer dispersion is 5.50 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000007039 s/s
system poll interval is 128, last update was 378 sec ago.
```

R2 show ntp associations

```
address         ref clock       st   when   poll reach  delay  offset   disp
*~192.168.99.10   68.183.147.240   3     38    128   377  0.066  -1.229  5.509
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R3 show ntp status

```
Clock is synchronized, stratum 4, reference is 192.168.99.10
nominal freq is 250.0000 Hz, actual freq is 250.0021 Hz, precision is 2**10
ntp uptime is 499000 (1/100 of seconds), resolution is 4000
reference time is EE49C6D8.2AC08388 (23:27:20.167 UTC Mon Sep 7 2026)
clock offset is 0.0665 msec, root delay is 50.63 msec
root dispersion is 14.92 msec, peer dispersion is 4.73 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.000008462 s/s
system poll interval is 128, last update was 625 sec ago.
```

R3 show ntp associations

```
address         ref clock       st   when   poll reach  delay  offset   disp
*~192.168.99.10   68.183.147.240   3     89    128   377  0.072   0.066  4.738
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

PASS Clock Offset Is Small On Every Router (0.1s, 3 commands)

R1 show ntp associations
```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     23    128   377  0.075   0.224  4.458
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R2 show ntp associations
```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     38    128   377  0.066  -1.229  5.509
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

R3 show ntp associations
```
  address         ref clock       st   when   poll reach  delay  offset   disp
  *~192.168.99.10   68.183.147.240   3     89    128   377  0.072   0.066  4.738
   * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

PASS All Routers Agree On The Time (0.0s, 3 commands)

The practical payoff: three independently synchronised clocks should read the same, which is what makes logs across the fabric correlatable.

R1 show clock
```
  23:37:45.512 UTC Mon Sep 7 2026
```

R2 show clock
```
  23:37:45.525 UTC Mon Sep 7 2026
```

R3 show clock
```
  23:37:45.535 UTC Mon Sep 7 2026
```

PASS The Clock Is No Longer At The Boot Epoch (0.1s, 6 commands)

An unsynchronised IOS device reports a 1993 or 1900 clock; a synchronised one reports now. This is the crude check that catches a clock that never moved at all.

R1 show clock
```
  23:37:45.548 UTC Mon Sep 7 2026
```

R1 show clock
```
  23:37:45.560 UTC Mon Sep 7 2026
```

R2 show clock
```
  23:37:45.575 UTC Mon Sep 7 2026
```

R2 show clock
```
  23:37:45.588 UTC Mon Sep 7 2026
```

R3 show clock
```
  23:37:45.601 UTC Mon Sep 7 2026
```

R3 show clock
```
  23:37:45.614 UTC Mon Sep 7 2026
```

15 Syslog

PASS The Collector Is A Service On The NMS Serving Every Router On One Port (0.1s, 2 commands)

What the move bought: one rsyslog listener for all three routers instead of one busybox listener per router, and a system service rather than something a suite starts -- so no run can leave a stale listener swallowing another's messages.

```
NMS systemctl is-active rsyslog
  active
NMS sudo ss -lunp | grep ':514 ' || echo NONE
  UNCONN 0      0            0.0.0.0:514       0.0.0.0:*    users:(("rsyslogd",pid=2925,fd=6))
  UNCONN 0      0               [::]:514          [::]:*    users:(("rsyslogd",pid=2925,fd=7))
```

PASS Every Router Is Configured To Log To The Collector (0.3s, 3 commands)

```
R1 show running-config | include ^logging|^service (timestamps|sequence)
  service timestamps debug datetime msec
  service timestamps log datetime msec show-timezone
  service sequence-numbers
  logging source-interface GigabitEthernet4 vrf MGMT
  logging host 192.168.99.10 vrf MGMT
R2 show running-config | include ^logging|^service (timestamps|sequence)
  service timestamps debug datetime msec
  service timestamps log datetime msec show-timezone
  service sequence-numbers
  logging source-interface GigabitEthernet4 vrf MGMT
  logging host 192.168.99.10 vrf MGMT
R3 show running-config | include ^logging|^service (timestamps|sequence)
  service timestamps debug datetime msec
  service timestamps log datetime msec show-timezone
  service sequence-numbers
  logging source-interface GigabitEthernet4 vrf MGMT
  logging host 192.168.99.10 vrf MGMT
```

PASS Every Router Reports The Collector As An Active Logging Host (0.2s, 3 commands)

The router's own view: it should name the collector and show a non-zero count of messages sent to it.

```
R1 show logging | include Trap logging|Logging to 192.168.99.10
  Trap logging: level informational, 1238 message lines logged
          Logging to 192.168.99.10  (MGMT) (udp port 514, audit disabled,
R2 show logging | include Trap logging|Logging to 192.168.99.10
  Trap logging: level informational, 1616 message lines logged
          Logging to 192.168.99.10  (MGMT) (udp port 514, audit disabled,
R3 show logging | include Trap logging|Logging to 192.168.99.10
  Trap logging: level informational, 974 message lines logged
          Logging to 192.168.99.10  (MGMT) (udp port 514, audit disabled,
```

PASS The Hub Message Reaches The Collector (4.0s, 1 commands)

End to end over the LAN: emit a uniquely marked message and find it at the collector.

```
NMS sudo grep -c -- 'LABSYSLOG-HUB-193745' /var/log/lab/192.168.99.1.log 2>/dev/null || echo 0
  1
```

PASS Each Spoke Message Reaches The Collector Across The Tunnel (8.1s, 2 commands)

The spokes have no direct path to h1's LAN; their messages are carried by the tunnels and the hub's routing.

```
NMS sudo grep -c -- 'LABSYSLOG-R2-193745' /var/log/lab/192.168.99.2.log 2>/dev/null || echo 0
  1
NMS sudo grep -c -- 'LABSYSLOG-R3-193745' /var/log/lab/192.168.99.3.log 2>/dev/null || echo 0
  1
```

PASS Received Messages Carry Facility Severity And Mnemonic (4.1s, 2 commands)

```
NMS sudo grep -c -- 'LABSYSLOG-FIELDS-193745' /var/log/lab/192.168.99.1.log 2>/dev/null || echo 0
  1
```

```
NMS sudo cat /var/log/lab/192.168.99.1.log 2>/dev/null || true
  <189>207: 000203: *Sep  7 22:17:21.168 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>208: 000204: *Sep  7 22:17:21.214 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:17:21 UTC Mon Sep 7 2026
  <189>209: 000205: *Sep  7 22:17:21.214 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <190>210: 000206: *Sep  7 22:17:56.590 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>211: 000207: *Sep  7 22:17:56.591 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <189>212: 000208: *Sep  7 22:18:27.361 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>213: 000209: *Sep  7 22:18:27.410 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:18:27 UTC Mon Sep 7 2026
  <189>214: 000210: *Sep  7 22:18:27.410 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>215: 000211: *Sep  7 22:18:27.605 UTC: %SYS-5-CONFIG_I: Configured from console by lab on vty0
  (10.0.2.2)
  <190>216: 000212: *Sep  7 22:18:27.747 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>217: 000213: *Sep  7 22:18:27.747 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <187>218: 000214: *Sep  7 22:19:26.134 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.3 NBMA: 100.64.0.1)
  <187>219: 000215: *Sep  7 22:19:26.227 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.2 NBMA: 100.64.0.1)
  <187>220: 000216: *Sep  7 22:19:26.906 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.3 NBMA: 100.64.0.1)
  ... 1020 more lines
```

PASS Received Messages Carry Sequence Numbers (0.1s, 1 commands)

'service sequence-numbers' is configured, so every message should be numbered -- which is how a collector detects loss.

```
NMS sudo cat /var/log/lab/192.168.99.1.log 2>/dev/null || true
  <189>207: 000203: *Sep  7 22:17:21.168 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>208: 000204: *Sep  7 22:17:21.214 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:17:21 UTC Mon Sep 7 2026
  <189>209: 000205: *Sep  7 22:17:21.214 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <190>210: 000206: *Sep  7 22:17:56.590 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>211: 000207: *Sep  7 22:17:56.591 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <189>212: 000208: *Sep  7 22:18:27.361 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>213: 000209: *Sep  7 22:18:27.410 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:18:27 UTC Mon Sep 7 2026
  <189>214: 000210: *Sep  7 22:18:27.410 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>215: 000211: *Sep  7 22:18:27.605 UTC: %SYS-5-CONFIG_I: Configured from console by lab on vty0
  (10.0.2.2)
  <190>216: 000212: *Sep  7 22:18:27.747 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>217: 000213: *Sep  7 22:18:27.747 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <187>218: 000214: *Sep  7 22:19:26.134 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.3 NBMA: 100.64.0.1)
  <187>219: 000215: *Sep  7 22:19:26.227 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.2 NBMA: 100.64.0.1)
  <187>220: 000216: *Sep  7 22:19:26.906 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.3 NBMA: 100.64.0.1)
  ... 1020 more lines
```

PASS Message Timestamps Agree With The Router Clock (4.1s, 3 commands)

Ties syslog to NTP: a message's timestamp should match the sending router's clock. Skewed timestamps make a collector's correlation across devices worthless.

```
NMS sudo grep -c -- 'LABSYSLOG-TIME-193745' /var/log/lab/192.168.99.1.log 2>/dev/null || echo 0
  1
R1 show clock
  23:38:08.968 UTC Mon Sep 7 2026
NMS sudo cat /var/log/lab/192.168.99.1.log 2>/dev/null || true
  <189>207: 000203: *Sep  7 22:17:21.168 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>208: 000204: *Sep  7 22:17:21.214 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:17:21 UTC Mon Sep 7 2026
  <189>209: 000205: *Sep  7 22:17:21.214 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <190>210: 000206: *Sep  7 22:17:56.590 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>211: 000207: *Sep  7 22:17:56.591 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <189>212: 000208: *Sep  7 22:18:27.361 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>213: 000209: *Sep  7 22:18:27.410 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:18:27 UTC Mon Sep 7 2026
  <189>214: 000210: *Sep  7 22:18:27.410 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>215: 000211: *Sep  7 22:18:27.605 UTC: %SYS-5-CONFIG_I: Configured from console by lab on vty0
  (10.0.2.2)
  <190>216: 000212: *Sep  7 22:18:27.747 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>217: 000213: *Sep  7 22:18:27.747 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <187>218: 000214: *Sep  7 22:19:26.134 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.3 NBMA: 100.64.0.1)
  <187>219: 000215: *Sep  7 22:19:26.227 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.2 NBMA: 100.64.0.1)
  <187>220: 000216: *Sep  7 22:19:26.906 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
  authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
  172.20.0.3 NBMA: 100.64.0.1)
  ... 1021 more lines
```

PASS Messages Below The Trap Level Are Not Forwarded (14.0s, 1 commands)

Negative control. Trap level is informational (6), so a debug-severity (7) message must not reach the collector. If this ever passes traffic, the level filter is not working and the positive tests above prove much less than they appear to.

```
NMS sudo grep -c -- 'LABSYSLOG-DEBUG-193745' /var/log/lab/192.168.99.1.log 2>/dev/null || echo 0
  0
  0
```

PASS All Three Routers Are Represented At The Collector (12.1s, 3 commands)

Messages from every router, distinguishable at the collector, which is the point of a central log host.

```
NMS sudo grep -c -- 'LABSYSLOG-ALL-R1-193745' /var/log/lab/192.168.99.1.log 2>/dev/null || echo 0
  1
NMS sudo grep -c -- 'LABSYSLOG-ALL-R2-193745' /var/log/lab/192.168.99.2.log 2>/dev/null || echo 0
  1
NMS sudo grep -c -- 'LABSYSLOG-ALL-R3-193745' /var/log/lab/192.168.99.3.log 2>/dev/null || echo 0
  1
```

16 Snmpv3

PASS Both Trap Receivers Are Services On The NMS (0.1s, 2 commands)

snmptrapd on the standard port and the raw capture on a second one, both system services rather than listeners a suite starts -- so no run can leave one behind, which is how a negative test once passed while nothing was arriving.

```
NMS systemctl is-active snmptrapd lab-trapcap | tr '\n' ' '
  active active
NMS sudo ss -lunp | grep -E ':(162|1162) ' || echo NONE
  UNCONN 0      0             0.0.0.0:1162      0.0.0.0:*    users:(("python3",pid=3082,fd=3))
  UNCONN 0      0             0.0.0.0:162       0.0.0.0:*
  users:(("snmptrapd",pid=3043,fd=3),("systemd",pid=1,fd=124))
  UNCONN 0      0                [::]:162          [::]:*
  users:(("snmptrapd",pid=3043,fd=4),("systemd",pid=1,fd=125))
```

PASS Every Router Has An SNMPv3 User With Authentication And Privacy (0.1s, 3 commands)

v3 without auth and priv is barely better than v2c, so the protocols in use are asserted, not just the user's existence.

```
R1 show snmp user
  User name: labmon
  Engine ID: 800000090300525400C80101
  storage-type: nonvolatile        active
  Authentication Protocol: SHA
  Privacy Protocol: AES128
  Group-name: LABGRP
R2 show snmp user
  User name: labmon
  Engine ID: 800000090300525400C80201
  storage-type: nonvolatile        active
  Authentication Protocol: SHA
  Privacy Protocol: AES128
  Group-name: LABGRP
R3 show snmp user
  User name: labmon
  Engine ID: 800000090300525400C80301
  storage-type: nonvolatile        active
  Authentication Protocol: SHA
  Privacy Protocol: AES128
  Group-name: LABGRP
```

PASS Every Router Has A v3 Group Requiring Privacy (0.1s, 3 commands)

```
R1 show snmp group
  groupname: ILMI                           security model:v1
  contextname: <no context specified>       storage-type: permanent
  readview : *ilmi                          writeview: *ilmi
  notifyview: <no notifyview specified>
  row status: active

  groupname: ILMI                           security model:v2c
  contextname: <no context specified>       storage-type: permanent
  readview : *ilmi                          writeview: *ilmi
  notifyview: <no notifyview specified>
  row status: active

  groupname: LABGRP                         security model:v3 priv
  contextname: <no context specified>       storage-type: nonvolatile
  ... 3 more lines
R2 show snmp group
  groupname: ILMI                           security model:v1
  contextname: <no context specified>       storage-type: permanent
  readview : *ilmi                          writeview: *ilmi
  notifyview: <no notifyview specified>
  row status: active

  groupname: ILMI                           security model:v2c
  contextname: <no context specified>       storage-type: permanent
  readview : *ilmi                          writeview: *ilmi
  notifyview: <no notifyview specified>
  row status: active
```

```
  groupname: LABGRP                          security model:v3 priv
  contextname: <no context specified>        storage-type: nonvolatile
  ... 3 more lines
```

R3 show snmp group

```
  groupname: ILMI                            security model:v1
  contextname: <no context specified>        storage-type: permanent
  readview : *ilmi                           writeview: *ilmi
  notifyview: <no notifyview specified>
  row status: active

  groupname: ILMI                            security model:v2c
  contextname: <no context specified>        storage-type: permanent
  readview : *ilmi                           writeview: *ilmi
  notifyview: <no notifyview specified>
  row status: active

  groupname: LABGRP                          security model:v3 priv
  contextname: <no context specified>        storage-type: nonvolatile
  ... 3 more lines
```

PASS No Router Accepts SNMPv1 Or v2c Communities (0.3s, 3 commands)

Security posture: configuring v3 is pointless if a community string still gets you in.

R1 show running-config | include ^snmp-server community

```
  ${output} =
```

R2 show running-config | include ^snmp-server community

```
  ${output} =
```

R3 show running-config | include ^snmp-server community

```
  ${output} =
```

PASS Every Router Targets The Collector With v3 Privacy (0.1s, 3 commands)

R1 show snmp host

```
  Notification host: 192.168.99.10        udp-port: 1162  VRFName: MGMT   type: trap
  user: labmon    security model: v3 priv

  Notification host: 192.168.99.10        udp-port: 162   VRFName: MGMT   type: trap
  user: labmon    security model: v3 priv
```

R2 show snmp host

```
  Notification host: 192.168.99.10        udp-port: 1162  VRFName: MGMT   type: trap
  user: labmon    security model: v3 priv

  Notification host: 192.168.99.10        udp-port: 162   VRFName: MGMT   type: trap
  user: labmon    security model: v3 priv
```

R3 show snmp host

```
  Notification host: 192.168.99.10        udp-port: 1162  VRFName: MGMT   type: trap
  user: labmon    security model: v3 priv

  Notification host: 192.168.99.10        udp-port: 162   VRFName: MGMT   type: trap
  user: labmon    security model: v3 priv
```

PASS Global Trap Sending Is Enabled (0.1s, 3 commands)

Enabling individual trap types leaves the global switch off: the router builds trap PDUs and never sends them, which looks exactly like a broken collector.

R1 show snmp | include global trap

```
  SNMP global trap: enabled
```

R2 show snmp | include global trap

```
  SNMP global trap: enabled
```

R3 show snmp | include global trap

```
  SNMP global trap: enabled
```

PASS Traps From Every Router Reach The Collector (13.0s, 51 commands)

R1 configure terminal

```
  Enter configuration commands, one per line.  End with CNTL/Z.
```

```
R1 interface Loopback270
  ${output} =
R1 ip address 10.99.97.1 255.255.255.255
  ${output} =
R1 snmp trap link-status
  ${output} =
R1 end
  ${output} =
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 interface Loopback270
  ${output} =
R1 shutdown
  ${output} =
R1 end
  ${output} =
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 interface Loopback270
  ${output} =
R1 no shutdown
  ${output} =
R1 end
  ${output} =
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 no interface Loopback270
  ${output} =
R1 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface Loopback270
  ${output} =
R2 ip address 10.99.97.1 255.255.255.255
  ${output} =
R2 snmp trap link-status
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface Loopback270
  ${output} =
R2 shutdown
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface Loopback270
  ${output} =
R2 no shutdown
  ${output} =
R2 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 no interface Loopback270
  ${output} =
R2 end
  ${output} =
R3 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R3 interface Loopback270
```

```
  ${output} =
R3 ip address 10.99.97.1 255.255.255.255
  ${output} =
R3 snmp trap link-status
  ${output} =
R3 end
  ${output} =
R3 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R3 interface Loopback270
  ${output} =
R3 shutdown
  ${output} =
R3 end
  ${output} =
R3 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R3 interface Loopback270
  ${output} =
R3 no shutdown
  ${output} =
R3 end
  ${output} =
R3 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R3 no interface Loopback270
  ${output} =
R3 end
  ${output} =
NMS sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true
  1788819441.732 192.168.99.1 3081f1020103300d020136020205dc040103020103043730350 40c800000090300525400c8010102
  0102020200a204066c61626d6f6e040c0330a96d73b02577bd14002704089b184efb1b39c2180481a31e0cb257972ac1650a9c016737
  d7c3450c8b69b1810963c1c351af94e662bb6294844083630796 5026c2d246d66d8c3bf10781cd8fcab6521f98448783a6d9bf665ade
  b66e773f6cb948e6c84fbc1c22baffabc9a7c820adbbccc0607f9fe235937749231d4e94bb8fdcc059dcffbba830d801e015c85863d7
  158e72f510620b1c9e484b7417b4d3a185d046ea549f3642f878698207c3f818a4b10c5927a8e880fcba
  1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc040103020103043730350 40c800000090300525400c8020102
  0102020200a104066c61626d6f6e040c280bc8173afb140f39665d400408bdf4dc46c97074930481a3485df5849e5eeeb771b44c093a
  ef6ddaf4b7ba8b009f4cb725b19f5e751850a70e9cd62e9471b527848f3350df4234902e59c6ba9cd696e552e207ef62af971e8908ef
  ae317dcaed8d6702a20fa8a0f5d3535538a2851e16b3bc0d2979168bf60354d2878e5cd7ac03c1daa98fd24eb8a451e70e624bdffc96
  8ee7b7c9e197db97da0102a62640bc8d2abf526e9a3bd5db09b0713ae471d14774a711e1c49770a339c6
  1788819441.806 192.168.99.3 3081f1020103300d02013a020205dc040103020103043730350 40c800000090300525400c8030102
  0102020200a104066c61626d6f6e040c1a06b8620cf2bdfae082242d0408a7c7be9c6efe40570481a3f13563f7a9d2b23f9d6aedd6db
  b3ee8cb9bfc314d080afa0b0fb48addca5f604a787508df6374629f81bf9c5e8ed322c4fbc9fd5daf2e665dcbc312cc01027c101b15d
  95d74b6c51ef9faf06c0670481620af82d566719918aab054f908d5415c32688a26757db8041390a1fd440c938835bf8a171ee3321ef
  59f0d1a550a2e55083266bba89add3ddb3176843bbfc92d3de40fb901ba83f7d8c7124f27c7fe6db1dce
  1788819441.982 192.168.99.1 3081f1020103300d020138020205dc040103020103043730350 40c800000090300525400c8010102
  0102020200a204066c61626d6f6e040c54e0b089dfb6d3286639954d04089b184efb1b39c21a0481a38399f66019ba392443b719d26a
  fd64cb17b4f7e47e6efc18540d7a161bb4df34a5d637d8baf88d7959b126d7f786e1521239899f10d3d27949f04880309d9a8e456a78
  4b512b0558a7215ca4ba9844e8fac890bae9434f944d06cc273d3d6bb9fd842b28c44aa4b6f7723acfc5a8d378b7f6d6019f1c750dbd
  2b44a96e3e05c10c5df1deb3e7c8f3b1022054494304e4456fad68c0f554b6016aa90535c790e85d921b
  1788819442.019 192.168.99.2 3081f1020103300d020140020205dc040103020103043730350 40c800000090300525400c8020102
  0102020200a204066c61626d6f6e040cc5e940312135bbb74315f07f0408bdf4dc46c97074950481a3d122cd69208ea63a33c15acfa8
  7a45102a3d13ff4011a6fe0077d1190d97e78309f972e8bd391feaf8f439f142fa831bc51566d9eb8017d4cb97e7436f0ff3c8ef79ef
  ea5d0c4c1aab31cc9b7f8cff78355da4f4fcfa92bddd9281133bec7fae933da59e755762b226e899cb3c6998c3fb887f3397554d5152
  dcbea7abdb77818b788f02536a47b9893019f437a968d65cf16414aaec7588c7acf31617d6f2d26c240f
  1788819442.056 192.168.99.3 3081f1020103300d02013c020205dc040103020103043730350 40c800000090300525400c8030102
  0102020200a204066c61626d6f6e040c97f59d812586c8cbc82aeec80408a7c7be9c6efe40590481a3944f05c35a695e8ab698a77fc0
  679d4817a25d2867b284b3553e5b9560d1abeb0194ef14399db882e9fa2c2b7a2e5a3a8776478141012d370690d28f11c26bfc8aa1fd
  53215e87e900d9dda1de7d41080b83bf95c9c0743949bd5c4af9ea11abc6a118939fad85eb0735991d6b9d8e891ccf0bd9cb99abf172
  805a8c9b5e5d778a279e1a0384713bb102e8ba0b0be1d56a9527722ef00de7e6baabfe3aae5f497a44f4
  1788819442.233 192.168.99.1 3081f1020103300d02013a020205dc040103020103043730350 40c800000090300525400c8010102
  0102020200a204066c61626d6f6e040ce97d7d93c11dac8ea0caaafe04089b184efb1b39c21c0481a3ee52a2e7caf58003f3aeaef04a
  dcaabcf43bd1c13a51d4087e88c6a9a9cfb270aec98cf2cbdfc6fd803608b8bc6591cde59384e91da399d6f1080102f98fe25152158b
  139ebf2f59507f8016a328a4c7a9d1b80a4219982fe2f74978cda2b2ef1bf7d7faf9d835a5cf3f9042d5c74a4e898d39833cc1dbe052
  02b505f5d02dbbe48944635bbb890fd08e79baaef5523fd4bd8e7aa0f86d71427b43736a5d9d7bef4403
  1788819442.267 192.168.99.2 3081f1020103300d020142020205dc040103020103043730350 40c800000090300525400c8020102
  0102020200a204066c61626d6f6e040cd6f8a0f7f93b069d069759170408bdf4dc46c97074970481a33116ac4348d5c39ada28f96d78
  e74d155c5cc9bffa42fe9fdadacbc9f298c97a79d1335ef72ad9631dc12834db86976c08bc0949678ce7926afec969d51ff59beb6fd1
  7b912bab7415c3068dc730665587dd829e838b378fbcd81aeaa7be721b39cc8ec406c7f91f5bf3e02ef0f84d884b62698b64590b35f1
  8921e3a8316c7d66a27f4300e3b40e92dcf8449782b483b7ebb1c0a3da45fbe4c24622a7d600f36d7023
  1788819442.306 192.168.99.3 3081f1020103300d02013e020205dc040103020103043730350 40c800000090300525400c8030102
  0102020200a204066c61626d6f6e040c3bb1f3582527a19034ec5d610408a7c7be9c6efe405b0481a3fa3381e2249898d509d85e1d9b
  3389b3128c7d34aaa0145cd77854357e6d69cd388db0d86c165a4fdf8a3d87f9bb961854ba187a1984c45dbbf58adca5541a5485c344
  583a562913d9b44704b325f28a9b0c3c74d18b4c3bd08fc9130c877165dc4c6d22a6e4226cd8546bac4ed78bd313ac2d76bfad8165bf
```

```
d95c8ff1fe7981815276c5c81bab3f027acbecb251449958991c430e2e4f57b98530410546f515e98124
1788819442.482 192.168.99.1 3081f1020103300d02013c020205dc0401030201030437303504 0c8000000903005254 00c8010102
0102020200a204066c61626d6f6e040c73a76bc49e552aab0d08f64d04089b184efb1b39c21e0481a3b1a6978d7875aefa7484d41426
fcac7bd01a45e729fb041e4e0053bcf6e1e7b4453849a0950cb51754d5aa8bb1e683b91e18dedd70c8eeb400fd5392669c3139475a2e
f9cea2e5f556ab286affc24b299f7257a7f9aaa3362d185225a4037aefe861fb964fcd2e3f759405bf4911bb9c8e340b9c3c32a39f9b
caf86df01c6728b43aa549379361193e7dccae3f3f0abd1c6f25b53985eb169cb05adfaa725d29e505e5
1788819442.518 192.168.99.2 3081f1020103300d020144020205dc0401030201030437303504 0c8000000903005254 00c8020102
0102020200a204066c61626d6f6e040ce22c3e1cccc3a0816b2de3090408bdf4dc46c97074990481a362ccc6cfc3fcb1f5dfe6a36ba9
061eb6d5f8e4cea2b22f8283e04ff27fe21962da8a88d91b1c4fbdc6a5d339e9dd070feed2193e628e3bdc3aeaea01f49bc99930a11e
69a68b57bc34e6500c2a923e4766fa1263512636869017b82cec5982625feded62ba54a93598fd3604d189683a16346138220d45f3a5
2b61fdeb71554fcc5d3fa447dc8681234e12ab5d5157c513e3981ae8abd5e8e564fe10aecfc7bd4560ef
1788819442.556 192.168.99.3 308201db020103300d020140020205dc0401030201030437303504 0c8000000903005254 00c80301
020102020200a204066c61626d6f6e040cd0e347d7a518a7d9e2f37c1b0408a7c7be9c6efe405d0482018cd8efa54000ad401bbc326d
2bbcde825ab5152edf654545b7ab79bde2ffadf60703003bf05fd372b55c6598a7edececfd536ad432095fb9260748bd46f1cc973fce
7d0c5d461a74567d653f8915b5eb8f3625a9acd114f2efc9c842fde25afe53f39a555ecb3dcf7d27a08432dc9340b766d913d297b4bb
07970a2510babd3db4f4ce0ebb07f01f9ffd45e6fb29ef8feac58621e676b92935f9ce739373e633a53e74e506575e6f46825bb060ff
e5b0c8526d79831062a4e95bdec7dd7039dd603bf20ecded96990e1d2ab506b0cb8e915f9e5b37d553f38e99197198e6c070324af943
30b1625bd961d67078f27e4290be8c1b30f9fdd4f9da38629eaf2dd334b0e0a26532c0549a3fc8782afe71d694abf3ac5084fb3ae4b9
34af1b612e329beb9c7e1163aa36dc290f9784b5cc2f25a844f00d69d85b8798ee860408950a0e0a5c9d4a79f2784d07c6aca87f8a39
ea45e822985914ea2cb93b21d583ae4f38bbbb056238ff969149d9ebbe2171e6f569e3e2f1e75f5a94e133e9fca802228704d2f319ba
aef92a4fd087aa
1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c8000000903005254 00c8010102
0102020200a204066c61626d6f6e040cf1375d27c9b13e3bc630dda704089b184efb1b39c2200481a30198f4b559036be6e04256f622
03359df9f4b249e253bfc47820d97178378d92b51f24de8d8455b5342f2d76797f484d9471253faea500058a89ac76482836c4d83314
b637ad7fc13ded93b704de011795c6d883a9036f15a8f96224a3162a8d83a10fe88c1e9da55743953b410a155c88ebec8dc5ed1f85e8
d6719b4b8a6db27cd5500b799d76f31678bbff135288e19a3de00a02a2b05ec9f77a51e2e82d417f4fd9
1788819442.769 192.168.99.2 3081bb020103300d020146020205dc0401030201030437303504 0c8000000903005254 00c8020102
0102020200a204066c61626d6f6e040c3df77a9a6185cfb1cfecf88a0408bdf4dc46c970749b046ef296014ded7c0ce032945da3386e
1ebd3a6f6a183b3c2e4ebf6a7517d3b4fbe0d2965d0cedde29f5e6919fa5f14ad44ce1b2ffc828265b33e24d5f8c4f415511af6b9294
f9d44b5f12d56f7e84a1eea2197ad6b4e73721c87bfd23d6a00a98a878bc9f8f206e82d8a3606be17431
... 3229 more lines
```

NMS `sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true`

```
1788819441.732 192.168.99.1 3081f1020103300d020136020205dc0401030201030437303504 0c8000000903005254 00c8010102
0102020200a204066c61626d6f6e040c0330a96d73b02577bd14002704089b184efb1b39c2180481a31e0cb257972ac1650a9c016737
d7c3450c8b69b1810963c1c351af94e662bb6294844083630796502 6c2d246d66d8c3bf10781cd8fcab6521f98448783a6d9bf665ade
b66e773f6cb948e6c84fbc1c22baffabc9a7c820adbbccc0607f9fe235937749231d4e94bb8fdcc059dcffbba830d801e015c85863d7
158e72f510620b1c9e484b7417b4d3a185d046ea549f3642f878698207c3f818a4b10c5927a8e880fcba
1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc0401030201030437303504 0c8000000903005254 00c8020102
0102020200a104066c61626d6f6e040c280bc8173afb140f39665d400408bdf4dc46c97074930481a3485df5849e5eeeb771b44c093a
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... 3229 more lines
```

NMS `sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true`

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  0102020200a204066c61626d6f6e040c3df77a9a6185cfb1cfecf88a0408bdf4dc46c970749b046ef296014ded7c0ce032945da3386e
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  ... 3229 more lines
```

PASS Received Traps Are SNMP Version 3 (0.2s, 3 commands)

Reads the version field out of the datagram itself rather than trusting the configuration.

```
NMS sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true
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  1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc0401030201030437303504 0c80000009030052540 0c8020102
  0102020200a104066c61626d6f6e040c280bc8173afb140f39665d400408bdf4dc46c97074930481a3485df5849e5eeeb771b44c093a
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```

```
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... 3230 more lines
```

```
NMS sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true
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1788819442.482 192.168.99.1 3081f1020103300d02013c020205dc0401030201030437303504 0c800000090300525400c8010102
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```

```
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... 3230 more lines
```

NMS `sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true`

```
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```

```
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... 3230 more lines
```

PASS Received Traps Carry The Configured User And Privacy Flags (0.2s, 3 commands)

```
NMS sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true
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```

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... 3231 more lines
```

NMS `sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true`

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1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c8000000903005254 00c8010102
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```

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... 3231 more lines
```

NMS `sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true`

```
1788819441.732 192.168.99.1 3081f1020103300d020136020205dc0401030201030437303504 0c800000090300525400c8010102
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1788819442.056 192.168.99.3 3081f1020103300d02013c020205dc0401030201030437303504 0c800000090300525400c8030102
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1788819442.482 192.168.99.1 3081f1020103300d02013c020205dc0401030201030437303504 0c800000090300525400c8010102
0102020200a204066c61626d6f6e040c73a76bc49e552aab0d08f64d04089b184efb1b39c21e0481a3b1a6978d7875aefa7484d41426
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1788819442.556 192.168.99.3 308201db020103300d020140020205dc0401030201030437303504 0c800000090300525400c80301
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1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c800000090300525400c8010102
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1788819442.769 192.168.99.2 3081bb020103300d020146020205dc0401030201030437303504 0c800000090300525400c8020102
0102020200a204066c61626d6f6e040c3df77a9a6185cfb1cfecf88a0408bdf4dc46c970749b046ef296014ded7c0ce032945da3386e
```

```
1ebd3a6f6a183b3c2e4ebf6a7517d3b4fbe0d2965d0cedde29f5e6919fa5f14ad44ce1b2ffc828265b33e24d5f8c4f415511af6b9294
f9d44b5f12d56f7e84a1eea2197ad6b4e73721c87bfd23d6a00a98a878bc9f8f206e82d8a3606be17431
... 3231 more lines
```

PASS Trap Payloads Are Encrypted (0.2s, 3 commands)

With privacy in force the scoped PDU arrives as an opaque OCTET STRING. If it were a readable SEQUENCE the varbinds would be on the wire in clear.

```
NMS sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true
1788819441.732 192.168.99.1 3081f1020103300d020136020205dc0401030201030437303504 0c8000000903005254 00c8010102
0102020200a204066c61626d6f6e040c0330a96d73b02577bd14002704089b184efb1b39c2180481a31e0cb257972ac1650a9c016737
d7c3450c8b69b1810963c1c351af94e662bb6294844083630796502 6c2d246d66d8c3bf10781cd8fcab6521f98448783a6d9bf665ade
b66e773f6cb948e6c84fbc1c22baffabc9a7c820adbbccc0607f9fe235937749231d4e94bb8fdcc059dcffbba830d801e015c85863d7
158e72f510620b1c9e484b7417b4d3a185d046ea549f3642f878698207c3f818a4b10c5927a8e880fcba
1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc0401030201030437303504 0c8000000903005254 00c8020102
0102020200a104066c61626d6f6e040c280bc8173afb140f39665d400408bdf4dc46c97074930481a3485df5849e5eeeb771b44c093a
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8ee7b7c9e197db97da0102a62640bc8d2abf526e9a3bd5db09b0713ae471d14774a711e1c49770a339c6
1788819441.806 192.168.99.3 3081f1020103300d02013a020205dc0401030201030437303504 0c8000000903005254 00c8030102
0102020200a104066c61626d6f6e040c1a06b8620cf2bdfae082242d0408a7c7be9c6efe40570481a3f13563f7a9d2b23f9d6aedd6db
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1788819441.982 192.168.99.1 3081f1020103300d020138020205dc0401030201030437303504 0c8000000903005254 00c8010102
0102020200a204066c61626d6f6e040c54e0b089dfb6d3286639954d04089b184efb1b39c21a0481a38399f66019ba392443b719d26a
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2b44a96e3e05c10c5df1deb3e7c8f3b1022054494304e4456fad68c0f554b6016aa90535c790e85d921b
1788819442.019 192.168.99.2 3081f1020103300d020140020205dc0401030201030437303504 0c8000000903005254 00c8020102
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dcbea7abdb77818b788f02536a47b9893019f437a968d65cf16414aaec7588c7acf31617d6f2d26c240f
1788819442.056 192.168.99.3 3081f1020103300d02013c020205dc0401030201030437303504 0c8000000903005254 00c8030102
0102020200a204066c61626d6f6e040c97f59d812586c8cbc82aeec80408a7c7be9c6efe40590481a3944f05c35a695e8ab698a77fc0
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1788819442.233 192.168.99.1 3081f1020103300d02013a020205dc0401030201030437303504 0c8000000903005254 00c8010102
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02b505f5d02dbbe48944635bbb890fd08e79baaef5523fd4bd8e7aa0f86d71427b43736a5d9d7bef4403
1788819442.267 192.168.99.2 3081f1020103300d020142020205dc0401030201030437303504 0c8000000903005254 00c8020102
0102020200a204066c61626d6f6e040cd6f8a0f7f93b069069759170408bdf4dc46c97074970481a33116ac4348d5c39ada28f96d78
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1788819442.306 192.168.99.3 3081f1020103300d02013e020205dc0401030201030437303504 0c8000000903005254 00c8030102
0102020200a204066c61626d6f6e040c3bb1f3582527a19034ec5d610408a7c7be9c6efe405b0481a3fa3381e2249898d509d85e1d9b
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1788819442.482 192.168.99.1 3081f1020103300d02013c020205dc0401030201030437303504 0c8000000903005254 00c8010102
0102020200a204066c61626d6f6e040c73a76bc49e552aab0d08f64d04089b184efb1b39c21e0481a3b1a6978d7875aefa7484d41426
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1788819442.518 192.168.99.2 3081f1020103300d020144020205dc0401030201030437303504 0c8000000903005254 00c8020102
0102020200a204066c61626d6f6e040ce22c3e1cccc3a0816b2de3090408bdf4dc46c97074990481a362ccc6cfc3fcb1f5dfe6a36ba9
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2b61fdeb71554fcc5d3fa447dc8681234e12ab5d5157c513e3981ae8abd5e8e564fe10aecfc7bd4560ef
1788819442.556 192.168.99.3 308201db020103300d020140020205dc0401030201030437303504 0c8000000903005254 00c80301
020102020200a204066c61626d6f6e040cd0e347d7a518a7d9e2f37c1b0408a7c7be9c6efe405d0482018cd8efa54000ad401bbc326d
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aef92a4fd087aa
1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c8000000903005254 00c8010102
0102020200a204066c61626d6f6e040cf1375d27c9b13e3bc630dda704089b184efb1b39c2200481a30198f4b559036be6e04256f622
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b637ad7fc13ded93b704de011795c6d883a9036f15a8f96224a3162a8d83a10fe88c1e9da55743953b410a155c88ebec8dc5ed1f85e8
```

```
d6719b4b8a6db27cd5500b799d76f31678bbff135288e19a3de00a02a2b05ec9f77a51e2e82d417f4fd9
1788819442.769 192.168.99.2 3081bb020103300d020146020205dc0401030201030437303504 0c8000000903005254 00c8020102
0102020200a204066c61626d6f6e040c3df77a9a6185cfb1cfecf88a0408bdf4dc46c970749b046ef296014ded7c0ce032945da3386e
1ebd3a6f6a183b3c2e4ebf6a7517d3b4fbe0d2965d0cedde29f5e6919fa5f14ad44ce1b2ffc828265b33e24d5f8c4f415511af6b9294
f9d44b5f12d56f7e84a1eea2197ad6b4e73721c87bfd23d6a00a98a878bc9f8f206e82d8a3606be17431
... 3231 more lines
```

NMS `sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true`

```
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  07970a2510babd3db4f4ce0ebb07f01f9ffd45e6fb29ef8feac58621e676b92935f9ce739373e633a53e74e506575e6f46825bb060ff
  e5b0c8526d79831062a4e95bdec7dd7039dd603bf20ecded96990e1d2ab506b0cb8e915f9e5b37d553f38e99197198e6c070324af943
  30b1625bd961d67078f27e4290be8c1b30f9fdd4f9da38629eaf2dd334b0e0a26532c0549a3fc8782afe71d694abf3ac5084fb3ae4b9
  34af1b612e329beb9c7e1163aa36dc290f9784b5cc2f25a844f00d69d85b8798ee860408950a0e0a5c9d4a79f2784d07c6aca87f8a39
  ea45e822985914ea2cb93b21d583ae4f38bbbb056238ff969149d9ebbe2171e6f569e3e2f1e75f5a94e133e9fca802228704d2f319ba
  aef92a4fd087aa
  1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c8000000903005254 00c8010102
  0102020200a204066c61626d6f6e040cf1375d27c9b13e3bc630dda704089b184efb1b39c2200481a30198f4b559036be6e04256f622
  03359df9f4b249e253bfc47820d97178378d92b51f24de8d8455b5342f2d76797f484d9471253faea500058a89ac76482836c4d83314
  b637ad7fc13ded93b704de011795c6d883a9036f15a8f96224a3162a8d83a10fe88c1e9da55743953b410a155c88ebec8dc5ed1f85e8
  d6719b4b8a6db27cd5500b799d76f31678bbff135288e19a3de00a02a2b05ec9f77a51e2e82d417f4fd9
  1788819442.769 192.168.99.2 3081bb020103300d020146020205dc0401030201030437303504 0c8000000903005254 00c8020102
  0102020200a204066c61626d6f6e040c3df77a9a6185cfb1cfecf88a0408bdf4dc46c970749b046ef296014ded7c0ce032945da3386e
  1ebd3a6f6a183b3c2e4ebf6a7517d3b4fbe0d2965d0cedde29f5e6919fa5f14ad44ce1b2ffc828265b33e24d5f8c4f415511af6b9294
  f9d44b5f12d56f7e84a1eea2197ad6b4e73721c87bfd23d6a00a98a878bc9f8f206e82d8a3606be17431
  ... 3232 more lines
```

PASS snmptrapd Decrypts Traps From Every Router (0.2s, 3 commands)

The strongest single statement this suite makes: a real SNMP manager, holding only the configured user and each router's engine ID, authenticated and decrypted the traps. That cannot happen unless the keys, the engine IDs and the privacy protocol all match on both sides.

```
NMS sudo cat /var/log/lab/snmptrapd.log 2>/dev/null || true
  NET-SNMP version 5.9.4.pre2
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.21        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.95        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:34.92        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.35        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:36.09        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.06        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  ... 6479 more lines
NMS sudo cat /var/log/lab/snmptrapd.log 2>/dev/null || true
  NET-SNMP version 5.9.4.pre2
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.21        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.95        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:34.92        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.35        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:36.09        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.06        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  ... 6479 more lines
NMS sudo cat /var/log/lab/snmptrapd.log 2>/dev/null || true
  NET-SNMP version 5.9.4.pre2
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.21        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.95        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:34.92        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.26 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.26 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.26 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.26 "lab"
  2026-09-07 22:17:21 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.35        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
```

```
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:36.09        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
  iso.3.6.1.2.1.1.3.0 0:0:03:35.06        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
  iso.3.6.1.4.1.9.9.43.1.1.6.1.3.27 1     iso.3.6.1.4.1.9.9.43.1.1.6.1.4.27 3
  iso.3.6.1.4.1.9.9.43.1.1.6.1.5.27 2     iso.3.6.1.4.1.9.9.43.1.1.6.1.8.27 "lab"
  2026-09-07 22:17:22 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
  ... 6481 more lines
```

PASS One Raw Listener Receives Every Router (0.1s, 1 commands)

The property the per-router-port workaround existed to dodge: a single socket now serves all three senders.

NMS `sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true`

```
  1788819441.732 192.168.99.1 3081f1020103300d020136020205dc0401030201030437303504 0c800000090300525400c8010102
  0102020200a204066c61626d6f6e040c0330a96d73b02577bd14002704089b184efb1b39c2180481a31e0cb257972ac1650a9c016737
  d7c3450c8b69b1810963c1c351af94e662bb62948440836307965026c2d246d66d8c3bf10781cd8fcab6521f98448783a6d9bf665ade
  b66e773f6cb948e6c84fbc1c22baffabc9a7c820adbbccc0607f9fe235937749231d4e94bb8fdcc059dcffbba830d801e015c85863d7
  158e72f510620b1c9e484b7417b4d3a185d046ea549f3642f878698207c3f818a4b10c5927a8e880fcba
  1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc0401030201030437303504 0c800000090300525400c8020102
  0102020200a104066c61626d6f6e040c280bc8173afb140f39665d400408bdf4dc46c97074930481a3485df5849e5eeeb771b44c093a
  ef6ddaf4b7ba8b009f4cb725b19f5e751850a70e9cd62e9471b527848f3350df4234902e59c6ba9cd696e552e207ef62af971e8908ef
  ae317dcaed8d6702a20fa8a0f5d3535538a2851e16b3bc0d2979168bf60354d2878e5cd7ac03c1daa98fd24eb8a451e70e624bdffc96
  8ee7b7c9e197db97da0102a62640bc8d2abf526e9a3bd5db09b0713ae471d14774a711e1c49770a339c6
  1788819441.806 192.168.99.3 3081f1020103300d02013a020205dc0401030201030437303504 0c800000090300525400c8030102
  0102020200a104066c61626d6f6e040c1a06b8620cf2bdfae082242d0408a7c7be9c6efe40570481a3f13563f7a9d2b23f9d6aedd6db
  b3ee8cb9bfc314d080afa0b0fb48addca5f604a787508df6374629f81bf9c5e8ed322c4fbc9fd5daf2e665dcbc312cc01027c101b15d
  95d74b6c51ef9faf06c0670481620af82d566719918aab054f908d5415c32688a26757db8041390a1fd440c938835bf8a171ee3321ef
  59f0d1a550a2e55083266bba89add3ddb3176843bbfc92d3de40fb901ba83f7d8c7124f27c7fe6db1dce
  1788819441.982 192.168.99.1 3081f1020103300d020138020205dc0401030201030437303504 0c800000090300525400c8010102
  0102020200a204066c61626d6f6e040c54e0b089dfb6d3286639954d04089b184efb1b39c21a0481a38399f66019ba392443b719d26a
  fd64cb17b4f7e47e6efc18540d7a161bb4df34a5d637d8baf88d7959b126d7f786e1521239899f10d3d27949f04880309d9a8e456a78
  4b512b0558a7215ca4ba9844e8fac890bae9434f944d06cc273d3d6bb9fd842b28c44aa4b6f7723acfc5a8d378b7f6d6019f1c750dbd
  2b44a96e3e05c10c5df1deb3e7c8f3b1022054494304e4456fad68c0f554b6016aa90535c790e85d921b
  1788819442.019 192.168.99.2 3081f1020103300d020140020205dc0401030201030437303504 0c800000090300525400c8020102
  0102020200a204066c61626d6f6e040cc5e940312135bbb74315f07f0408bdf4dc46c97074950481a3d122cd69208ea63a33c15acfa8
  7a45102a3d13ff4011a6fe0077d1190d97e78309f972e8bd391feaf8f439f142fa831bc51566d9eb8017d4cb97e7436f0ff3c8ef79ef
  ea5d0c4c1aab31cc9b7f8cff78355da4f4fcfa92bddd9281133bec7fae933da59e755762b226e899cb3c6998c3fb887f3397554d5152
  dcbea7abdb77818b788f02536a47b9893019f437a968d65cf16414aaec7588c7acf31617d6f2d26c240f
  1788819442.056 192.168.99.3 3081f1020103300d02013c020205dc0401030201030437303504 0c800000090300525400c8030102
  0102020200a204066c61626d6f6e040c97f59d812586c8cbc82aeec80408a7c7be9c6efe40590481a3944f05c35a695e8ab698a77fc0
  679d4817a25d2867b284b3553e5b9560d1abeb0194ef14399db882e9fa2c2b7a2e5a3a8776478141012d370690d28f11c26bfc8aa1fd
  53215e87e900d9dda1de7d41080b83bf95c9c0743949bd5c4af9ea11abc6a118939fad85eb0735991d6b9d8e891ccf0bd9cb99abf172
  805a8c9b5e5d778a279e1a0384713bb102e8ba0b0be1d56a9527722ef00de7e6baabfe3aae5f497a44f4
  1788819442.233 192.168.99.1 3081f1020103300d02013a020205dc0401030201030437303504 0c800000090300525400c8010102
  0102020200a204066c61626d6f6e040ce97d7d93c11dac8ea0caaafe04089b184efb1b39c21c0481a3ee52a2e7caf58003f3aeaef04a
  dcaabcf43bd1c13a51d4087e88c6a9a9cfb270aec98cf2cbdfc6fd803608b8bc6591cde59384e91da399d6f1080102f98fe25152158b
  139ebf2f59507f8016a328a4c7a9d1b80a4219982fe2f74978cda2b2ef1bf7d7faf9d835a5cf3f9042d5c74a4e898d39833cc1dbe052
  02b505f5d02dbbe48944635bbb890fd08e79baaef5523fd4bd8e7aa0f86d71427b43736a5d9d7bef4403
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  0102020200a204066c61626d6f6e040cd6f8a0f7f93b069d069759170408bdf4dc46c97074970481a33116ac4348d5c39ada28f96d78
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  1788819442.306 192.168.99.3 3081f1020103300d02013e020205dc0401030201030437303504 0c800000090300525400c8030102
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  1788819442.556 192.168.99.3 308201db020103300d020140020205dc0401030201030437303504 0c800000090300525400c80301
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```

```
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aef92a4fd087aa
1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c80000009030052540 0c8010102
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1788819442.769 192.168.99.2 3081bb020103300d020146020205dc0401030201030437303504 0c80000009030052540 0c8020102
0102020200a204066c61626d6f6e040c3df77a9a6185cfb1cfecf88a0408bdf4dc46c970749b046ef296014ded7c0ce032945da3386e
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f9d44b5f12d56f7e84a1eea2197ad6b4e73721c87bfd23d6a00a98a878bc9f8f206e82d8a3606be17431
... 3233 more lines
```

PASS Each Router Identifies Itself By Its Own Engine ID (0.3s, 6 commands)

The engine ID in the received trap must match the one the router reports, and must differ between routers -- that is what lets a collector attribute a trap to a device.

R1 show snmp engineID | include Local

```
Local SNMP engineID: 800000090300525400C80101
```

NMS sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true

```
1788819441.732 192.168.99.1 3081f1020103300d020136020205dc0401030201030437303504 0c80000009030052540 0c8010102
0102020200a204066c61626d6f6e040c0330a96d73b02577bd14002704089b184efb1b39c2180481a31e0cb257972ac1650a9c016737
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158e72f510620b1c9e484b7417b4d3a185d046ea549f3642f878698207c3f818a4b10c5927a8e880fcba
1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc0401030201030437303504 0c80000009030052540 0c8020102
0102020200a104066c61626d6f6e040c280bc8173afb140f39665d400408bdf4dc46c97074930481a3485df5849e5eeeb771b44c093a
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8ee7b7c9e197db97da0102a62640bc8d2abf526e9a3bd5db09b0713ae471d14774a711e1c49770a339c6
1788819441.806 192.168.99.3 3081f1020103300d02013a020205dc0401030201030437303504 0c80000009030052540 0c8030102
0102020200a104066c61626d6f6e040c1a06b8620cf2bdfae082242d0408a7c7be9c6efe40570481a3f13563f7a9d2b23f9d6aedd6db
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1788819441.982 192.168.99.1 3081f1020103300d020138020205dc0401030201030437303504 0c80000009030052540 0c8010102
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1788819442.056 192.168.99.3 3081f1020103300d02013c020205dc0401030201030437303504 0c80000009030052540 0c8030102
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1788819442.233 192.168.99.1 3081f1020103300d02013a020205dc0401030201030437303504 0c80000009030052540 0c8010102
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1788819442.267 192.168.99.2 3081f1020103300d020142020205dc0401030201030437303504 0c80000009030052540 0c8020102
0102020200a204066c61626d6f6e040cd6f8a0f7f93b069d069759170408bdf4dc46c97074970481a33116ac4348d5c39ada28f96d78
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8921e3a8316c7d66a27f4300e3b40e92dcf8449782b483b7ebb1c0a3da45fbe4c24622a7d600f36d7023
1788819442.306 192.168.99.3 3081f1020103300d02013e020205dc0401030201030437303504 0c80000009030052540 0c8030102
0102020200a204066c61626d6f6e040c3bb1f3582527a19034ec5d610408a7c7be9c6efe405b0481a3fa3381e2249898d509d85e1d9b
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1788819442.482 192.168.99.1 3081f1020103300d02013c020205dc0401030201030437303504 0c80000009030052540 0c8010102
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1788819442.518 192.168.99.2 3081f1020103300d020144020205dc0401030201030437303504 0c80000009030052540 0c8020102
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2b61fdeb71554fcc5d3fa447dc8681234e12ab5d5157c513e3981ae8abd5e8e564fe10aecfc7bd4560ef
1788819442.556 192.168.99.3 308201db020103300d020140020205dc0401030201030437303504 0c80000009030052540 0c80301
```

```
020102020200a204066c61626d6f6e040cd0e347d7a518a7d9e2f37c1b0408a7c7be9c6efe405d0482018cd8efa54000ad401bbc326d
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aef92a4fd087aa
1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c800000090300525400c8010102
0102020200a204066c61626d6f6e040cf1375d27c9b13e3bc630dda704089b184efb1b39c2200481a30198f4b559036be6e04256f622
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d6719b4b8a6db27cd5500b799d76f31678bbff135288e19a3de00a02a2b05ec9f77a51e2e82d417f4fd9
1788819442.769 192.168.99.2 3081bb020103300d020146020205dc0401030201030437303504 0c800000090300525400c8020102
0102020200a204066c61626d6f6e040c3df77a9a6185cfb1cfecf88a0408bdf4dc46c970749b046ef296014ded7c0ce032945da3386e
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f9d44b5f12d56f7e84a1eea2197ad6b4e73721c87bfd23d6a00a98a878bc9f8f206e82d8a3606be17431
... 3233 more lines
```

R2 **show snmp engineID | include Local**

```
Local SNMP engineID: 800000090300525400C80201
```

NMS **sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true**

```
1788819441.732 192.168.99.1 3081f1020103300d020136020205dc0401030201030437303504 0c800000090300525400c8010102
0102020200a204066c61626d6f6e040c0330a96d73b02577bd14002704089b184efb1b39c2180481a31e0cb257972ac1650a9c016737
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b66e773f6cb948e6c84fbc1c22baffabc9a7c820adbbccc0607f9fe235937749231d4e94bb8fdcc059dcffbba830d801e015c85863d7
158e72f510620b1c9e484b7417b4d3a185d046ea549f3642f878698207c3f818a4b10c5927a8e880fcba
1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc0401030201030437303504 0c800000090300525400c8020102
0102020200a104066c61626d6f6e040c280bc8173afb140f39665d400408bdf4dc46c97074930481a3485df5849e5eeeb771b44c093a
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8ee7b7c9e197db97da0102a62640bc8d2abf526e9a3bd5db09b0713ae471d14774a711e1c49770a339c6
1788819441.806 192.168.99.3 3081f1020103300d02013a020205dc0401030201030437303504 0c800000090300525400c8030102
0102020200a104066c61626d6f6e040c1a06b8620cf2bdfae082242d0408a7c7be9c6efe40570481a3f13563f7a9d2b23f9d6aedd6db
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59f0d1a550a2e55083266bba89add3ddb3176843bbfc92d3de40fb901ba83f7d8c7124f27c7fe6db1dce
1788819441.982 192.168.99.1 3081f1020103300d020138020205dc0401030201030437303504 0c800000090300525400c8010102
0102020200a204066c61626d6f6e040c54e0b089dfb6d3286639954d04089b184efb1b39c21a0481a38399f66019ba392443b719d26a
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```

```
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... 3233 more lines
```

R3 show snmp engineID | include Local

```
Local SNMP engineID: 800000090300525400C80301
```

NMS sudo cat /var/log/lab/traps-raw.log 2>/dev/null || true

```
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1788819441.768 192.168.99.2 3081f1020103300d02013e020205dc04010302010304373035040c80000009030052540 0c8020102
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1788819442.019 192.168.99.2 3081f1020103300d020140020205dc04010302010304373035040c80000009030052540 0c8020102
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```

```
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1788819442.733 192.168.99.1 3081f1020103300d02013e020205dc0401030201030437303504 0c800000090300525400c8010102
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... 3233 more lines
```

17 Snmp Polling

PASS The NMS Runs Real Net-SNMP Tooling (0.1s, 2 commands)

The point of this VM: unlike the cirros hosts it has a genuine SNMP client, so the polling below is the real thing rather than something hand rolled for the test.

```
NMS snmpget --version 2>&1 | head -2; snmpwalk --version 2>&1 | head -1
  NET-SNMP version: 5.9.4.pre2
  NET-SNMP version: 5.9.4.pre2
NMS command -v snmpget snmpwalk snmptrapd
  /usr/bin/snmpget
  /usr/bin/snmpwalk
  /usr/sbin/snmptrapd
```

PASS Every Router Answers An SNMPv3 authPriv Poll (0.2s, 3 commands)

The agent must be reachable and must accept the credentials the provisioner configured.

```
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
```

PASS Polled sysName Matches The Router's Own Hostname (0.4s, 6 commands)

Cross-check: the value SNMP returns is compared against what the device says on its CLI, so a plausible-looking answer from the wrong box cannot pass.

```
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
R1 show running-config | include ^hostname
  hostname c8000v-r1
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
R2 show running-config | include ^hostname
  hostname c8000v-r2
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
R3 show running-config | include ^hostname
  hostname c8000v-r3
```

PASS Polled sysDescr Identifies The Platform (0.2s, 6 commands)

```
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.1.1.0
  .1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
  UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
  Technical Support: http://www.cisco.com/techsupport
  Copyright (c) 1986-2026 by Cisco Systems, Inc.
  Compiled Wed 22-Jul-26 03:39 b"
R1 show version | include Version
  Cisco IOS XE Software, Version 17.15.06
  Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-UNIVERSALK9-M), Version 17.15.6, RELEASE
  SOFTWARE (fc2)
  licensed under the GNU General Public License ("GPL") Version 2.0.  The
  software code licensed under GPL Version 2.0 is free software that comes
  GPL code under the terms of GPL Version 2.0.  For more details, see the
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.1.0

```
.1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2026 by Cisco Systems, Inc.
Compiled Wed 22-Jul-26 03:39 b"
```

R2 show version | include Version

```
Cisco IOS XE Software, Version 17.15.06
Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-UNIVERSALK9-M), Version 17.15.6, RELEASE
SOFTWARE (fc2)
licensed under the GNU General Public License ("GPL") Version 2.0.  The
software code licensed under GPL Version 2.0 is free software that comes
GPL code under the terms of GPL Version 2.0.  For more details, see the
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3 1.3.6.1.2.1.1.1.0

```
.1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2026 by Cisco Systems, Inc.
Compiled Wed 22-Jul-26 03:39 b"
```

R3 show version | include Version

```
Cisco IOS XE Software, Version 17.15.06
Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-UNIVERSALK9-M), Version 17.15.6, RELEASE
SOFTWARE (fc2)
licensed under the GNU General Public License ("GPL") Version 2.0.  The
software code licensed under GPL Version 2.0 is free software that comes
GPL code under the terms of GPL Version 2.0.  For more details, see the
```

PASS sysUpTime Advances Between Two Polls (5.1s, 2 commands)

Proves the answers come from a live agent rather than a cached or replayed response.

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1 1.3.6.1.2.1.1.3.0

```
.1.3.6.1.2.1.1.3.0 = Timeticks: (512734) 1:25:27.34
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1 1.3.6.1.2.1.1.3.0

```
.1.3.6.1.2.1.1.3.0 = Timeticks: (513236) 1:25:32.36
```

PASS Walking The Interface Table Returns Every Interface The CLI Shows (0.2s, 6 commands)

A walk, not a get: the agent must return the whole subtree. Every physical interface named by the CLI must appear in it.

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1 1.3.6.1.2.1.2.2.1.2

```
.1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
.1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
.1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
.1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
.1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
.1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
.1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
.1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
.1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

R1 show ip interface brief

```
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet1       10.0.2.15       YES DHCP   up                    up
GigabitEthernet2       100.64.0.1      YES TFTP   up                    up
GigabitEthernet3       192.168.10.1    YES TFTP   up                    up
GigabitEthernet4       192.168.99.1    YES TFTP   up                    up
Loopback0              172.16.1.1      YES TFTP   up                    up
Loopback1              10.20.1.1       YES manual up                    up
Tunnel0                172.20.0.1      YES manual up                    up
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.2.2.1.2

```
.1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
.1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
.1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
.1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
.1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
.1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
.1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
```

```
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

R2 show ip interface brief

```
  Interface              IP-Address      OK? Method Status                Protocol
  GigabitEthernet1       10.0.2.15       YES DHCP   up                    up
  GigabitEthernet2       100.64.0.2      YES TFTP   up                    up
  GigabitEthernet3       192.168.20.1    YES TFTP   up                    up
  GigabitEthernet4       192.168.99.2    YES TFTP   up                    up
  Loopback0              172.16.2.1      YES TFTP   up                    up
  Loopback1              10.20.2.1       YES manual up                    up
  Tunnel0                172.20.0.2      YES manual up                    up
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

R3 show ip interface brief

```
  Interface              IP-Address      OK? Method Status                Protocol
  GigabitEthernet1       10.0.2.15       YES DHCP   up                    up
  GigabitEthernet2       100.64.0.3      YES TFTP   up                    up
  GigabitEthernet3       192.168.30.1    YES TFTP   up                    up
  GigabitEthernet4       192.168.99.3    YES TFTP   up                    up
  Loopback0              172.16.3.1      YES TFTP   up                    up
  Loopback1              10.20.3.1       YES manual up                    up
  Tunnel0                172.20.0.3      YES manual up                    up
```

PASS Polled Interface Count Agrees With The Interface Table (0.3s, 6 commands)

ifNumber is a scalar the agent maintains separately from the table, so the two disagreeing would mean a broken agent.

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1 1.3.6.1.2.1.2.1.0

```
  .1.3.6.1.2.1.2.1.0 = INTEGER: 9
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.2.1.0

```
  .1.3.6.1.2.1.2.1.0 = INTEGER: 9
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3 1.3.6.1.2.1.2.1.0

```
  .1.3.6.1.2.1.2.1.0 = INTEGER: 9
```

NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3 1.3.6.1.2.1.2.2.1.2

```
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
```

```
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

PASS The LAN Interface Is Reported Up By Both SNMP And The CLI (0.4s, 9 commands)

ifOperStatus 1 is up(1). Checked against the CLI line protocol state for the same interface.

```
NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.2.2.1.2
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.2.2.1.8
  .1.3.6.1.2.1.2.2.1.8.1 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.2 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.3 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.4 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.5 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.6 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.7 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.8 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.9 = INTEGER: 1
R1 show interfaces GigabitEthernet3 | include line protocol
  GigabitEthernet3 is up, line protocol is up
NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.2.2.1.2
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.2.2.1.8
  .1.3.6.1.2.1.2.2.1.8.1 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.2 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.3 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.4 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.5 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.6 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.7 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.8 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.9 = INTEGER: 1
R2 show interfaces GigabitEthernet3 | include line protocol
  GigabitEthernet3 is up, line protocol is up
NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.2.2.1.2
  .1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
  .1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
  .1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
  .1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
  .1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
  .1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
  .1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
  .1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
  .1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
NMS snmpwalk -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.2.2.1.8
  .1.3.6.1.2.1.2.2.1.8.1 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.2 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.3 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.4 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.5 = INTEGER: 1
```

```
  .1.3.6.1.2.1.2.2.1.8.6 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.7 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.8 = INTEGER: 1
  .1.3.6.1.2.1.2.2.1.8.9 = INTEGER: 1
```

R3 show interfaces GigabitEthernet3 | include line protocol

```
  GigabitEthernet3 is up, line protocol is up
```

PASS Spokes Are Polled Across The Encrypted Tunnel (1.2s, 16 commands)

The NMS shares a LAN with the hub only. Traffic to R2 and R3 crosses the IPsec tunnels, so a burst of polling must show up on the ESP counters at both ends.

R1 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 79927, #pkts encrypt: 79927, #pkts digest: 79927
      #pkts decaps: 43120, #pkts decrypt: 43120, #pkts verify: 43120
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
```

R2 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
     current_peer 100.64.0.3 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 52413, #pkts encrypt: 52413, #pkts digest: 52413
      #pkts decaps: 28013, #pkts decrypt: 28013, #pkts verify: 28013
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

```
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 79935, #pkts encrypt: 79935, #pkts digest: 79935
      #pkts decaps: 43126, #pkts decrypt: 43126, #pkts verify: 43126
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.2

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.3/255.255.255.255/47/0)
     current_peer 100.64.0.3 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 52418, #pkts encrypt: 52418, #pkts digest: 52418
      #pkts decaps: 28018, #pkts decrypt: 28018, #pkts verify: 28018
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
```

PASS A Wrong Authentication Password Is Refused (0.1s, 2 commands)

Negative control. The agent answers the correct credentials first, so a refusal here cannot be a dead router.

```
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A NotTheRightPassword -x AES -X LabPrivPass123 -t 2 -r 0
192.168.99.1 1.3.6.1.2.1.1.5.0
  snmpget: Authentication failure (incorrect password, community or key)
```

PASS A Wrong Privacy Password Is Refused (2.2s, 3 commands)

Authentication succeeds but the payload will not decrypt, so the router drops the request silently and the client times out. Bracketed by a good poll to prove it is still alive.

```
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X NotTheRightPassword -t 2 -r 0
192.168.99.1 1.3.6.1.2.1.1.5.0
  Timeout: No Response from 192.168.99.1.
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
```

PASS Polling Without Privacy Is Refused By Every Router (0.3s, 6 commands)

The group is configured "v3 priv". Correct credentials at a lower security level must still be denied, otherwise the privacy requirement is decorative.

```
NMS snmpget -On -v3 -l noAuthNoPriv -u labmon -t 2 -r 0 192.168.99.1 1.3.6.1.2.1.1.5.0
  Error in packet
  Reason: authorizationError (access denied to that object)
NMS snmpget -On -v3 -l authNoPriv -u labmon -a SHA -A LabAuthPass123 -t 2 -r 0 192.168.99.1 1.3.6.1.2.1.1.5.0
  Error in packet
  Reason: authorizationError (access denied to that object)
NMS snmpget -On -v3 -l noAuthNoPriv -u labmon -t 2 -r 0 192.168.99.2 1.3.6.1.2.1.1.5.0
  Error in packet
  Reason: authorizationError (access denied to that object)
NMS snmpget -On -v3 -l authNoPriv -u labmon -a SHA -A LabAuthPass123 -t 2 -r 0 192.168.99.2 1.3.6.1.2.1.1.5.0
  Error in packet
  Reason: authorizationError (access denied to that object)
NMS snmpget -On -v3 -l noAuthNoPriv -u labmon -t 2 -r 0 192.168.99.3 1.3.6.1.2.1.1.5.0
  Error in packet
  Reason: authorizationError (access denied to that object)
NMS snmpget -On -v3 -l authNoPriv -u labmon -a SHA -A LabAuthPass123 -t 2 -r 0 192.168.99.3 1.3.6.1.2.1.1.5.0
  Error in packet
  Reason: authorizationError (access denied to that object)
```

PASS An Unknown User Is Refused (0.1s, 1 commands)

Only the provisioned user exists in the USM table.

```
NMS snmpget -On -v3 -l authPriv -u intruder -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 2 -r 0 192.168.99.1
1.3.6.1.2.1.1.5.0
  snmpget: Unknown user name
```

PASS SNMPv2c Gets No Answer At The Wire (6.3s, 6 commands)

Suite 16 asserts no community is configured. This asserts the consequence on the network: a v2c poll gets nothing back, while a v3 poll to the same address succeeds.

```
NMS snmpget -On -v2c -c public -t 2 -r 0 192.168.99.1 1.3.6.1.2.1.1.5.0
  Timeout: No Response from 192.168.99.1.
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
NMS snmpget -On -v2c -c public -t 2 -r 0 192.168.99.2 1.3.6.1.2.1.1.5.0
  Timeout: No Response from 192.168.99.2.
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v2c -c public -t 2 -r 0 192.168.99.3 1.3.6.1.2.1.1.5.0
  Timeout: No Response from 192.168.99.3.
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
```

18 Mtu

PASS Every Tunnel Reports The Expected Transport MTU (0.3s, 9 commands)

The tunnel MTU must be below the physical one by the ESP overhead. Equal would mean encryption costs nothing, which would mean it is not happening.

```
R1 show ip interface brief | include ^Tunnel
  Tunnel0                172.20.0.1      YES manual up                    up
R1 show interfaces Tunnel0 | include Tunnel transport MTU
  Tunnel transport MTU 1472 bytes
R1 show ip interface Tunnel0 | include MTU
  MTU is 1472 bytes
R2 show ip interface brief | include ^Tunnel
  Tunnel0                172.20.0.2      YES manual up                    up
R2 show interfaces Tunnel0 | include Tunnel transport MTU
  Tunnel transport MTU 1472 bytes
R2 show ip interface Tunnel0 | include MTU
  MTU is 1472 bytes
R3 show ip interface brief | include ^Tunnel
  Tunnel0                172.20.0.3      YES manual up                    up
R3 show interfaces Tunnel0 | include Tunnel transport MTU
  Tunnel transport MTU 1472 bytes
R3 show ip interface Tunnel0 | include MTU
  MTU is 1472 bytes
```

PASS The Overhead Is What GRE With A Tunnel Key Costs (0.0s, 0 commands)

Records the number rather than assuming it: 20 bytes of outer IP, 4 of GRE and 4 for the tunnel key. If the encapsulation changes -- dropping the key, or moving IPsec from transport to tunnel mode -- this is the test that should fail first.

No device commands (assertion used earlier output).

PASS A Packet Exactly At The Tunnel MTU Crosses With DF Set (0.1s, 2 commands)

The permissive half of the boundary. Sourced from Loopback1 so the traffic is inside the protected selector. Warmed up first: the first packet between two spokes is consumed establishing the shortcut and its security association, so a cold measurement here reports 80 percent and says nothing about the MTU. That first-packet loss is DMVPN working, not failing.

```
R2 ping 10.20.3.1 source Loopback1 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/3 ms
R2 ping 10.20.3.1 source Loopback1 size 1472 df-bit repeat 5
  Type escape sequence to abort.
  Sending 5, 1472-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  Packet sent with the DF bit set
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/3 ms
```

PASS One Byte Over The Tunnel MTU Does Not Cross With DF Set (10.0s, 1 commands)

The restrictive half. Without this the test above would pass just as well against a tunnel with no MTU limit at all.

```
R2 ping 10.20.3.1 source Loopback1 size 1473 df-bit repeat 5
  Type escape sequence to abort.
  Sending 5, 1473-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  Packet sent with the DF bit set
  .....
  Success rate is 0 percent (0/5)
```

PASS Oversize Traffic Still Crosses When Fragmentation Is Allowed (0.1s, 2 commands)

Distinguishes an MTU limit from a blackhole: the same sizes that fail with DF set must succeed without it.

```
R2 ping 10.20.3.1 source Loopback1 size 1500 repeat 5
  Type escape sequence to abort.
  Sending 5, 1500-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/3 ms
R2 ping 10.20.3.1 source Loopback1 size 2000 repeat 5
  Type escape sequence to abort.
  Sending 5, 2000-byte ICMP Echos to 10.20.3.1, timeout is 2 seconds:
  Packet sent with a source address of 10.20.2.1
  !!!!!
  Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

PASS Hosts Pass Sub-MTU Traffic With DF Set (4.0s, 1 commands)

End to end across two encrypt/decrypt hops, from machines that know nothing about the tunnel.

```
H2 ping -c 5 -M do -s 1444 192.168.30.10
  PING 192.168.30.10 (192.168.30.10) 1444(1472) bytes of data.
  1452 bytes from 192.168.30.10: icmp_seq=1 ttl=62 time=1.48 ms
  1452 bytes from 192.168.30.10: icmp_seq=2 ttl=62 time=1.43 ms
  1452 bytes from 192.168.30.10: icmp_seq=3 ttl=62 time=1.36 ms
  1452 bytes from 192.168.30.10: icmp_seq=4 ttl=62 time=1.33 ms
  1452 bytes from 192.168.30.10: icmp_seq=5 ttl=62 time=1.50 ms

  --- 192.168.30.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.329/1.421/1.503/0.066 ms
```

PASS An End Host Learns The Tunnel Path MTU (2.0s, 1 commands)

The test that matters most in practice. The host is two hops and an encryption boundary away from the constraint, yet it must end up knowing the real limit -- otherwise a client retransmits into a black hole instead of backing off. The host reporting the exact tunnel MTU is proof that path MTU discovery survived the tunnel.

```
H2 ping -c 2 -M do -s 1472 192.168.30.10
  PING 192.168.30.10 (192.168.30.10) 1472(1500) bytes of data.
  From 192.168.20.1 icmp_seq=1 Frag needed and DF set (mtu = 1472)
  ping: local error: message too long, mtu=1472

  --- 192.168.30.10 ping statistics ---
  2 packets transmitted, 0 received, +2 errors, 100% packet loss, time 1005ms
```

PASS Hosts Pass Oversize Traffic Without DF Set (4.0s, 1 commands)

The counterpart: the same payload that was refused with DF set gets through when it may be fragmented.

```
H2 ping -c 5 -s 1472 192.168.30.10
  PING 192.168.30.10 (192.168.30.10) 1472(1500) bytes of data.
  1480 bytes from 192.168.30.10: icmp_seq=1 ttl=62 time=1.47 ms
  1480 bytes from 192.168.30.10: icmp_seq=2 ttl=62 time=1.46 ms
  1480 bytes from 192.168.30.10: icmp_seq=3 ttl=62 time=2.01 ms
  1480 bytes from 192.168.30.10: icmp_seq=4 ttl=62 time=1.57 ms
  1480 bytes from 192.168.30.10: icmp_seq=5 ttl=62 time=1.41 ms

  --- 192.168.30.10 ping statistics ---
  5 packets transmitted, 5 received, 0% packet loss, time 4006ms
  rtt min/avg/max/mdev = 1.414/1.582/2.008/0.218 ms
```

19 Oob

PASS Every Router Has A Management VRF (0.0s, 3 commands)

```
R1 show vrf
  Name                             Default RD            Protocols   Interfaces
    MGMT                             <not set>             ipv4        Gi4
R2 show vrf
  Name                             Default RD            Protocols   Interfaces
    MGMT                             <not set>             ipv4        Gi4
R3 show vrf
  Name                             Default RD            Protocols   Interfaces
    MGMT                             <not set>             ipv4        Gi4
```

PASS Only The OOB Interface Is In The Management VRF (0.1s, 3 commands)

A VRF containing a data interface would defeat the point, so this asserts membership is exactly one interface.

```
R1 show vrf MGMT
  Name                             Default RD            Protocols   Interfaces
    MGMT                             <not set>             ipv4        Gi4
R2 show vrf MGMT
  Name                             Default RD            Protocols   Interfaces
    MGMT                             <not set>             ipv4        Gi4
R3 show vrf MGMT
  Name                             Default RD            Protocols   Interfaces
    MGMT                             <not set>             ipv4        Gi4
```

PASS Every Router Holds Its OOB Address On The Flat Network (0.1s, 3 commands)

```
R1 show ip interface brief | include GigabitEthernet4
  GigabitEthernet4       192.168.99.1    YES TFTP   up                    up
R2 show ip interface brief | include GigabitEthernet4
  GigabitEthernet4       192.168.99.2    YES TFTP   up                    up
R3 show ip interface brief | include GigabitEthernet4
  GigabitEthernet4       192.168.99.3    YES TFTP   up                    up
```

PASS The Management VRF Routing Table Holds Only The Flat Network (0.1s, 3 commands)

The isolation, stated as routing: the VRF must know how to reach the management network and nothing else. A default route or a data prefix here would be a leak.

```
R1 show ip route vrf MGMT
  Routing Table: MGMT
  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, m - OMP
         n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
         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
         H - NHRP, G - NHRP registered, g - NHRP registration summary
         o - ODR, P - periodic downloaded static route, l - LISP
         a - application route
         + - replicated route, % - next hop override, p - overrides from PfR
         & - replicated local route overrides by connected

  ... 5 more lines
R2 show ip route vrf MGMT
  Routing Table: MGMT
  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, m - OMP
         n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
         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
         H - NHRP, G - NHRP registered, g - NHRP registration summary
```

```
        o - ODR, P - periodic downloaded static route, l - LISP
        a - application route
        + - replicated route, % - next hop override, p - overrides from PfR
        & - replicated local route overrides by connected

  ... 5 more lines
```

R3 show ip route vrf MGMT

```
  Routing Table: MGMT
  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, m - OMP
         n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
         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
         H - NHRP, G - NHRP registered, g - NHRP registration summary
         o - ODR, P - periodic downloaded static route, l - LISP
         a - application route
         + - replicated route, % - next hop override, p - overrides from PfR
         & - replicated local route overrides by connected

  ... 5 more lines
```

PASS The Global Table Cannot Reach The Management Network (0.1s, 3 commands)

The other direction. Traffic in the global table must have no path to the OOB network, otherwise the VRF is decorative.

R1 show ip route 192.168.99.0

```
  % Network not in table
```

R2 show ip route 192.168.99.0

```
  % Network not in table
```

R3 show ip route 192.168.99.0

```
  % Network not in table
```

PASS Every Router Answers SNMP On Its OOB Address (0.3s, 6 commands)

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.1 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
```

R1 show running-config | include ^hostname

```
  hostname c8000v-r1
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

R2 show running-config | include ^hostname

```
  hostname c8000v-r2
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3 1.3.6.1.2.1.1.5.0

```
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
```

R3 show running-config | include ^hostname

```
  hostname c8000v-r3
```

PASS Management Traffic Never Touches The Data Path (3.2s, 28 commands)

The negative property that makes this out-of-band. Polling a spoke used to cross an IPsec tunnel and was asserted to advance the ESP counters; now it must do the opposite. The comparison is against an idle window of the same length, because BGP and BFD tick those counters continuously regardless -- so an absolute delta proves nothing.

R1 show crypto ipsec sa

```
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 80145, #pkts encrypt: 80145, #pkts digest: 80145
      #pkts decaps: 43337, #pkts decrypt: 43337, #pkts verify: 43337
```

```
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
  ... 78 more lines
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

```
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.3
1.3.6.1.2.1.1.5.0
  .1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 80151, #pkts encrypt: 80151, #pkts digest: 80151
      #pkts decaps: 43343, #pkts decrypt: 43343, #pkts verify: 43343
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 80151, #pkts encrypt: 80151, #pkts digest: 80151
      #pkts decaps: 43343, #pkts decrypt: 43343, #pkts verify: 43343
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
R1 show crypto ipsec sa
  interface: Tunnel0
      Crypto map tag: Tunnel0-head-0, local addr 100.64.0.1

     protected vrf: (none)
     local  ident (addr/mask/prot/port): (100.64.0.1/255.255.255.255/47/0)
     remote ident (addr/mask/prot/port): (100.64.0.2/255.255.255.255/47/0)
     current_peer 100.64.0.2 port 500
       PERMIT, flags={origin_is_acl,}
      #pkts encaps: 80165, #pkts encrypt: 80165, #pkts digest: 80165
      #pkts decaps: 43356, #pkts decrypt: 43356, #pkts verify: 43356
      #pkts compressed: 0, #pkts decompressed: 0
      #pkts not compressed: 0, #pkts compr. failed: 0
      #pkts not decompressed: 0, #pkts decompress failed: 0
      #send errors 0, #recv errors 0
  ... 78 more lines
```

PASS Syslog Reaches The Collector From The OOB Address (12.2s, 4 commands)

rsyslog files are named for the sender. A file named after a LAN address would mean the router is logging from the data path despite the configuration. Each router is made to emit a marked message rather than waiting on ambient traffic: whether a router happens to have logged recently is not what this test is about, and depending on it makes the result a matter of timing.

```
NMS sudo grep -c -- 'LABOOB-SRC-R1-193959' /var/log/lab/192.168.99.1.log 2>/dev/null || echo 0
  1
NMS sudo grep -c -- 'LABOOB-SRC-R2-193959' /var/log/lab/192.168.99.2.log 2>/dev/null || echo 0
  1
NMS sudo grep -c -- 'LABOOB-SRC-R3-193959' /var/log/lab/192.168.99.3.log 2>/dev/null || echo 0
  1
NMS sudo ls -l /var/log/lab
  total 3412
  -rw-r--r-- 1 syslog syslog  162978 Sep  7 23:40 192.168.99.1.log
```

```
-rw-r--r-- 1 syslog syslog  204503 Sep  7 23:40 192.168.99.2.log
-rw-r--r-- 1 syslog syslog  127160 Sep  7 23:40 192.168.99.3.log
-rw-r--r-- 1 root   root   1136638 Sep  7 23:39 snmptrapd.log
-rw-r--r-- 1 root   root   1832337 Sep  7 23:39 traps-raw.log
```

PASS A Spoke Stays Manageable With Its Tunnel Down (14.4s, 15 commands)

The reason out-of-band management exists. Shutting R2's tunnel removes every data path between the hub and the spoke -- BGP drops, the LAN becomes unreachable -- and the spoke must still answer SNMP and keep logging, because none of that ever used the tunnel.

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
.1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

R2 configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 interface Tunnel0

```
${output} =
```

R2 shutdown

```
${output} =
```

R2 end

```
${output} =
```

R1 show ip route 192.168.20.0

```
Routing entry for 192.168.20.0/24
  Known via "bgp 65001", distance 20, metric 0
  Tag 65002, type external
  Last update from 172.20.0.2 00:08:27 ago
  Routing Descriptor Blocks:
  * 172.20.0.2, from 172.20.0.2, 00:08:27 ago
      opaque_ptr 0x747B4EAD55B8
      Route metric is 0, traffic share count is 1
      AS Hops 1
      Route tag 65002
      MPLS label: none
```

R1 show ip route 192.168.20.0

```
% Network not in table
```

NMS snmpget -On -v3 -l authPriv -u labmon -a SHA -A LabAuthPass123 -x AES -X LabPrivPass123 -t 3 -r 1 192.168.99.2 1.3.6.1.2.1.1.5.0

```
.1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
```

NMS sudo grep -c -- 'LABOOB-194017' /var/log/lab/192.168.99.2.log 2>/dev/null || echo 0

```
1
```

R2 configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

R2 interface Tunnel0

```
${output} =
```

R2 no shutdown

```
${output} =
```

R2 end

```
${output} =
```

R1 show bgp ipv4 unicast summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 13, main routing table version 13
6 network entries using 1488 bytes of memory
6 path entries using 816 bytes of memory
4/4 BGP path/bestpath attribute entries using 1184 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
3 BGP community entries using 72 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3584 total bytes of memory
BGP activity 189/183 prefixes, 195/189 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (01:06:22.165 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
... 2 more lines
```

R1 show bgp ipv4 unicast summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 16, main routing table version 16
9 network entries using 2232 bytes of memory
9 path entries using 1224 bytes of memory
7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
```

```
2 BGP AS-PATH entries using 48 bytes of memory
6 BGP community entries using 144 bytes of memory
3 BGP route-map cache entries using 216 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 5936 total bytes of memory
BGP activity 192/183 prefixes, 198/189 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (01:06:27.205 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
... 2 more lines
```

20 Tacacs

PASS The TACACS Server Runs On The NMS (0.1s, 2 commands)

```
NMS systemctl is-active tacacs-lab
  active
NMS sudo ss -ltnp | grep ':49 ' || echo NONE
  LISTEN 0      128          0.0.0.0:49        0.0.0.0:*    users:(("tac_plus",pid=3254,fd=4))
  LISTEN 0      128             [::]:49           [::]:*    users:(("tac_plus",pid=3254,fd=5))
```

PASS The Server Holds Both Remote Users And The Automation Account (0.1s, 1 commands)

The automation account has to exist on the server as well as locally on each router. Without it the first router to get AAA becomes unmanageable by this very test suite, while the server sits there perfectly healthy.

```
NMS sudo grep -oE '^user = [A-Za-z0-9_-]+' /etc/tacacs+/tac_plus.conf
  user = netadmin
  user = netops
  user = lab
```

PASS Every Router Points At The Server Through The Management VRF (0.4s, 3 commands)

```
R1 show running-config | include ^aaa |^tacacs server|^ address ipv4|^ ip vrf forwarding|^ ip tacacs source
  aaa new-model
  aaa group server tacacs+ LABTACGRP
   ip vrf forwarding MGMT
   ip tacacs source-interface GigabitEthernet4
  aaa authentication login default group LABTACGRP local
  aaa authentication enable default group LABTACGRP enable
  aaa authorization exec default group LABTACGRP local if-authenticated
  aaa accounting exec default start-stop group LABTACGRP
  aaa accounting commands 15 default start-stop group LABTACGRP
  aaa session-id common
  tacacs server LAB-TAC
   address ipv4 192.168.99.10
R2 show running-config | include ^aaa |^tacacs server|^ address ipv4|^ ip vrf forwarding|^ ip tacacs source
  aaa new-model
  aaa group server tacacs+ LABTACGRP
   ip vrf forwarding MGMT
   ip tacacs source-interface GigabitEthernet4
  aaa authentication login default group LABTACGRP local
  aaa authentication enable default group LABTACGRP enable
  aaa authorization exec default group LABTACGRP local if-authenticated
  aaa accounting exec default start-stop group LABTACGRP
  aaa accounting commands 15 default start-stop group LABTACGRP
  aaa session-id common
  tacacs server LAB-TAC
   address ipv4 192.168.99.10
R3 show running-config | include ^aaa |^tacacs server|^ address ipv4|^ ip vrf forwarding|^ ip tacacs source
  aaa new-model
  aaa group server tacacs+ LABTACGRP
   ip vrf forwarding MGMT
   ip tacacs source-interface GigabitEthernet4
  aaa authentication login default group LABTACGRP local
  aaa authentication enable default group LABTACGRP enable
  aaa authorization exec default group LABTACGRP local if-authenticated
  aaa accounting exec default start-stop group LABTACGRP
  aaa accounting commands 15 default start-stop group LABTACGRP
  aaa session-id common
  tacacs server LAB-TAC
   address ipv4 192.168.99.10
```

PASS Every Method List Falls Back To The Local Database (0.3s, 3 commands)

A method list with no local fallback locks the lab out the moment the server is unreachable -- including from the console, which is the one way back in.

```
R1 show running-config | include ^aaa authentication login|^aaa authorization exec
  aaa authentication login default group LABTACGRP local
  aaa authorization exec default group LABTACGRP local if-authenticated
```

```
R2 show running-config | include ^aaa authentication login|^aaa authorization exec
  aaa authentication login default group LABTACGRP local
  aaa authorization exec default group LABTACGRP local if-authenticated
R3 show running-config | include ^aaa authentication login|^aaa authorization exec
  aaa authentication login default group LABTACGRP local
  aaa authorization exec default group LABTACGRP local if-authenticated
```

PASS Every Router Reports The Server Alive (0.1s, 3 commands)

```
R1 show tacacs
  Tacacs+ Server -  public  :
                 Server name: LAB-TAC
              Server address: 192.168.99.10
                 Server port: 49
                Socket opens:       1279
              Socket closes:       1279
              Socket aborts:          0
              Socket errors:          0
            Socket Timeouts:          0
     Failed Connect Attempts:          0
          Total Packets Sent:       1348
          Total Packets Recv:       1348
               Server Status: Alive
  Continous Authc fail count:          3
  ... 1 more lines
R2 show tacacs
  Tacacs+ Server -  public  :
                 Server name: LAB-TAC
              Server address: 192.168.99.10
                 Server port: 49
                Socket opens:       1974
              Socket closes:       1974
              Socket aborts:          0
              Socket errors:          0
            Socket Timeouts:          0
     Failed Connect Attempts:          0
          Total Packets Sent:       2010
          Total Packets Recv:       2010
               Server Status: Alive
  Continous Authc fail count:          2
  ... 1 more lines
R3 show tacacs
  Tacacs+ Server -  public  :
                 Server name: LAB-TAC
              Server address: 192.168.99.10
                 Server port: 49
                Socket opens:        733
              Socket closes:        733
              Socket aborts:          0
              Socket errors:          0
            Socket Timeouts:          0
     Failed Connect Attempts:          0
          Total Packets Sent:        799
          Total Packets Recv:        799
               Server Status: Alive
  Continous Authc fail count:          2
  ... 1 more lines
```

PASS A Remote Administrator Authenticates And Is Given Privilege 15 (0.2s, 0 commands)

No device commands (assertion used earlier output).

PASS A Remote Operator Authenticates And Is Held At Privilege 1 (0.3s, 0 commands)

The pair that proves the level comes from the server. Two users, same router, same method list, different levels -- which cannot happen if the router is applying a default.

No device commands (assertion used earlier output).

PASS A Wrong Password Is Refused (2.1s, 0 commands)

No device commands (assertion used earlier output).

PASS An Unknown User Is Refused (2.1s, 0 commands)

The server rejects the user and the router honours that rather than quietly trying the local database.

No device commands (assertion used earlier output).

PASS The Server Records Authentication In Its Accounting Log (0.1s, 1 commands)

Accounting is what makes remote authentication auditable; without it the router knows who logged in and nobody else ever finds out.

```
NMS sudo tail -200 /var/log/tac_plus.acct 2>/dev/null || true
  Sep  7 23:37:39 192.168.99.1    lab     tty434  10.0.2.2        stop    task_id=4959    timezone=UTC
  service=shell   start_time=1788824259   priv-lvl=15     cmd=show monitor capture POOLCAP buffer brief <cr>
  Sep  7 23:37:41 192.168.99.1    lab     tty434  10.0.2.2        stop    task_id=4960    timezone=UTC
  service=shell   start_time=1788824261   priv-lvl=15     cmd=no monitor capture POOLCAP <cr>
  Sep  7 23:37:41 192.168.99.2    lab     tty434  10.0.2.2        stop    task_id=5649    timezone=UTC
  service=shell   start_time=1788824172   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=89 stop_time=1788824261
  Sep  7 23:37:42 192.168.99.3    lab     tty434  10.0.2.2        stop    task_id=4434    timezone=UTC
  service=shell   start_time=1788824172   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=90 stop_time=1788824262
  Sep  7 23:37:42 192.168.99.1    lab     tty435  10.0.2.2        start   task_id=4962    timezone=UTC
  service=shell   start_time=1788824262
  Sep  7 23:37:42 192.168.99.1    lab     tty434  10.0.2.2        stop    task_id=4941    timezone=UTC
  service=shell   start_time=1788824172   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=90 stop_time=1788824262
  Sep  7 23:37:42 192.168.99.2    lab     tty435  10.0.2.2        start   task_id=5657    timezone=UTC
  service=shell   start_time=1788824262
  Sep  7 23:37:42 192.168.99.3    lab     tty434  10.0.2.2        start   task_id=4440    timezone=UTC
  service=shell   start_time=1788824262
  Sep  7 23:37:42 192.168.99.1    lab     tty435  10.0.2.2        stop    task_id=4962    timezone=UTC
  service=shell   start_time=1788824262   priv-lvl=15     cmd=show running-config <cr>
  Sep  7 23:37:42 192.168.99.2    lab     tty435  10.0.2.2        stop    task_id=5657    timezone=UTC
  service=shell   start_time=1788824262   priv-lvl=15     cmd=show running-config <cr>
  Sep  7 23:37:42 192.168.99.3    lab     tty434  10.0.2.2        stop    task_id=4440    timezone=UTC
  service=shell   start_time=1788824262   priv-lvl=15     cmd=show running-config <cr>
  Sep  7 23:37:45 192.168.99.1    lab     tty435  10.0.2.2        stop    task_id=4962    timezone=UTC
  service=shell   start_time=1788824262   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=3  stop_time=1788824265
  Sep  7 23:37:45 192.168.99.2    lab     tty435  10.0.2.2        stop    task_id=5657    timezone=UTC
  service=shell   start_time=1788824262   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=3  stop_time=1788824265
  Sep  7 23:37:45 192.168.99.1    lab     tty434  10.0.2.2        start   task_id=4964    timezone=UTC
  service=shell   start_time=1788824265
  ... 186 more lines
```

PASS Accounting Records Carry The Privilege Level And Come From The OOB Address (0.1s, 1 commands)

```
NMS sudo tail -200 /var/log/tac_plus.acct 2>/dev/null || true
  Sep  7 23:37:39 192.168.99.1    lab     tty434  10.0.2.2        stop    task_id=4959    timezone=UTC
  service=shell   start_time=1788824259   priv-lvl=15     cmd=show monitor capture POOLCAP buffer brief <cr>
  Sep  7 23:37:41 192.168.99.1    lab     tty434  10.0.2.2        stop    task_id=4960    timezone=UTC
  service=shell   start_time=1788824261   priv-lvl=15     cmd=no monitor capture POOLCAP <cr>
  Sep  7 23:37:41 192.168.99.2    lab     tty434  10.0.2.2        stop    task_id=5649    timezone=UTC
  service=shell   start_time=1788824172   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=89 stop_time=1788824261
  Sep  7 23:37:42 192.168.99.3    lab     tty434  10.0.2.2        stop    task_id=4434    timezone=UTC
  service=shell   start_time=1788824172   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=90 stop_time=1788824262
  Sep  7 23:37:42 192.168.99.1    lab     tty435  10.0.2.2        start   task_id=4962    timezone=UTC
  service=shell   start_time=1788824262
  Sep  7 23:37:42 192.168.99.1    lab     tty434  10.0.2.2        stop    task_id=4941    timezone=UTC
  service=shell   start_time=1788824172   disc-cause=1    disc-cause-ext=9        pre-session-time=0
  elapsed_time=90 stop_time=1788824262
  Sep  7 23:37:42 192.168.99.2    lab     tty435  10.0.2.2        start   task_id=5657    timezone=UTC
  service=shell   start_time=1788824262
  Sep  7 23:37:42 192.168.99.3    lab     tty434  10.0.2.2        start   task_id=4440    timezone=UTC
  service=shell   start_time=1788824262
  Sep  7 23:37:42 192.168.99.1    lab     tty435  10.0.2.2        stop    task_id=4962    timezone=UTC
  service=shell   start_time=1788824262   priv-lvl=15     cmd=show running-config <cr>
  Sep  7 23:37:42 192.168.99.2    lab     tty435  10.0.2.2        stop    task_id=5657    timezone=UTC
```

```
service=shell   start_time=1788824262   priv-lvl=15     cmd=show running-config <cr>
Sep  7 23:37:42 192.168.99.3    lab     tty434  10.0.2.2        stop    task_id=4440    timezone=UTC
service=shell   start_time=1788824262   priv-lvl=15     cmd=show running-config <cr>
Sep  7 23:37:45 192.168.99.1    lab     tty435  10.0.2.2        stop    task_id=4962    timezone=UTC
service=shell   start_time=1788824262   disc-cause=1    disc-cause-ext=9        pre-session-time=0
elapsed_time=3  stop_time=1788824265
Sep  7 23:37:45 192.168.99.2    lab     tty435  10.0.2.2        stop    task_id=5657    timezone=UTC
service=shell   start_time=1788824262   disc-cause=1    disc-cause-ext=9        pre-session-time=0
elapsed_time=3  stop_time=1788824265
Sep  7 23:37:45 192.168.99.1    lab     tty434  10.0.2.2        start   task_id=4964    timezone=UTC
service=shell   start_time=1788824265
... 186 more lines
```

PASS The Local Account Still Works When The Server Is Unreachable (19.6s, 21 commands)

The resilience property. R2's out-of-band interface is shut, which is the only path to the server, so TACACS becomes unreachable rather than merely unwilling. The automation account must still get in through the local database, and a remote-only user must not -- it exists nowhere else. The precondition is a ping inside the VRF, not "show tacacs". That field reports cached state -- it keeps saying Alive until a transaction actually fails -- so waiting on it would either hang or, worse, let this test run with the server still reachable and prove nothing.

```
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface GigabitEthernet4
  ${output} =
R2 shutdown
  ${output} =
R2 end
  ${output} =
R2 ping vrf MGMT 192.168.99.10 repeat 2
  % VRF MGMT does not have a usable source address
R1 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R1 interface GigabitEthernet4
  ${output} =
R1 no shutdown
  ${output} =
R1 end
  ${output} =
R2 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R2 interface GigabitEthernet4
  ${output} =
R2 no shutdown
  ${output} =
R2 end
  ${output} =
R3 configure terminal
  Enter configuration commands, one per line.  End with CNTL/Z.
R3 interface GigabitEthernet4
  ${output} =
R3 no shutdown
  ${output} =
R3 end
  ${output} =
R2 ping vrf MGMT 192.168.99.10 repeat 5
  % VRF MGMT does not have a usable source address
R2 ping vrf MGMT 192.168.99.10 repeat 5
  % VRF MGMT does not have a usable source address
R2 ping vrf MGMT 192.168.99.10 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 192.168.99.10, timeout is 2 seconds:
  .!!!!
  Success rate is 80 percent (4/5), round-trip min/avg/max = 1/1/1 ms
R2 ping vrf MGMT 192.168.99.10 repeat 5
  Type escape sequence to abort.
  Sending 5, 100-byte ICMP Echos to 192.168.99.10, timeout is 2 seconds:
```

```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

21 Vty Acl

PASS Every Router Applies The ACL Inbound On All VTY Lines (0.3s, 3 commands)

```
R1 show running-config | section ^line vty
  line vty 0 4
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
  line vty 5 15
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
R2 show running-config | section ^line vty
  line vty 0 4
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
  line vty 5 15
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
R3 show running-config | section ^line vty
  line vty 0 4
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
  line vty 5 15
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
```

PASS Only SSH Is Accepted On The VTY Lines (0.3s, 3 commands)

An ACL restricting who may connect is worth less if telnet is still an option for those who may.

```
R1 show running-config | section ^line vty
  line vty 0 4
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
  line vty 5 15
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
R2 show running-config | section ^line vty
  line vty 0 4
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
  line vty 5 15
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
R3 show running-config | section ^line vty
  line vty 0 4
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
  line vty 5 15
   access-class VTY-MGMT in vrf-also
   exec-timeout 0 0
   activation-character 13
   transport input ssh
```

PASS The ACL Permits The Management Network And Denies The Rest (0.1s, 3 commands)

```
R1 show ip access-lists VTY-MGMT
  Standard IP access list VTY-MGMT
      10 permit 192.168.99.0, wildcard bits 0.0.0.255 (4 matches)
      20 permit 10.0.2.0, wildcard bits 0.0.0.255 (186 matches)
      30 deny   any log (6 matches)
R2 show ip access-lists VTY-MGMT
  Standard IP access list VTY-MGMT
      10 permit 192.168.99.0, wildcard bits 0.0.0.255
      20 permit 10.0.2.0, wildcard bits 0.0.0.255 (212 matches)
      30 deny   any log (2 matches)
R3 show ip access-lists VTY-MGMT
  Standard IP access list VTY-MGMT
      10 permit 192.168.99.0, wildcard bits 0.0.0.255
      20 permit 10.0.2.0, wildcard bits 0.0.0.255 (184 matches)
      30 deny   any log (2 matches)
```

PASS The Documented Exception Is Present And Is Only The Hypervisor Path (0.1s, 3 commands)

Pinned deliberately. This permit is the one concession in the policy, so it should be visible in a test rather than only in a comment -- and widening it should break something.

```
R1 show ip access-lists VTY-MGMT
  Standard IP access list VTY-MGMT
      10 permit 192.168.99.0, wildcard bits 0.0.0.255 (4 matches)
      20 permit 10.0.2.0, wildcard bits 0.0.0.255 (186 matches)
      30 deny   any log (6 matches)
R2 show ip access-lists VTY-MGMT
  Standard IP access list VTY-MGMT
      10 permit 192.168.99.0, wildcard bits 0.0.0.255
      20 permit 10.0.2.0, wildcard bits 0.0.0.255 (212 matches)
      30 deny   any log (2 matches)
R3 show ip access-lists VTY-MGMT
  Standard IP access list VTY-MGMT
      10 permit 192.168.99.0, wildcard bits 0.0.0.255
      20 permit 10.0.2.0, wildcard bits 0.0.0.255 (184 matches)
      30 deny   any log (2 matches)
```

PASS SSH From The Management Network Is Allowed (0.0s, 1 commands)

```
NMS python3 -c "import socket,sys
  s=socket.socket()
  s.settimeout(6)
  s.bind(('192.168.99.10',0))
  try:
      s.connect(('192.168.99.1',22))
      print(s.recv(64).decode(errors='replace').strip() or 'EMPTY')
  except Exception as e:
      print(f'REFUSED {type(e).__name__}: {e}')
  "
  SSH-2.0-Cisco-1.25
```

PASS SSH From Outside The Management Network Is Refused (0.1s, 1 commands)

The same machine, a different source address, and a target it is directly connected to -- so nothing but the ACL can account for the difference. Before the access-class was applied this path returned a banner just like the one above.

```
NMS python3 -c "import socket,sys
  s=socket.socket()
  s.settimeout(6)
  s.bind(('192.168.10.20',0))
  try:
      s.connect(('192.168.10.1',22))
      print(s.recv(64).decode(errors='replace').strip() or 'EMPTY')
  except Exception as e:
      print(f'REFUSED {type(e).__name__}: {e}')
  "
  REFUSED ConnectionRefusedError: [Errno 111] Connection refused
```

PASS Every Router Refuses A Login From Outside The Management Network (0.2s, 3 commands)

```
NMS python3 -c "import socket,sys
  s=socket.socket()
  s.settimeout(6)
  s.bind(('192.168.10.20',0))
  try:
      s.connect(('192.168.10.1',22))
      print(s.recv(64).decode(errors='replace').strip() or 'EMPTY')
  except Exception as e:
      print(f'REFUSED {type(e).__name__}: {e}')
  "
  REFUSED ConnectionRefusedError: [Errno 111] Connection refused
NMS python3 -c "import socket,sys
  s=socket.socket()
  s.settimeout(6)
  s.bind(('192.168.10.20',0))
  try:
      s.connect(('192.168.20.1',22))
      print(s.recv(64).decode(errors='replace').strip() or 'EMPTY')
  except Exception as e:
      print(f'REFUSED {type(e).__name__}: {e}')
  "
  REFUSED ConnectionRefusedError: [Errno 111] Connection refused
NMS python3 -c "import socket,sys
  s=socket.socket()
  s.settimeout(6)
  s.bind(('192.168.10.20',0))
  try:
      s.connect(('192.168.30.1',22))
      print(s.recv(64).decode(errors='replace').strip() or 'EMPTY')
  except Exception as e:
      print(f'REFUSED {type(e).__name__}: {e}')
  "
  REFUSED ConnectionRefusedError: [Errno 111] Connection refused
```

PASS The Refusal Is Logged And Reaches The Collector (0.1s, 2 commands)

"deny any log" makes a rejected connection auditable rather than merely blocked, and the message travels the OOB network to the collector like every other log.

```
NMS python3 -c "import socket,sys
  s=socket.socket()
  s.settimeout(6)
  s.bind(('192.168.10.20',0))
  try:
      s.connect(('192.168.10.1',22))
      print(s.recv(64).decode(errors='replace').strip() or 'EMPTY')
  except Exception as e:
      print(f'REFUSED {type(e).__name__}: {e}')
  "
  REFUSED ConnectionRefusedError: [Errno 111] Connection refused
NMS sudo cat /var/log/lab/192.168.99.1.log 2>/dev/null || true
  <189>207: 000203: *Sep  7 22:17:21.168 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>208: 000204: *Sep  7 22:17:21.214 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:17:21 UTC Mon Sep 7 2026
  <189>209: 000205: *Sep  7 22:17:21.214 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <190>210: 000206: *Sep  7 22:17:56.590 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>211: 000207: *Sep  7 22:17:56.591 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <189>212: 000208: *Sep  7 22:18:27.361 UTC: %SSH-5-SSH2_SESSION: SSH2 Session request from 10.0.2.2 (tty =
  0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>213: 000209: *Sep  7 22:18:27.410 UTC: %SEC_LOGIN-5-LOGIN_SUCCESS: Login Success [user: lab] [Source:
  10.0.2.2] [localport: 22] at 22:18:27 UTC Mon Sep 7 2026
  <189>214: 000210: *Sep  7 22:18:27.410 UTC: %SSH-5-SSH2_USERAUTH: User 'lab' authentication for SSH2 Session
  from 10.0.2.2 (tty = 0) using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' Succeeded
  <189>215: 000211: *Sep  7 22:18:27.605 UTC: %SYS-5-CONFIG_I: Configured from console by lab on vty0
  (10.0.2.2)
  <190>216: 000212: *Sep  7 22:18:27.747 UTC: %SYS-6-LOGOUT: User lab has exited tty session 434(10.0.2.2)
  <189>217: 000213: *Sep  7 22:18:27.747 UTC: %SSH-5-SSH2_CLOSE: SSH2 Session from 10.0.2.2 (tty = 0) for user
  '' using crypto cipher 'aes128-ctr', hmac 'hmac-sha2-256' closed
  <187>218: 000214: *Sep  7 22:19:26.134 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
```

```
authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
172.20.0.3 NBMA: 100.64.0.1)
<187>219: 000215: *Sep  7 22:19:26.227 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
172.20.0.2 NBMA: 100.64.0.1)
<187>220: 000216: *Sep  7 22:19:26.906 UTC: %DMVPN-3-DMVPN_NHRP_ERROR:  Tunnel0: Recieved wrong
authentication string for  Registration Request , Reason:  authentication failure (11) on (Tunnel:
172.20.0.3 NBMA: 100.64.0.1)
... 1098 more lines
```

PASS The Harness Path Still Works (0.1s, 3 commands)

The reason the second permit exists. If this fails the lab is unreachable by every other suite, so it is asserted here rather than discovered in the next run. Asserted from the ACL's own hit counter rather than from "show users". That column prints a resolved name when reverse DNS answers -- inside the packaged appliance the same session shows as "_gateway" instead of 10.0.2.2 -- so matching on the rendered address made this depend on name resolution rather than on the thing being tested. A hit on that ACE means a session was admitted by exactly the permit under discussion.

R1 show ip access-lists VTY-MGMT

```
Standard IP access list VTY-MGMT
    10 permit 192.168.99.0, wildcard bits 0.0.0.255 (6 matches)
    20 permit 10.0.2.0, wildcard bits 0.0.0.255 (186 matches)
    30 deny   any log (9 matches)
```

R2 show ip access-lists VTY-MGMT

```
Standard IP access list VTY-MGMT
    10 permit 192.168.99.0, wildcard bits 0.0.0.255
    20 permit 10.0.2.0, wildcard bits 0.0.0.255 (212 matches)
    30 deny   any log (3 matches)
```

R3 show ip access-lists VTY-MGMT

```
Standard IP access list VTY-MGMT
    10 permit 192.168.99.0, wildcard bits 0.0.0.255
    20 permit 10.0.2.0, wildcard bits 0.0.0.255 (184 matches)
    30 deny   any log (3 matches)
```

22 Banner

PASS Every Router Has A Login Banner Configured (0.3s, 3 commands)

```
R1 show running-config | include ^banner
  banner login ^C
R2 show running-config | include ^banner
  banner login ^C
R3 show running-config | include ^banner
  banner login ^C
```

PASS The Banner Is Presented Before Authentication (6.2s, 0 commands)

Captured from a login that is refused, so the banner demonstrably reaches an unauthenticated client.

No device commands (assertion used earlier output).

PASS The Presented Banner Matches The Source File Exactly (6.3s, 0 commands)

Line for line, not a substring match: a device carrying a stale or truncated copy should fail rather than pass on one memorable phrase still being present.

No device commands (assertion used earlier output).

PASS The Banner States The Warning It Exists To Give (2.1s, 0 commands)

A banner that does not actually warn is decoration. These are the elements that make it one: restricted access, a statement of monitoring, and consent following from use.

No device commands (assertion used earlier output).

PASS The Banner Discloses Nothing About The Platform (6.2s, 0 commands)

An unauthenticated visitor should learn that they are not welcome, and nothing else. A banner naming the vendor, model, software or hostname helps whoever should not be there more than it helps anyone who should.

No device commands (assertion used earlier output).

PASS The Banner Survives A Configuration Save (0.1s, 3 commands)

Guards the case where a banner is applied to the running configuration and never written -- present until the next reload, and absent exactly when it would be needed.

```
R1 show startup-config | include ^banner
  banner login ^C
R2 show startup-config | include ^banner
  banner login ^C
R3 show startup-config | include ^banner
  banner login ^C
```

Appendix — captured device state

Written by suite *05 Capture State* during the run. Routing tables and protocol state first, then what the NMS sees for each router -- polled over SNMPv3, and received as syslog and traps -- then the full running configuration of each router.

R1 — 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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is 10.0.2.2 to network 0.0.0.0

S*    0.0.0.0/0 [254/0] via 10.0.2.2
      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
C        10.0.2.0/24 is directly connected, GigabitEthernet1
L        10.0.2.15/32 is directly connected, GigabitEthernet1
C        10.20.1.1/32 is directly connected, Loopback1
B        10.20.2.1/32 [20/0] via 172.20.0.2, 00:03:08
B        10.20.3.1/32 [20/0] via 172.20.0.3, 00:15:29
S        10.30.1.0/24 is directly connected, Null0
B        10.30.2.0/24 [20/0] via 172.20.0.2, 00:03:08
B        10.30.3.0/24 [20/0] via 172.20.0.3, 00:15:29
      100.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        100.64.0.0/24 is directly connected, GigabitEthernet2
L        100.64.0.1/32 is directly connected, GigabitEthernet2
      172.16.0.0/32 is subnetted, 1 subnets
C        172.16.1.1 is directly connected, Loopback0
      172.20.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.20.0.0/24 is directly connected, Tunnel0
L        172.20.0.1/32 is directly connected, Tunnel0
      192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.10.0/24 is directly connected, GigabitEthernet3
L        192.168.10.1/32 is directly connected, GigabitEthernet3
B     192.168.20.0/24 [20/0] via 172.20.0.2, 00:03:08
B     192.168.30.0/24 [20/0] via 172.20.0.3, 00:15:29
```

R2 — 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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is 10.0.2.2 to network 0.0.0.0

S*    0.0.0.0/0 [254/0] via 10.0.2.2
      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
C        10.0.2.0/24 is directly connected, GigabitEthernet1
L        10.0.2.15/32 is directly connected, GigabitEthernet1
B        10.20.1.1/32 [20/0] via 172.20.0.1, 00:03:09
C        10.20.2.1/32 is directly connected, Loopback1
B        10.20.3.1/32 [20/0] via 172.20.0.3, 00:03:09
B        10.30.1.0/24 [20/0] via 172.20.0.1, 00:03:09
S        10.30.2.0/24 is directly connected, Null0
B        10.30.3.0/24 [20/0] via 172.20.0.3, 00:03:09
      100.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        100.64.0.0/24 is directly connected, GigabitEthernet2
L        100.64.0.2/32 is directly connected, GigabitEthernet2
      172.16.0.0/32 is subnetted, 1 subnets
```

```
C        172.16.2.1 is directly connected, Loopback0
      172.20.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.20.0.0/24 is directly connected, Tunnel0
L        172.20.0.2/32 is directly connected, Tunnel0
B     192.168.10.0/24 [20/0] via 172.20.0.1, 00:03:09
      192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.20.0/24 is directly connected, GigabitEthernet3
L        192.168.20.1/32 is directly connected, GigabitEthernet3
B     192.168.30.0/24 [20/0] via 172.20.0.3, 00:03:09
```

R3 — 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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected

Gateway of last resort is 10.0.2.2 to network 0.0.0.0

S*    0.0.0.0/0 [254/0] via 10.0.2.2
      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
C        10.0.2.0/24 is directly connected, GigabitEthernet1
L        10.0.2.15/32 is directly connected, GigabitEthernet1
B        10.20.1.1/32 [20/0] via 172.20.0.1, 00:15:29
B        10.20.2.1/32 [20/0] via 172.20.0.2, 00:02:46
C        10.20.3.1/32 is directly connected, Loopback1
B        10.30.1.0/24 [20/0] via 172.20.0.1, 00:15:29
B        10.30.2.0/24 [20/0] via 172.20.0.2, 00:02:46
S        10.30.3.0/24 is directly connected, Null0
      100.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        100.64.0.0/24 is directly connected, GigabitEthernet2
L        100.64.0.3/32 is directly connected, GigabitEthernet2
      172.16.0.0/32 is subnetted, 1 subnets
C        172.16.3.1 is directly connected, Loopback0
      172.20.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.20.0.0/24 is directly connected, Tunnel0
L        172.20.0.3/32 is directly connected, Tunnel0
B     192.168.10.0/24 [20/0] via 172.20.0.1, 00:15:29
B     192.168.20.0/24 [20/0] via 172.20.0.2, 00:02:46
      192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.30.0/24 is directly connected, GigabitEthernet3
L        192.168.30.1/32 is directly connected, GigabitEthernet3
```

R1 — bgp summary

```
BGP router identifier 172.16.1.1, local AS number 65001
BGP table version is 28, main routing table version 28
9 network entries using 2232 bytes of memory
9 path entries using 1224 bytes of memory
7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
6 BGP community entries using 144 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 5720 total bytes of memory
BGP activity 136/127 prefixes, 139/130 paths, scan interval 60 secs
22 networks peaked at 22:33:59 Sep 7 2026 UTC (00:48:55.594 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
172.20.0.2      4        65002      26      29       28    0    0 00:03:08        3
172.20.0.3      4        65003     106     115       28    0    0 00:15:40        3
```

R2 — bgp summary

```
BGP router identifier 172.16.2.1, local AS number 65002
BGP table version is 46, main routing table version 46
9 network entries using 2232 bytes of memory
9 path entries using 1224 bytes of memory
7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
```

```
2 BGP AS-PATH entries using 64 bytes of memory
6 BGP community entries using 144 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 5736 total bytes of memory
BGP activity 160/151 prefixes, 162/153 paths, scan interval 60 secs
31 networks peaked at 22:34:42 Sep 7 2026 UTC (00:48:12.674 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
172.20.0.1      4        65001      29      26       46    0    0 00:03:08        6
```

R3 — bgp summary

```
BGP router identifier 172.16.3.1, local AS number 65003
BGP table version is 146, main routing table version 146
9 network entries using 2232 bytes of memory
9 path entries using 1224 bytes of memory
7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
2 BGP AS-PATH entries using 64 bytes of memory
6 BGP community entries using 144 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 5736 total bytes of memory
BGP activity 72/63 prefixes, 77/68 paths, scan interval 60 secs
9 networks peaked at 22:15:22 Sep 7 2026 UTC (01:07:32.746 ago)

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
172.20.0.1      4        65001     115     106      146    0    0 00:15:41        6
```

R1 — bgp table

```
BGP table version is 28, local router ID is 172.16.1.1
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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.1.1/32     0.0.0.0                  0         32768 i
 *>   10.20.2.1/32     172.20.0.2               0             0 65002 i
 *>   10.20.3.1/32     172.20.0.3               0             0 65003 i
 *>   10.30.1.0/24     0.0.0.0                  0         32768 i
 *>   10.30.2.0/24     172.20.0.2               0             0 65002 i
 *>   10.30.3.0/24     172.20.0.3               0             0 65003 i
 *>   192.168.10.0     0.0.0.0                  0         32768 i
 *>   192.168.20.0     172.20.0.2               0             0 65002 i
 *>   192.168.30.0     172.20.0.3               0             0 65003 i
```

R2 — bgp table

```
BGP table version is 46, local router ID is 172.16.2.1
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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.1.1/32     172.20.0.1               0             0 65001 i
 *>   10.20.2.1/32     0.0.0.0                  0         32768 i
 *>   10.20.3.1/32     172.20.0.3                             0 65001 65003 i
 *>   10.30.1.0/24     172.20.0.1               0             0 65001 i
 *>   10.30.2.0/24     0.0.0.0                  0         32768 i
 *>   10.30.3.0/24     172.20.0.3                             0 65001 65003 i
 *>   192.168.10.0     172.20.0.1               0             0 65001 i
 *>   192.168.20.0     0.0.0.0                  0         32768 i
 *>   192.168.30.0     172.20.0.3                             0 65001 65003 i
```

R3 — bgp table

```
BGP table version is 146, local router ID is 172.16.3.1
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,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   10.20.1.1/32     172.20.0.1               0             0 65001 i
 *>   10.20.2.1/32     172.20.0.2                             0 65001 65002 i
 *>   10.20.3.1/32     0.0.0.0                  0         32768 i
 *>   10.30.1.0/24     172.20.0.1               0             0 65001 i
 *>   10.30.2.0/24     172.20.0.2                             0 65001 65002 i
 *>   10.30.3.0/24     0.0.0.0                  0         32768 i
 *>   192.168.10.0     172.20.0.1               0             0 65001 i
 *>   192.168.20.0     172.20.0.2                             0 65001 65002 i
 *>   192.168.30.0     0.0.0.0                  0         32768 i
```

R1 — crypto ikev2 sa

```
IPv4 Crypto IKEv2  SA

Tunnel-id Local                 Remote                fvrf/ivrf            Status
1         100.64.0.1/500        100.64.0.2/500        none/none            READY
      Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
      Life/Active Time: 86400/100 sec
      CE id: 1029, Session-id: 26
      Local spi: 674CC240C9A38803       Remote spi: 6B960B9A3952A45C

Tunnel-id Local                 Remote                fvrf/ivrf            Status
2         100.64.0.1/500        100.64.0.3/500        none/none            READY
      Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
      Life/Active Time: 86400/100 sec
      CE id: 1030, Session-id: 27
      Local spi: C7ABC0CAC6503940       Remote spi: 54006597FF55CAD2

 IPv6 Crypto IKEv2  SA
```

R2 — crypto ikev2 sa

```
IPv4 Crypto IKEv2  SA

Tunnel-id Local                 Remote                fvrf/ivrf            Status
1         100.64.0.2/500        100.64.0.1/500        none/none            READY
      Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
      Life/Active Time: 86400/101 sec
      CE id: 1029, Session-id: 24
      Local spi: 6B960B9A3952A45C       Remote spi: 674CC240C9A38803

 IPv6 Crypto IKEv2  SA
```

R3 — crypto ikev2 sa

```
IPv4 Crypto IKEv2  SA

Tunnel-id Local                 Remote                fvrf/ivrf            Status
1         100.64.0.3/500        100.64.0.1/500        none/none            READY
      Encr: AES-CBC, keysize: 256, PRF: SHA256, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
      Life/Active Time: 86400/101 sec
      CE id: 1026, Session-id: 26
      Local spi: 54006597FF55CAD2       Remote spi: C7ABC0CAC6503940

 IPv6 Crypto IKEv2  SA
```

H1 — ip addr

```
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:01:01 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute eth0
       valid_lft 82334sec preferred_lft 71534sec
```

```
    inet6 fec0::5054:ff:feaa:101/64 scope site dynamic noprefixroute flags 100
       valid_lft 86212sec preferred_lft 14212sec
    inet6 fe80::5054:ff:feaa:101/64 scope link
       valid_lft forever preferred_lft forever
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:01:02 brd ff:ff:ff:ff:ff:ff
    inet 192.168.10.10/24 scope global eth1
       valid_lft forever preferred_lft forever
    inet 169.254.229.55/16 brd 169.254.255.255 scope global noprefixroute eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.11/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.12/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.13/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.14/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.15/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.16/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.17/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.18/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.19/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.64/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.65/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.66/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.67/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.68/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.69/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.70/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.71/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.72/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.73/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.74/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.75/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.76/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.77/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.78/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.79/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.80/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.81/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.82/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.83/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.84/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.85/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.86/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.87/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.88/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.89/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.90/24 scope global secondary eth1
```

```
       valid_lft forever preferred_lft forever
    inet 192.168.10.91/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.92/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.10.93/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
```

H1 — ip route

```
default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
10.30.0.0/16 via 192.168.10.1 dev eth1
169.254.0.0/16 dev eth1 scope link  src 169.254.229.55  metric 1003
192.168.10.0/24 dev eth1 scope link  src 192.168.10.10
192.168.20.0/24 via 192.168.10.1 dev eth1
192.168.30.0/24 via 192.168.10.1 dev eth1
```

H2 — ip addr

```
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:02:01 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute eth0
       valid_lft 82337sec preferred_lft 71537sec
    inet6 fec0::5054:ff:feaa:201/64 scope site dynamic noprefixroute flags 100
       valid_lft 86083sec preferred_lft 14083sec
    inet6 fe80::5054:ff:feaa:201/64 scope link
       valid_lft forever preferred_lft forever
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:02:02 brd ff:ff:ff:ff:ff:ff
    inet 192.168.20.10/24 scope global eth1
       valid_lft forever preferred_lft forever
    inet 169.254.199.41/16 brd 169.254.255.255 scope global noprefixroute eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.11/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.12/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.13/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.14/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.15/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.16/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.17/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.18/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.19/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.64/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.65/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.66/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.67/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.68/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.69/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.70/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.71/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.72/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.73/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
```

```
    inet 192.168.20.74/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.75/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.76/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.77/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.78/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.79/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.80/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.81/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.82/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.83/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.84/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.85/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.86/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.87/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.88/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.89/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.90/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.91/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.92/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.20.93/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
```

H2 — ip route

```
default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
10.30.0.0/16 via 192.168.20.1 dev eth1
192.168.30.10 via 192.168.20.1 dev eth1
169.254.0.0/16 dev eth1 scope link  src 169.254.199.41  metric 1003
192.168.10.0/24 via 192.168.20.1 dev eth1
192.168.30.10 via 192.168.20.1 dev eth1
192.168.20.0/24 dev eth1 scope link  src 192.168.20.10
192.168.30.0/24 via 192.168.20.1 dev eth1
192.168.30.10 via 192.168.20.1 dev eth1
```

H3 — ip addr

```
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:03:01 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute eth0
       valid_lft 82336sec preferred_lft 71536sec
    inet6 fec0::5054:ff:feaa:301/64 scope site dynamic noprefixroute flags 100
       valid_lft 86292sec preferred_lft 14292sec
    inet6 fe80::5054:ff:feaa:301/64 scope link
       valid_lft forever preferred_lft forever
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast qlen 1000
    link/ether 52:54:00:aa:03:02 brd ff:ff:ff:ff:ff:ff
    inet 192.168.30.10/24 scope global eth1
       valid_lft forever preferred_lft forever
    inet 169.254.207.242/16 brd 169.254.255.255 scope global noprefixroute eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.11/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
```

```
    inet 192.168.30.12/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.13/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.14/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.15/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.16/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.17/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.18/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.19/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.64/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.65/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.66/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.67/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.68/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.69/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.70/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.71/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.72/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.73/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.74/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.75/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.76/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.77/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.78/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.79/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.80/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.81/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.82/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.83/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.84/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.85/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.86/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.87/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.88/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.89/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.90/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.91/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.92/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
    inet 192.168.30.93/24 scope global secondary eth1
       valid_lft forever preferred_lft forever
```

H3 — ip route

```
default via 10.0.2.2 dev eth0  src 10.0.2.15  metric 1002
```

```
10.0.2.0/24 dev eth0 scope link  src 10.0.2.15  metric 1002
10.30.0.0/16 via 192.168.30.1 dev eth1
169.254.0.0/16 dev eth1 scope link  src 169.254.207.242  metric 1003
192.168.10.0/24 via 192.168.30.1 dev eth1
192.168.20.0/24 via 192.168.30.1 dev eth1
192.168.30.0/24 dev eth1 scope link  src 192.168.30.10
```

NMS — network

```
lo               UNKNOWN        127.0.0.1/8 ::1/128
ens3             UP             10.0.2.15/24 metric 100 fec0::5054:ff:febb:101/64 fe80::5054:ff:febb:101/64
ens4             UP             192.168.10.20/24 fe80::5054:ff:febb:102/64
ens5             UP             192.168.99.10/24 fe80::5054:ff:febb:103/64
default via 10.0.2.2 dev ens3 proto dhcp src 10.0.2.15 metric 100
10.0.2.0/24 dev ens3 proto kernel scope link src 10.0.2.15 metric 100
10.0.2.2 dev ens3 proto dhcp scope link src 10.0.2.15 metric 100
10.0.2.3 dev ens3 proto dhcp scope link src 10.0.2.15 metric 100
10.30.0.0/16 via 192.168.10.1 dev ens4
192.168.10.0/24 dev ens4 proto kernel scope link src 192.168.10.20
192.168.20.0/24 via 192.168.10.1 dev ens4
192.168.30.0/24 via 192.168.10.1 dev ens4
192.168.99.0/24 dev ens5 proto kernel scope link src 192.168.99.10
```

NMS — snmp version

```
NET-SNMP version: 5.9.4.pre2
```

NMS — collectors

```
active
active
active
```

NMS — collector files

```
total 2660
-rw-r--r-- 1 syslog syslog  128123 Sep  7 23:22 192.168.99.1.log
-rw-r--r-- 1 syslog syslog  159924 Sep  7 23:22 192.168.99.2.log
-rw-r--r-- 1 syslog syslog  105045 Sep  7 23:22 192.168.99.3.log
-rw-r--r-- 1 root   root    881546 Sep  7 23:22 snmptrapd.log
-rw-r--r-- 1 root   root   1416130 Sep  7 23:22 traps-raw.log
```

NMS — R1 syslog received

```
tail: cannot open '/var/log/lab/192.168.10.1.log' for reading: No such file or directory
```

NMS — R2 syslog received

```
tail: cannot open '/var/log/lab/192.168.20.1.log' for reading: No such file or directory
```

NMS — R3 syslog received

```
tail: cannot open '/var/log/lab/192.168.30.1.log' for reading: No such file or directory
```

NMS — snmptrapd

```
2026-09-07 23:22:26 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:39.57        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.7
iso.3.6.1.4.1.9.9.171.1.3.2.1.9.29 3600 iso.3.6.1.4.1.9.9.171.1.3.2.1.8.29 4608000
iso.3.6.1.4.1.9.9.171.1.3.3.1.3.29.1 1  iso.3.6.1.4.1.9.9.171.1.3.3.1.4.29.1 "64 40 00 03 "
iso.3.6.1.4.1.9.9.171.1.3.3.1.5.29.1 "64 40 00 03 "     iso.3.6.1.4.1.9.9.171.1.3.3.1.9.29.1 1
iso.3.6.1.4.1.9.9.171.1.3.3.1.10.29.1 "64 40 00 02 "    iso.3.6.1.4.1.9.9.171.1.3.3.1.11.29.1 "64 40 00 02 "
iso.3.6.1.4.1.9.9.171.1.3.3.1.6.29.1 47 iso.3.6.1.4.1.9.9.171.1.3.3.1.7.29.1 0
2026-09-07 23:22:26 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:40.66        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.7
iso.3.6.1.4.1.9.9.171.1.3.2.1.9.29 3600 iso.3.6.1.4.1.9.9.171.1.3.2.1.8.29 4608000
iso.3.6.1.4.1.9.9.171.1.3.3.1.3.29.1 1  iso.3.6.1.4.1.9.9.171.1.3.3.1.4.29.1 "64 40 00 02 "
iso.3.6.1.4.1.9.9.171.1.3.3.1.5.29.1 "64 40 00 02 "     iso.3.6.1.4.1.9.9.171.1.3.3.1.9.29.1 1
iso.3.6.1.4.1.9.9.171.1.3.3.1.10.29.1 "64 40 00 03 "    iso.3.6.1.4.1.9.9.171.1.3.3.1.11.29.1 "64 40 00 03 "
```

```
iso.3.6.1.4.1.9.9.171.1.3.3.1.6.29.1 47 iso.3.6.1.4.1.9.9.171.1.3.3.1.7.29.1 0
2026-09-07 23:22:27 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:40.41        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.1
iso.3.6.1.4.1.9.10.137.1.2.1.8.1708049 0        iso.3.6.1.4.1.9.10.137.1.2.1.8.1708049 0
iso.3.6.1.2.1.2.2.1.1.8 8
2026-09-07 23:22:27 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:41.50        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.1
iso.3.6.1.4.1.9.10.137.1.2.1.8.1708035 0        iso.3.6.1.4.1.9.10.137.1.2.1.8.1708035 0
iso.3.6.1.2.1.2.2.1.1.8 8
2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:42.80        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.62.2.0.4
iso.3.6.1.4.1.9.10.62.1.2.3.1.1.2.14.84.117.110.110.101.108.48.45.104.101.97.100.45.48 3
2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:41.71        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.2
iso.3.6.1.4.1.9.9.171.1.2.2.1.6.1.4.100.64.0.3.1.4.100.64.0.2.29 "64 40 00 03 "
iso.3.6.1.4.1.9.9.171.1.2.2.1.7.1.4.100.64.0.3.1.4.100.64.0.2.29 "64 40 00 02 "
iso.3.6.1.4.1.9.9.171.1.2.3.1.16.29 2   iso.3.6.1.4.1.9.9.171.1.4.2.1.1.2.29 4
2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:42.80        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.8
iso.3.6.1.4.1.9.9.171.1.3.2.1.10.29 213 iso.3.6.1.4.1.9.9.171.1.4.3.1.1.12.28 213
iso.3.6.1.4.1.9.9.171.1.4.3.1.1.10.28 3600      iso.3.6.1.4.1.9.9.171.1.4.3.1.1.9.28 4608000
iso.3.6.1.4.1.9.9.171.1.4.3.1.1.2.28 1  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.5.28 1
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.11.28 1 iso.3.6.1.4.1.9.9.171.1.4.3.2.1.6.28 "64 40 00 02 "
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.7.28 "64 40 00 02 "     iso.3.6.1.4.1.9.9.171.1.4.3.2.1.12.28 "64 40 00 03 "
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.13.28 "64 40 00 03 "    iso.3.6.1.4.1.9.9.171.1.4.3.2.1.8.28 47
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.9.28 0
2026-09-07 23:22:28 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:41.72        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.8
iso.3.6.1.4.1.9.9.171.1.3.2.1.10.29 214 iso.3.6.1.4.1.9.9.171.1.4.3.1.1.12.28 214
iso.3.6.1.4.1.9.9.171.1.4.3.1.1.10.28 3600      iso.3.6.1.4.1.9.9.171.1.4.3.1.1.9.28 4608000
iso.3.6.1.4.1.9.9.171.1.4.3.1.1.2.28 1  iso.3.6.1.4.1.9.9.171.1.4.3.2.1.5.28 1
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.11.28 1 iso.3.6.1.4.1.9.9.171.1.4.3.2.1.6.28 "64 40 00 03 "
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.7.28 "64 40 00 03 "     iso.3.6.1.4.1.9.9.171.1.4.3.2.1.12.28 "64 40 00 02 "
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.13.28 "64 40 00 02 "    iso.3.6.1.4.1.9.9.171.1.4.3.2.1.8.28 47
iso.3.6.1.4.1.9.9.171.1.4.3.2.1.9.28 0
2026-09-07 23:22:29 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:42.80        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.2
iso.3.6.1.4.1.9.10.137.1.2.1.8.987139 3 iso.3.6.1.4.1.9.10.137.1.2.1.8.987139 3 iso.3.6.1.2.1.2.2.1.1.8 8
2026-09-07 23:22:29 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:41.72        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.62.2.0.4
iso.3.6.1.4.1.9.10.62.1.2.3.1.1.2.14.84.117.110.110.101.108.48.45.104.101.97.100.45.48 3
2026-09-07 23:22:29 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:42.81        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.171.2.0.2
iso.3.6.1.4.1.9.9.171.1.2.2.1.6.1.4.100.64.0.2.1.4.100.64.0.3.29 "64 40 00 02 "
iso.3.6.1.4.1.9.9.171.1.2.2.1.7.1.4.100.64.0.2.1.4.100.64.0.3.29 "64 40 00 03 "
iso.3.6.1.4.1.9.9.171.1.2.3.1.16.29 2   iso.3.6.1.4.1.9.9.171.1.4.2.1.1.2.29 6
2026-09-07 23:22:29 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:41.72        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.10.137.0.2
iso.3.6.1.4.1.9.10.137.1.2.1.8.987153 3 iso.3.6.1.4.1.9.10.137.1.2.1.8.987153 3 iso.3.6.1.2.1.2.2.1.1.8 8
2026-09-07 23:22:29 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:43.64        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.41.2.0.1
iso.3.6.1.4.1.9.9.41.1.2.3.1.2.59 "DMVPN"       iso.3.6.1.4.1.9.9.41.1.2.3.1.3.59 4
iso.3.6.1.4.1.9.9.41.1.2.3.1.4.59 "DMVPN_NHRP_ERROR"    iso.3.6.1.4.1.9.9.41.1.2.3.1.5.59 " Tunnel0: NHRP
Encap Error for  Purge Reply , Reason:  protocol generic error (7) on (Tunnel: 172.20.0.2 NBMA: 100.64.0.2)"
iso.3.6.1.4.1.9.9.41.1.2.3.1.6.59 0:1:08:43.64
2026-09-07 23:22:29 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:42.55        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.41.2.0.1
iso.3.6.1.4.1.9.9.41.1.2.3.1.2.50 "DMVPN"       iso.3.6.1.4.1.9.9.41.1.2.3.1.3.50 4
iso.3.6.1.4.1.9.9.41.1.2.3.1.4.50 "DMVPN_NHRP_ERROR"    iso.3.6.1.4.1.9.9.41.1.2.3.1.5.50 " Tunnel0: NHRP
Encap Error for  Purge Request , Reason:  protocol generic error (7) on (Tunnel: 172.20.0.3 NBMA:
100.64.0.3)"        iso.3.6.1.4.1.9.9.41.1.2.3.1.6.50 0:1:08:42.55
2026-09-07 23:22:38 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:52.91        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.0.1
iso.3.6.1.4.1.9.2.9.3.1.1.435.1 6       iso.3.6.1.2.1.6.13.1.1.10.0.2.15.22.10.0.2.2.57102 8
iso.3.6.1.4.1.9.2.6.1.1.5.10.0.2.15.22.10.0.2.2.57102 3555
iso.3.6.1.4.1.9.2.6.1.1.1.10.0.2.15.22.10.0.2.2.57102 3504
iso.3.6.1.4.1.9.2.6.1.1.2.10.0.2.15.22.10.0.2.2.57102 52339     iso.3.6.1.4.1.9.2.9.2.1.18.435 "lab"
2026-09-07 23:22:38 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:51.84        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.0.1
iso.3.6.1.4.1.9.2.9.3.1.1.434.1 6       iso.3.6.1.2.1.6.13.1.1.10.0.2.15.22.10.0.2.2.55618 8
iso.3.6.1.4.1.9.2.6.1.1.5.10.0.2.15.22.10.0.2.2.55618 3547
iso.3.6.1.4.1.9.2.6.1.1.1.10.0.2.15.22.10.0.2.2.55618 2784
iso.3.6.1.4.1.9.2.6.1.1.2.10.0.2.15.22.10.0.2.2.55618 29731     iso.3.6.1.4.1.9.2.9.2.1.18.434 "lab"
2026-09-07 23:22:38 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:52.21        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.0.1
iso.3.6.1.4.1.9.2.9.3.1.1.435.1 6       iso.3.6.1.2.1.6.13.1.1.10.0.2.15.22.10.0.2.2.36348 8
iso.3.6.1.4.1.9.2.6.1.1.5.10.0.2.15.22.10.0.2.2.36348 3571
iso.3.6.1.4.1.9.2.6.1.1.1.10.0.2.15.22.10.0.2.2.36348 2688
iso.3.6.1.4.1.9.2.6.1.1.2.10.0.2.15.22.10.0.2.2.36348 28707     iso.3.6.1.4.1.9.2.9.2.1.18.435 "lab"
2026-09-07 23:22:41 <UNKNOWN> [UDP: [192.168.99.1]:54980->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:08:55.08        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
```

```
iso.3.6.1.4.1.9.9.43.1.1.6.1.3.174 1    iso.3.6.1.4.1.9.9.43.1.1.6.1.4.174 3
iso.3.6.1.4.1.9.9.43.1.1.6.1.5.174 2    iso.3.6.1.4.1.9.9.43.1.1.6.1.8.174 "lab"
2026-09-07 23:22:46 <UNKNOWN> [UDP: [192.168.99.2]:49602->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:09:00.46        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
iso.3.6.1.4.1.9.9.43.1.1.6.1.3.387 1    iso.3.6.1.4.1.9.9.43.1.1.6.1.4.387 3
iso.3.6.1.4.1.9.9.43.1.1.6.1.5.387 2    iso.3.6.1.4.1.9.9.43.1.1.6.1.8.387 "lab"
2026-09-07 23:22:50 <UNKNOWN> [UDP: [192.168.99.3]:50049->[192.168.99.10]:162]:
iso.3.6.1.2.1.1.3.0 0:1:09:03.74        iso.3.6.1.6.3.1.1.4.1.0 iso.3.6.1.4.1.9.9.43.2.0.1
iso.3.6.1.4.1.9.9.43.1.1.6.1.3.127 1    iso.3.6.1.4.1.9.9.43.1.1.6.1.4.127 3
iso.3.6.1.4.1.9.9.43.1.1.6.1.5.127 2    iso.3.6.1.4.1.9.9.43.1.1.6.1.8.127 "lab"
```

NMS — R1 polled over SNMPv3: snmp system

```
.1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2026 by Cisco Systems, Inc.
Compiled Wed 22-Jul-26 03:39 b"
.1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
.1.3.6.1.2.1.1.3.0 = Timeticks: (415000) 1:09:10.00
.1.3.6.1.2.1.1.4.0 = ""
.1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r1.lab.local"
.1.3.6.1.2.1.1.6.0 = ""
.1.3.6.1.2.1.1.7.0 = INTEGER: 78
.1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS — R1 polled over SNMPv3: snmp interfaces

```
.1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
.1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
.1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
.1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
.1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
.1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
.1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
.1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
.1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS — R2 polled over SNMPv3: snmp system

```
.1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2026 by Cisco Systems, Inc.
Compiled Wed 22-Jul-26 03:39 b"
.1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
.1.3.6.1.2.1.1.3.0 = Timeticks: (415086) 1:09:10.86
.1.3.6.1.2.1.1.4.0 = ""
.1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r2.lab.local"
.1.3.6.1.2.1.1.6.0 = ""
.1.3.6.1.2.1.1.7.0 = INTEGER: 78
.1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS — R2 polled over SNMPv3: snmp interfaces

```
.1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
.1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
.1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
.1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
.1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
.1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
.1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
.1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
.1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

NMS — R3 polled over SNMPv3: snmp system

```
.1.3.6.1.2.1.1.1.0 = STRING: "Cisco IOS Software [IOSXE], Virtual XE Software (X86_64_LINUX_IOSD-
UNIVERSALK9-M), Version 17.15.6, RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2026 by Cisco Systems, Inc.
Compiled Wed 22-Jul-26 03:39 b"
.1.3.6.1.2.1.1.2.0 = OID: .1.3.6.1.4.1.9.1.3004
.1.3.6.1.2.1.1.3.0 = Timeticks: (414990) 1:09:09.90
```

```
.1.3.6.1.2.1.1.4.0 = ""
.1.3.6.1.2.1.1.5.0 = STRING: "c8000v-r3.lab.local"
.1.3.6.1.2.1.1.6.0 = ""
.1.3.6.1.2.1.1.7.0 = INTEGER: 78
.1.3.6.1.2.1.1.8.0 = Timeticks: (0) 0:00:00.00
```

NMS — R3 polled over SNMPv3: snmp interfaces

```
.1.3.6.1.2.1.2.2.1.2.1 = STRING: "GigabitEthernet1"
.1.3.6.1.2.1.2.2.1.2.2 = STRING: "GigabitEthernet2"
.1.3.6.1.2.1.2.2.1.2.3 = STRING: "GigabitEthernet3"
.1.3.6.1.2.1.2.2.1.2.4 = STRING: "GigabitEthernet4"
.1.3.6.1.2.1.2.2.1.2.5 = STRING: "VoIP-Null0"
.1.3.6.1.2.1.2.2.1.2.6 = STRING: "Null0"
.1.3.6.1.2.1.2.2.1.2.7 = STRING: "Loopback0"
.1.3.6.1.2.1.2.2.1.2.8 = STRING: "Tunnel0"
.1.3.6.1.2.1.2.2.1.2.9 = STRING: "Loopback1"
```

R1 — running config

```
Building configuration...

Current configuration : 21292 bytes
!
! Last configuration change at 23:22:01 UTC Mon Sep 7 2026 by lab
!
version 17.15
service timestamps debug datetime msec
service timestamps log datetime msec show-timezone
service sequence-numbers
platform qfp utilization monitor load 80
platform sslvpn use-pd
platform console serial
!
hostname c8000v-r1
!
boot-start-marker
boot-end-marker
!
!
vrf definition MGMT
 description out-of-band management
 !
 address-family ipv4
 exit-address-family
!
aaa new-model
!
!
aaa group server tacacs+ LABTACGRP
 server name LAB-TAC
 ip vrf forwarding MGMT
 ip tacacs source-interface GigabitEthernet4
!
aaa authentication login default group LABTACGRP local
aaa authentication enable default group LABTACGRP enable
aaa authorization exec default group LABTACGRP local if-authenticated
aaa accounting exec default start-stop group LABTACGRP
aaa accounting commands 15 default start-stop group LABTACGRP
!
!
aaa session-id common
!
!
!
!
!
!
!
!
!
!
!
!
ip domain name lab.local
!
!
!
```

```
login on-success log
!
!
subscriber templating
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
crypto pki trustpoint TP-self-signed-2558801973
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-2558801973
 revocation-check none
 rsakeypair TP-self-signed-2558801973
 hash sha512
!
crypto pki trustpoint SLA-TrustPoint
 enrollment pkcs12
 revocation-check crl
 hash sha512
!
!
crypto pki certificate chain TP-self-signed-2558801973
 certificate self-signed 01
  30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 0D050030
  31312F30 2D060355 04030C26 494F532D 53656C66 2D536967 6E65642D 43657274
  69666963 6174652D 32353538 38303139 3733301E 170D3236 30393037 32323134
  31335A17 0D333630 39303632 32313431 335A3031 312F302D 06035504 030C2649
  4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D32 35353838
  30313937 33308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
  0A028201 0100A3B0 B1A31C69 7CE0D771 3CC0FD10 E87466FF 8D56B97B 7AD85044
  91C4659E DCED2F64 193AAD2A 709A1A7F B0F9945F 797749AD F86A4510 7E1F80A1
  1FE80C60 D4E397B7 4846E65C C13B5B9C 05D21CDF EAB8EA3A 202D3F4F 693E67C9
  169D42DB F7000DF8 676793A5 8AEB92D4 877721B9 A083A1F4 72CFA262 004898FA
  CD75F76C 287F9957 6AAF716E 30D9DA53 CEBC2C14 5F41C80F 3247EDB8 C35AA5E6
  CC2628B6 F19CF7C9 2537F3FD 995067E0 20535AD0 B8B892C3 549EBA73 8A0E9DB3
  990300B6 76DD444A 8F5E5B8E A6E30FC6 ACF04379 0B7C0CBD 047905B0 EAB4E9F3
  DDB03158 10BCF670 6405B592 C4C94F7C 0A9A3A87 907BD41D 26C6734C F6CA0371
  9B89CA94 82710203 010001A3 53305130 1D060355 1D0E0416 0414DABC F43EC8F4
  32D3489E 11DFF4F8 E2C8D1CB D88B301F 0603551D 23041830 168014DA BCF43EC8
  F432D348 9E11DFF4 F8E2C8D1 CBD88B30 0F060355 1D130101 FF040530 030101FF
  300D0609 2A864886 F70D0101 0D050003 82010100 354BEB77 02B9B574 B6A2A7B3
  DB44EAF0 BD91B085 A514CC8F 9F3CBE65 28A9C7C1 17ECD656 73651630 FF4E1EDE
  0D09C01D F0C223D8 8B936734 EC239D25 4C9F5648 A5DA5CB6 D9144CA0 8CB781EA
  8E80B81E 07E2D33B 767E629F E52A6505 6C10A855 85E69C37 348B0823 7209371E
  CE045D6E FB230443 69EC02A4 830956CB 31AB98AF F9F426FD 52C3BC02 68B742EB
  5EE2700E EC289D1A 40499A5A 10AA5DEA 6C7B7346 45CB66A7 B91BA82E 8439642E
  687AE6AA FAA120C7 F7BE113A 20EF3FD2 BC31C20B 35F3EB98 4FA898A6 6D0434B6
  0D2B4A11 924B2538 0956F607 5BA8D57C 011E753D E62C7505 3E534885 97469D4E
  C86EDCB7 8895F4ED F4756850 60602A97 34796304
        quit
crypto pki certificate chain SLA-TrustPoint
 certificate ca 01
  30820321 30820209 A0030201 02020101 300D0609 2A864886 F70D0101 0B050030
  32310E30 0C060355 040A1305 43697363 6F312030 1E060355 04031317 43697363
  6F204C69 63656E73 696E6720 526F6F74 20434130 1E170D31 33303533 30313934
  3834375A 170D3338 30353330 31393438 34375A30 32310E30 0C060355 040A1305
  43697363 6F312030 1E060355 04031317 43697363 6F204C69 63656E73 696E6720
  526F6F74 20434130 82012230 0D06092A 864886F7 0D010101 05000382 010F0030
  82010A02 82010100 A6BCBD96 131E05F7 145EA72C 2CD686E6 17222EA1 F1EFF64D
  CBB4C798 212AA147 C655D8D7 9471380D 8711441E 1AAF071A 9CAE6388 8A38E520
  1C394D78 462EF239 C659F715 B98C0A59 5BBB5CBD 0CFEBEA3 700A8BF7 D8F256EE
  4AA4E80D DB6FD1C9 60B1FD18 FFC69C96 6FA68957 A2617DE7 104FDC5F EA2956AC
  7390A3EB 2B5436AD C847A2C5 DAB553EB 69A9A535 58E9F3E3 C0BD23CF 58BD7188
  68E69491 20F320E7 948E71D7 AE3BCC84 F10684C7 4BC8E00F 539BA42B 42C68BB7
  C7479096 B4CB2D62 EA2F505D C7B062A4 6811D95B E8250FC4 5D5D5FB8 8F27D191
  C55F0D76 61F9A4CD 3D992327 A8BB03BD 4E6D7069 7CBADF8B DF5F4368 95135E44
  DFC7C6CF 04DD7FD1 02030100 01A34230 40300E06 03551D0F 0101FF04 04030201
  06300F06 03551D13 0101FF04 05300301 01FF301D 0603551D 0E041604 1449DC85
  4B3D31E5 1B3E6A17 606AF333 3D3B4C73 E8300D06 092A8648 86F70D01 010B0500
  03820101 00507F24 D3932A66 86025D9F E838AE5C 6D4DF6B0 49631C78 240DA905
```

```
  604EDCDE FF4FED2B 77FC460E CD636FDB DD44681E 3A5673AB 9093D3B1 6C9E3D8B
  D98987BF E40CBD9E 1AECA0C2 2189BB5C 8FA85686 CD98B646 5575B146 8DFC66A8
  467A3DF4 4D565700 6ADF0F0D CF835015 3C04FF7C 21E878AC 11BA9CD2 55A9232C
  7CA7B7E6 C1AF74F6 152E99B7 B1FCF9BB E973DE7F 5BDDEB86 C71E3B49 1765308B
  5FB0DA06 B92AFE7F 494E8A9E 07B85737 F3A58BE1 1A48A229 C37C1E69 39F08678
  80DDCD16 D6BACECA EEBC7CF9 8428787B 35202CDC 60E4616A B623CDBD 230E3AFB
  418616A9 4093E049 4D10AB75 27E86F73 932E35B5 8862FDAE 0275156F 719BB2F0
  D697DF7F 28
        quit
!
!
!
!
!
!
!
!
!
license udi pid C8000V sn 9VRWIY571LW
license boot level network-premier addon dna-premier
memory free low-watermark processor 31774
diagnostic bootup level minimal
!
!
spanning-tree extend system-id
!
!
enable secret 9 $9$uia9E1anibovxE$Oqyklcz.SLvh8epz2w2TjV6d9TggTO3p9KSxEGgTTD2
!
username lab privilege 15 secret 9 $9$ksvY7W/rHjFg0.$AdIeocLbIuwaSOCYSoWgOl/6LNagQ58URuynu0Dbtq6
!
redundancy
!
!
!
crypto ikev2 proposal LAB-PROP
 encryption aes-cbc-256
 integrity sha256
 group 14
!
crypto ikev2 policy LAB-POL
 proposal LAB-PROP
!
crypto ikev2 keyring LAB-KR
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key LabPreSharedKey123
 !
!
!
crypto ikev2 profile LAB-PROF
 match identity remote address 0.0.0.0
 authentication remote pre-share
 authentication local pre-share
 keyring local LAB-KR
!
!
!
!
!
!
!
!
!
!
!
!
!
crypto ipsec transform-set LAB-TS esp-aes 256 esp-sha256-hmac
 mode transport
!
crypto ipsec profile LAB-IPSEC
 set transform-set LAB-TS
 set ikev2-profile LAB-PROF
!
!
!
!
!
!
!
```

```
!
!
!
interface Loopback0
 description Protected endpoint
 ip address 172.16.1.1 255.255.255.255
!
interface Loopback1
 description BGP-advertised prefix
 ip address 10.20.1.1 255.255.255.255
!
interface Tunnel0
 description DMVPN hub
 ip address 172.20.0.1 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp redirect
 ip tcp adjust-mss 1360
 bfd interval 500 min_rx 500 multiplier 3
 tunnel source GigabitEthernet2
 tunnel mode gre multipoint
 tunnel key 100
 tunnel protection ipsec profile LAB-IPSEC
!
interface GigabitEthernet1
 description MGMT - QEMU user-mode net (DHCP)
 ip address dhcp
 negotiation auto
!
interface GigabitEthernet2
 description WAN - shared provider segment, DMVPN underlay
 ip address 100.64.0.1 255.255.255.0
 negotiation auto
!
interface GigabitEthernet3
 description LAN toward the local host
 ip address 192.168.10.1 255.255.255.0
 ip nat inside
 negotiation auto
!
interface GigabitEthernet4
 description OOB management - NTP, syslog, SNMP
 vrf forwarding MGMT
 ip address 192.168.99.1 255.255.255.0
 negotiation auto
!
router bgp 65001
 bgp router-id 172.16.1.1
 bgp log-neighbor-changes
 neighbor 172.20.0.2 remote-as 65002
 neighbor 172.20.0.2 password LabBgpSecret
 neighbor 172.20.0.2 timers 10 30
 neighbor 172.20.0.2 fall-over bfd
 neighbor 172.20.0.3 remote-as 65003
 neighbor 172.20.0.3 password LabBgpSecret
 neighbor 172.20.0.3 timers 10 30
 neighbor 172.20.0.3 fall-over bfd
 !
 address-family ipv4
  network 10.20.1.1 mask 255.255.255.255
  network 10.30.1.0 mask 255.255.255.0
  network 192.168.10.0
  neighbor 172.20.0.2 activate
  neighbor 172.20.0.2 send-community both
  neighbor 172.20.0.2 route-map RM-IN-R2 in
  neighbor 172.20.0.2 route-map RM-OUT-R2 out
  neighbor 172.20.0.2 maximum-prefix 15 80
  neighbor 172.20.0.3 activate
  neighbor 172.20.0.3 send-community both
  neighbor 172.20.0.3 route-map RM-IN-R3 in
  neighbor 172.20.0.3 route-map RM-OUT-R3 out
  neighbor 172.20.0.3 maximum-prefix 15 80
 exit-address-family
!
ip forward-protocol nd
!
ip bgp-community new-format
ip community-list standard CL-VALID permit 65001:1
```

```
ip community-list standard CL-VALID permit 65001:2
ip community-list standard CL-VALID permit 65001:3
ip community-list standard CL-VALID permit 65002:1
ip community-list standard CL-VALID permit 65002:2
ip community-list standard CL-VALID permit 65002:3
ip community-list standard CL-VALID permit 65003:1
ip community-list standard CL-VALID permit 65003:2
ip community-list standard CL-VALID permit 65003:3
ip as-path access-list 10 permit ^65002$
ip as-path access-list 20 permit ^65003$
no ip http server
ip http secure-server
ip route 10.30.1.0 255.255.255.0 Null0
ip nat pool SITE-POOL 10.30.1.100 10.30.1.129 prefix-length 24
ip nat inside source static 192.168.10.10 10.30.1.10 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.11 10.30.1.11 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.12 10.30.1.12 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.13 10.30.1.13 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.14 10.30.1.14 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.15 10.30.1.15 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.16 10.30.1.16 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.17 10.30.1.17 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.18 10.30.1.18 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.10.19 10.30.1.19 route-map NAT-TO-DOMAIN
ip nat inside source list NAT-POOL-SRC pool SITE-POOL
ip ssh bulk-mode 131072
ip ssh server algorithm authentication password
!
ip prefix-list PL-FAR-R2 seq 40 permit 10.20.2.1/32
ip prefix-list PL-FAR-R2 seq 45 permit 10.30.2.0/24
ip prefix-list PL-FAR-R2 seq 50 permit 192.168.20.0/24
!
ip prefix-list PL-FAR-R3 seq 40 permit 10.20.3.1/32
ip prefix-list PL-FAR-R3 seq 45 permit 10.30.3.0/24
ip prefix-list PL-FAR-R3 seq 50 permit 192.168.30.0/24
!
ip prefix-list PL-OWN-LAN seq 5 permit 192.168.10.0/24
!
ip prefix-list PL-OWN-LO seq 5 permit 10.20.1.1/32
!
ip prefix-list PL-OWN-NAT seq 5 permit 10.30.1.0/24
!
ip access-list standard VTY-MGMT
 10 remark out-of-band management network
 10 permit 192.168.99.0 0.0.0.255
 20 remark hypervisor user-mode NAT: how the harness reaches these devices
 20 permit 10.0.2.0 0.0.0.255
 30 deny any log
!
ip access-list extended NAT-DOMAIN
 10 permit ip host 192.168.10.10 10.30.0.0 0.0.255.255
 20 permit ip host 192.168.10.11 10.30.0.0 0.0.255.255
 30 permit ip host 192.168.10.12 10.30.0.0 0.0.255.255
 40 permit ip host 192.168.10.13 10.30.0.0 0.0.255.255
 50 permit ip host 192.168.10.14 10.30.0.0 0.0.255.255
 60 permit ip host 192.168.10.15 10.30.0.0 0.0.255.255
 70 permit ip host 192.168.10.16 10.30.0.0 0.0.255.255
 80 permit ip host 192.168.10.17 10.30.0.0 0.0.255.255
 90 permit ip host 192.168.10.18 10.30.0.0 0.0.255.255
 100 permit ip host 192.168.10.19 10.30.0.0 0.0.255.255
ip access-list extended NAT-POOL-SRC
 10 permit ip 192.168.10.64 0.0.0.31 10.30.0.0 0.0.255.255
logging source-interface GigabitEthernet4 vrf MGMT
logging host 192.168.99.10 vrf MGMT
route-map RM-OUT-R2 permit 10
 description R1's own LO, tagged 65001:1
 match ip address prefix-list PL-OWN-LO
 set community 65001:1
!
route-map RM-OUT-R2 permit 20
 description R1's own NAT, tagged 65001:2
 match ip address prefix-list PL-OWN-NAT
 set community 65001:2
!
route-map RM-OUT-R2 permit 30
 description R1's own LAN, tagged 65001:3
 match ip address prefix-list PL-OWN-LAN
 set community 65001:3
!
route-map RM-OUT-R2 permit 55
 description re-advertise R3, preserving its communities
```

```
 match ip address prefix-list PL-FAR-R3
!
route-map RM-OUT-R3 permit 10
 description R1's own LO, tagged 65001:1
 match ip address prefix-list PL-OWN-LO
 set community 65001:1
!
route-map RM-OUT-R3 permit 20
 description R1's own NAT, tagged 65001:2
 match ip address prefix-list PL-OWN-NAT
 set community 65001:2
!
route-map RM-OUT-R3 permit 30
 description R1's own LAN, tagged 65001:3
 match ip address prefix-list PL-OWN-LAN
 set community 65001:3
!
route-map RM-OUT-R3 permit 55
 description re-advertise R2, preserving its communities
 match ip address prefix-list PL-FAR-R2
!
route-map NAT-TO-DOMAIN permit 10
 match ip address NAT-DOMAIN
!
route-map RM-IN-R2 permit 10
 description accept only known communities on an AS path R2 can produce
 match as-path 10
 match community CL-VALID
!
route-map RM-IN-R3 permit 10
 description accept only known communities on an AS path R3 can produce
 match as-path 20
 match community CL-VALID
!
snmp-server group LABGRP v3 priv read LABVIEW notify LABVIEW
snmp-server view LABVIEW iso included
snmp-server trap-source GigabitEthernet4
snmp-server enable traps snmp authentication linkdown linkup coldstart warmstart
snmp-server enable traps vrrp
snmp-server enable traps flowmon
snmp-server enable traps pfr
snmp-server enable traps ds1
snmp-server enable traps sdwan security policy system omp bfd
snmp-server enable traps entity-perf throughput-notif
snmp-server enable traps call-home message-send-fail server-fail
snmp-server enable traps tty
snmp-server enable traps ospf state-change
snmp-server enable traps ospf errors
snmp-server enable traps ospf retransmit
snmp-server enable traps ospf lsa
snmp-server enable traps ospf cisco-specific state-change nssa-trans-change
snmp-server enable traps ospf cisco-specific state-change shamlink interface
snmp-server enable traps ospf cisco-specific state-change shamlink neighbor
snmp-server enable traps ospf cisco-specific errors
snmp-server enable traps ospf cisco-specific retransmit
snmp-server enable traps ospf cisco-specific lsa
snmp-server enable traps eigrp
snmp-server enable traps casa
snmp-server enable traps xgcp
snmp-server enable traps cef resource-failure peer-state-change peer-fib-state-change inconsistency
snmp-server enable traps smart-license
snmp-server enable traps diameter
snmp-server enable traps entity-qfp mem-res-thresh throughput-notif
snmp-server enable traps entity-state
snmp-server enable traps ethernet cfm cc mep-up mep-down cross-connect loop config
snmp-server enable traps ethernet cfm crosscheck mep-missing mep-unknown service-up
snmp-server enable traps ether-oam
snmp-server enable traps ethernet evc status create delete
snmp-server enable traps aaa_server
snmp-server enable traps config-copy
snmp-server enable traps config
snmp-server enable traps config-ctid
snmp-server enable traps memory bufferpeak
snmp-server enable traps fru-ctrl
snmp-server enable traps entity-sensor
snmp-server enable traps resource-policy
snmp-server enable traps flash insertion removal lowspace
snmp-server enable traps hsrp
snmp-server enable traps entity
snmp-server enable traps ip local pool
snmp-server enable traps cpu threshold
```

```
snmp-server enable traps auth-framework sec-violation
snmp-server enable traps atm subif
snmp-server enable traps frame-relay
snmp-server enable traps frame-relay subif
snmp-server enable traps bgp state-changes all backward-trans limited updown-limited
snmp-server enable traps bgp threshold prefix
snmp-server enable traps bgp cbgp2 state-changes all backward-trans limited updown-limited
snmp-server enable traps bgp cbgp2 threshold prefix
snmp-server enable traps pim neighbor-change rp-mapping-change invalid-pim-message
snmp-server enable traps ipmulticast
snmp-server enable traps msdp
snmp-server enable traps mvpn
snmp-server enable traps rsvp
snmp-server enable traps isis
snmp-server enable traps dhcp
snmp-server enable traps nhrp nhs
snmp-server enable traps nhrp nhc
snmp-server enable traps nhrp nhp
snmp-server enable traps nhrp quota-exceeded
snmp-server enable traps ipsla
snmp-server enable traps bfd
snmp-server enable traps cnpd
snmp-server enable traps event-manager
snmp-server enable traps dlsw
snmp-server enable traps ospfv3 state-change
snmp-server enable traps ospfv3 errors
snmp-server enable traps pppoe
snmp-server enable traps l2tun session
snmp-server enable traps l2tun pseudowire status
snmp-server enable traps l2tun tunnel
snmp-server enable traps pki
snmp-server enable traps pimstdmib neighbor-loss invalid-register invalid-join-prune rp-mapping-change
interface-election
snmp-server enable traps adslline
snmp-server enable traps entity-diag boot-up-fail hm-test-recover hm-thresh-reached scheduled-test-fail
snmp-server enable traps vdsl2line
snmp-server enable traps vtp
snmp-server enable traps vlancreate
snmp-server enable traps vlandelete
snmp-server enable traps port-security
snmp-server enable traps isdn call-information
snmp-server enable traps isdn layer2
snmp-server enable traps isdn chan-not-avail
snmp-server enable traps isdn ietf
snmp-server enable traps c3g
snmp-server enable traps LTE
snmp-server enable traps lisp
snmp-server enable traps firewall serverstatus
snmp-server enable traps ike policy add
snmp-server enable traps ike policy delete
snmp-server enable traps ike tunnel start
snmp-server enable traps ike tunnel stop
snmp-server enable traps ipsec cryptomap add
snmp-server enable traps ipsec cryptomap delete
snmp-server enable traps ipsec cryptomap attach
snmp-server enable traps ipsec cryptomap detach
snmp-server enable traps ipsec tunnel start
snmp-server enable traps ipsec tunnel stop
snmp-server enable traps ipsec too-many-sas
snmp-server enable traps gdoi gm-start-registration
snmp-server enable traps gdoi gm-registration-complete
snmp-server enable traps gdoi gm-re-register
snmp-server enable traps gdoi gm-rekey-rcvd
snmp-server enable traps gdoi gm-rekey-fail
snmp-server enable traps gdoi ks-rekey-pushed
snmp-server enable traps gdoi gm-incomplete-cfg
snmp-server enable traps gdoi ks-no-rsa-keys
snmp-server enable traps gdoi ks-new-registration
snmp-server enable traps gdoi ks-reg-complete
snmp-server enable traps gdoi ks-role-change
snmp-server enable traps gdoi ks-gm-deleted
snmp-server enable traps gdoi ks-peer-reachable
snmp-server enable traps gdoi ks-peer-unreachable
snmp-server enable traps mpls rfc ldp
snmp-server enable traps mpls ldp
snmp-server enable traps mpls rfc traffic-eng
snmp-server enable traps mpls traffic-eng
snmp-server enable traps mpls fast-reroute protected
snmp-server enable traps otn
snmp-server enable traps pw vc
snmp-server enable traps frame-relay multilink bundle-mismatch
```

```
snmp-server enable traps dial
snmp-server enable traps dsp card-status
snmp-server enable traps dsp oper-state
snmp-server enable traps dsp video-usage
snmp-server enable traps dsp video-out-of-resource
snmp-server enable traps syslog
snmp-server enable traps sbc adj-status
snmp-server enable traps sbc blacklist
snmp-server enable traps sbc congestion-alarm
snmp-server enable traps sbc h248-ctrlr-status
snmp-server enable traps sbc media-source
snmp-server enable traps sbc radius-conn-status
snmp-server enable traps sbc sla-violation
snmp-server enable traps sbc sla-violation-rev1
snmp-server enable traps sbc svc-state
snmp-server enable traps sbc qos-statistics
snmp-server enable traps bulkstat collection transfer
snmp-server enable traps ethernet cfm alarm
snmp-server enable traps alarms informational
snmp-server enable traps transceiver all
snmp-server enable traps rf
snmp-server enable traps vrfmib vrf-up vrf-down vnet-trunk-up vnet-trunk-down
snmp-server enable traps ccme
snmp-server enable traps srst
snmp-server enable traps mpls vpn
snmp-server enable traps mpls rfc vpn
snmp-server enable traps voice
snmp-server host 192.168.99.10 vrf MGMT version 3 priv labmon udp-port 1162
snmp-server host 192.168.99.10 vrf MGMT version 3 priv labmon
tacacs server LAB-TAC
 address ipv4 192.168.99.10
 key LabTacacsKey123
!
!
!
!
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
!
!
banner login ^C
******************************************************************************
                          AUTHORISED ACCESS ONLY

  Access to this device is restricted to authorised personnel. If you are not
  an authorised user, disconnect now.

  All activity is monitored, logged and audited. Continued use of this system
  constitutes consent to that monitoring.

  Unauthorised access or use may result in disciplinary action and civil or
  criminal penalties.
******************************************************************************
^C
!
line con 0
 exec-timeout 0 0
 activation-character 13
 logging synchronous
 stopbits 1
line aux 0
 activation-character 13
line vty 0 4
 access-class VTY-MGMT in vrf-also
 exec-timeout 0 0
 activation-character 13
 transport input ssh
line vty 5 15
 access-class VTY-MGMT in vrf-also
 exec-timeout 0 0
```

```
 activation-character 13
 transport input ssh
!
ntp source GigabitEthernet4
ntp server vrf MGMT 192.168.99.10
!
!
!
!
!
!
netconf-yang
restconf
end
```

R2 — running config

```
Building configuration...

Current configuration : 19872 bytes
!
! Last configuration change at 23:21:14 UTC Mon Sep 7 2026 by lab
!
version 17.15
service timestamps debug datetime msec
service timestamps log datetime msec show-timezone
service sequence-numbers
platform qfp utilization monitor load 80
platform sslvpn use-pd
platform console serial
!
hostname c8000v-r2
!
boot-start-marker
boot-end-marker
!
!
vrf definition MGMT
 description out-of-band management
 !
 address-family ipv4
 exit-address-family
!
aaa new-model
!
!
aaa group server tacacs+ LABTACGRP
 server name LAB-TAC
 ip vrf forwarding MGMT
 ip tacacs source-interface GigabitEthernet4
!
aaa authentication login default group LABTACGRP local
aaa authentication enable default group LABTACGRP enable
aaa authorization exec default group LABTACGRP local if-authenticated
aaa accounting exec default start-stop group LABTACGRP
aaa accounting commands 15 default start-stop group LABTACGRP
!
!
aaa session-id common
!
!
!
!
!
!
!
!
!
!
!
!
ip domain name lab.local
!
!
!
login on-success log
!
!
subscriber templating
!
```

```
!
!
!
!
!
!
!
!
!
!
!
!
!
crypto pki trustpoint TP-self-signed-451475034
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-451475034
 revocation-check none
 rsakeypair TP-self-signed-451475034
 hash sha512
!
crypto pki trustpoint SLA-TrustPoint
 enrollment pkcs12
 revocation-check crl
 hash sha512
!
!
crypto pki certificate chain TP-self-signed-451475034
 certificate self-signed 01
  3082032E 30820216 A0030201 02020101 300D0609 2A864886 F70D0101 0D050030
  30312E30 2C060355 04030C25 494F532D 53656C66 2D536967 6E65642D 43657274
  69666963 6174652D 34353134 37353033 34301E17 0D323630 39303732 32313431
  325A170D 33363039 30363232 31343132 5A303031 2E302C06 03550403 0C25494F
  532D5365 6C662D53 69676E65 642D4365 72746966 69636174 652D3435 31343735
  30333430 82012230 0D06092A 864886F7 0D010101 05000382 010F0030 82010A02
  82010100 C9CFA37B 39E41985 6120CCAF 0AE693B6 F671562D 0F4B676A 7D14741D
  929C02B1 B6E17AC0 E6F0C660 BA1A9C4E 45B077E6 7C7C3AF9 7F3BE083 A805381B
  84C48F6F 8806352B E69AA1FD 5D0D6D65 4B5276E3 6677EC55 851DBE2B 92AAB096
  8C5B49D6 05B47713 A8B77C13 1CD15A64 6F37D0A6 D35BBF4C A97471F7 07461355
  E9EEBD7E 16F1459D 22302CC8 BA056BD0 ADE0190A 00DBA2B8 8D6977E5 2CAACBE4
  FDBFD944 0D6771FD DC46CA79 327E1B61 5E2F4A7A 991E75E4 6723C838 249320FC
  597FACA0 77533D57 9E92FB49 873D1F4A EEC9C052 06CB9D3B 4A2360C5 5362DECA
  9271CF20 14DD10E5 BBB01C17 6556ADCF 533222FC 3869400A 2933F291 27F723E8
  BB49B7E3 02030100 01A35330 51301D06 03551D0E 04160414 F21BB9E2 A8780800
  8A7482B4 A872EB5E FE8688B9 301F0603 551D2304 18301680 14F21BB9 E2A87808
  008A7482 B4A872EB 5EFE8688 B9300F06 03551D13 0101FF04 05300301 01FF300D
  06092A86 4886F70D 01010D05 00038201 0100B90C 297103CA B34A6FA5 57C2310E
  D3C86AD7 863193A6 12D30D52 35310D37 3E948055 2B965E6B 505BFC95 A3107821
  FD7FB67F 7FE22E75 0512C3C1 0D13EE47 53B9D736 63B13871 324360F7 4B1D8067
  3236EF41 3A44DC6D 57540BE4 E2BED3A2 0E9A231C 9FC34FF9 03F30438 F71FA888
  2951138B 46D6C4F8 E94EC7F7 7FE4EB9C 987FDC76 7974B4F6 7834B88B 7A3A7766
  EEFDF646 437A7DBD 993C13D9 7D5CE081 55A05480 004CD0F5 7E81F48D 20AAD5C9
  E46B42EC 8C43C089 A3B8A082 D27D4DE8 621EFE73 6A7ECBB3 FDA089A7 1E1BCD34
  3210A8A8 3BE602C4 8F6104D2 AF27AF4C 76D7513E 0AE9CDDE 149BD06B D29D1593
  B6BECC04 8C99DE76 29F09F47 74FF35E2 0C74
       quit
crypto pki certificate chain SLA-TrustPoint
 certificate ca 01
  30820321 30820209 A0030201 02020101 300D0609 2A864886 F70D0101 0B050030
  32310E30 0C060355 040A1305 43697363 6F312030 1E060355 04031317 43697363
  6F204C69 63656E73 696E6720 526F6F74 20434130 1E170D31 33303533 30313934
  3834375A 170D3338 30353330 31393438 34375A30 32310E30 0C060355 040A1305
  43697363 6F312030 1E060355 04031317 43697363 6F204C69 63656E73 696E6720
  526F6F74 20434130 82012230 0D06092A 864886F7 0D010101 05000382 010F0030
  82010A02 82010100 A6BCBD96 131E05F7 145EA72C 2CD686E6 17222EA1 F1EFF64D
  CBB4C798 212AA147 C655D8D7 9471380D 8711441E 1AAF071A 9CAE6388 8A38E520
  1C394D78 462EF239 C659F715 B98C0A59 5BBB5CBD 0CFEBEA3 700A8BF7 D8F256EE
  4AA4E80D DB6FD1C9 60B1FD18 FFC69C96 6FA68957 A2617DE7 104FDC5F EA2956AC
  7390A3EB 2B5436AD C847A2C5 DAB553EB 69A9A535 58E9F3E3 C0BD23CF 58BD7188
  68E69491 20F320E7 948E71D7 AE3BCC84 F10684C7 4BC8E00F 539BA42B 42C68BB7
  C7479096 B4CB2D62 EA2F505D C7B062A4 6811D95B E8250FC4 5D5D5FB8 8F27D191
  C55F0D76 61F9A4CD 3D992327 A8BB03BD 4E6D7069 7CBADF8B DF5F4368 95135E44
  DFC7C6CF 04DD7FD1 02030100 01A34230 40300E06 03551D0F 0101FF04 04030201
  06300F06 03551D13 0101FF04 05300301 01FF301D 0603551D 0E041604 1449DC85
  4B3D31E5 1B3E6A17 606AF333 3D3B4C73 E8300D06 092A8648 86F70D01 010B0500
  03820101 00507F24 D3932A66 86025D9F E838AE5C 6D4DF6B0 49631C78 240DA905
  604EDCDE FF4FED2B 77FC460E CD636FDB DD44681E 3A5673AB 9093D3B1 6C9E3D8B
  D98987BF E40CBD9E 1AECA0C2 2189BB5C 8FA85686 CD98B646 5575B146 8DFC66A8
  467A3DF4 4D565700 6ADF0F0D CF835015 3C04FF7C 21E878AC 11BA9CD2 55A9232C
  7CA7B7E6 C1AF74F6 152E99B7 B1FCF9BB E973DE7F 5BDDEB86 C71E3B49 1765308B
  5FB0DA06 B92AFE7F 494E8A9E 07B85737 F3A58BE1 1A48A229 C37C1E69 39F08678
```

```
  80DDCD16 D6BACECA EEBC7CF9 8428787B 35202CDC 60E4616A B623CDBD 230E3AFB
  418616A9 4093E049 4D10AB75 27E86F73 932E35B5 8862FDAE 0275156F 719BB2F0
  D697DF7F 28
        quit
!
!
!
!
!
!
!
!
!
license udi pid C8000V sn 99MT1OJLO06
license boot level network-premier addon dna-premier
memory free low-watermark processor 31774
diagnostic bootup level minimal
!
!
spanning-tree extend system-id
!
!
enable secret 9 $9$IzR6xMPRz4hVOU$O/V1R.nWlX98duswhDwnTGs67nYdgYArKX89ewvQ67s
!
username lab privilege 15 secret 9 $9$bqcYxwxYLmCe2E$3qzzD/xblonG/KBzgLi14CgQBnGkOqBWmswiHb1oxLU
!
redundancy
!
!
!
crypto ikev2 proposal LAB-PROP
 encryption aes-cbc-256
 integrity sha256
 group 14
!
crypto ikev2 policy LAB-POL
 proposal LAB-PROP
!
crypto ikev2 keyring LAB-KR
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key LabPreSharedKey123
 !
 peer R1
  pre-shared-key LabPreSharedKey123
 !
!
!
crypto ikev2 profile LAB-PROF
 match identity remote address 0.0.0.0
 authentication remote pre-share
 authentication local pre-share
 keyring local LAB-KR
!
!
!
!
!
!
!
!
!
!
!
!
crypto ipsec transform-set LAB-TS esp-aes 256 esp-sha256-hmac
 mode transport
!
crypto ipsec profile LAB-IPSEC
 set transform-set LAB-TS
 set ikev2-profile LAB-PROF
!
!
!
!
!
!
!
!
!
```

```
!
interface Loopback0
 description Protected endpoint
 ip address 172.16.2.1 255.255.255.255
!
interface Loopback1
 description BGP-advertised prefix
 ip address 10.20.2.1 255.255.255.255
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.2 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
 bfd interval 500 min_rx 500 multiplier 3
 tunnel source GigabitEthernet2
 tunnel mode gre multipoint
 tunnel key 100
 tunnel protection ipsec profile LAB-IPSEC
!
interface GigabitEthernet1
 description MGMT - QEMU user-mode net (DHCP)
 ip address dhcp
 negotiation auto
!
interface GigabitEthernet2
 description WAN - shared provider segment, DMVPN underlay
 ip address 100.64.0.2 255.255.255.0
 negotiation auto
!
interface GigabitEthernet3
 description LAN toward the local host
 ip address 192.168.20.1 255.255.255.0
 ip nat inside
 negotiation auto
!
interface GigabitEthernet4
 description OOB management - NTP, syslog, SNMP
 vrf forwarding MGMT
 ip address 192.168.99.2 255.255.255.0
 negotiation auto
!
router bgp 65002
 bgp router-id 172.16.2.1
 bgp log-neighbor-changes
 neighbor 172.20.0.1 remote-as 65001
 neighbor 172.20.0.1 password LabBgpSecret
 neighbor 172.20.0.1 timers 10 30
 neighbor 172.20.0.1 fall-over bfd
 !
 address-family ipv4
  network 10.20.2.1 mask 255.255.255.255
  network 10.30.2.0 mask 255.255.255.0
  network 192.168.20.0
  neighbor 172.20.0.1 activate
  neighbor 172.20.0.1 send-community both
  neighbor 172.20.0.1 route-map RM-IN-R1 in
  neighbor 172.20.0.1 route-map RM-OUT-R1 out
  neighbor 172.20.0.1 maximum-prefix 15 80
 exit-address-family
!
ip forward-protocol nd
!
ip bgp-community new-format
ip community-list standard CL-VALID permit 65001:1
ip community-list standard CL-VALID permit 65001:2
ip community-list standard CL-VALID permit 65001:3
ip community-list standard CL-VALID permit 65002:1
ip community-list standard CL-VALID permit 65002:2
ip community-list standard CL-VALID permit 65002:3
ip community-list standard CL-VALID permit 65003:1
ip community-list standard CL-VALID permit 65003:2
ip community-list standard CL-VALID permit 65003:3
ip as-path access-list 10 permit ^65001$
ip as-path access-list 10 permit ^65001_65003$
no ip http server
```

```
ip http secure-server
ip route 10.30.2.0 255.255.255.0 Null0
ip nat pool SITE-POOL 10.30.2.100 10.30.2.129 prefix-length 24
ip nat inside source static 192.168.20.10 10.30.2.10 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.11 10.30.2.11 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.12 10.30.2.12 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.13 10.30.2.13 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.14 10.30.2.14 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.15 10.30.2.15 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.16 10.30.2.16 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.17 10.30.2.17 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.18 10.30.2.18 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.20.19 10.30.2.19 route-map NAT-TO-DOMAIN
ip nat inside source list NAT-POOL-SRC pool SITE-POOL
ip ssh bulk-mode 131072
ip ssh server algorithm authentication password
!
ip prefix-list PL-OWN-LAN seq 5 permit 192.168.20.0/24
!
ip prefix-list PL-OWN-LO seq 5 permit 10.20.2.1/32
!
ip prefix-list PL-OWN-NAT seq 5 permit 10.30.2.0/24
!
ip access-list standard VTY-MGMT
 10 remark out-of-band management network
 10 permit 192.168.99.0 0.0.0.255
 20 remark hypervisor user-mode NAT: how the harness reaches these devices
 20 permit 10.0.2.0 0.0.0.255
 30 deny any log
!
ip access-list extended NAT-DOMAIN
 10 permit ip host 192.168.20.10 10.30.0.0 0.0.255.255
 20 permit ip host 192.168.20.11 10.30.0.0 0.0.255.255
 30 permit ip host 192.168.20.12 10.30.0.0 0.0.255.255
 40 permit ip host 192.168.20.13 10.30.0.0 0.0.255.255
 50 permit ip host 192.168.20.14 10.30.0.0 0.0.255.255
 60 permit ip host 192.168.20.15 10.30.0.0 0.0.255.255
 70 permit ip host 192.168.20.16 10.30.0.0 0.0.255.255
 80 permit ip host 192.168.20.17 10.30.0.0 0.0.255.255
 90 permit ip host 192.168.20.18 10.30.0.0 0.0.255.255
 100 permit ip host 192.168.20.19 10.30.0.0 0.0.255.255
ip access-list extended NAT-POOL-SRC
 10 permit ip 192.168.20.64 0.0.0.31 10.30.0.0 0.0.255.255
logging source-interface GigabitEthernet4 vrf MGMT
logging host 192.168.99.10 vrf MGMT
route-map RM-OUT-R1 permit 10
 description R2's own LO, tagged 65002:1
 match ip address prefix-list PL-OWN-LO
 set community 65002:1
!
route-map RM-OUT-R1 permit 20
 description R2's own NAT, tagged 65002:2
 match ip address prefix-list PL-OWN-NAT
 set community 65002:2
!
route-map RM-OUT-R1 permit 30
 description R2's own LAN, tagged 65002:3
 match ip address prefix-list PL-OWN-LAN
 set community 65002:3
!
route-map NAT-TO-DOMAIN permit 10
 match ip address NAT-DOMAIN
!
route-map RM-IN-R1 permit 10
 description accept only known communities on an AS path R1 can produce
 match as-path 10
 match community CL-VALID
!
snmp-server group LABGRP v3 priv read LABVIEW notify LABVIEW
snmp-server view LABVIEW iso included
snmp-server trap-source GigabitEthernet4
snmp-server enable traps snmp authentication linkdown linkup coldstart warmstart
snmp-server enable traps vrrp
snmp-server enable traps flowmon
snmp-server enable traps pfr
snmp-server enable traps ds1
snmp-server enable traps sdwan security policy system omp bfd
snmp-server enable traps entity-perf throughput-notif
snmp-server enable traps call-home message-send-fail server-fail
snmp-server enable traps tty
snmp-server enable traps ospf state-change
```

```
snmp-server enable traps ospf errors
snmp-server enable traps ospf retransmit
snmp-server enable traps ospf lsa
snmp-server enable traps ospf cisco-specific state-change nssa-trans-change
snmp-server enable traps ospf cisco-specific state-change shamlink interface
snmp-server enable traps ospf cisco-specific state-change shamlink neighbor
snmp-server enable traps ospf cisco-specific errors
snmp-server enable traps ospf cisco-specific retransmit
snmp-server enable traps ospf cisco-specific lsa
snmp-server enable traps eigrp
snmp-server enable traps casa
snmp-server enable traps xgcp
snmp-server enable traps cef resource-failure peer-state-change peer-fib-state-change inconsistency
snmp-server enable traps smart-license
snmp-server enable traps diameter
snmp-server enable traps entity-qfp mem-res-thresh throughput-notif
snmp-server enable traps entity-state
snmp-server enable traps ethernet cfm cc mep-up mep-down cross-connect loop config
snmp-server enable traps ethernet cfm crosscheck mep-missing mep-unknown service-up
snmp-server enable traps ether-oam
snmp-server enable traps ethernet evc status create delete
snmp-server enable traps aaa_server
snmp-server enable traps config-copy
snmp-server enable traps config
snmp-server enable traps config-ctid
snmp-server enable traps memory bufferpeak
snmp-server enable traps fru-ctrl
snmp-server enable traps entity-sensor
snmp-server enable traps resource-policy
snmp-server enable traps flash insertion removal lowspace
snmp-server enable traps hsrp
snmp-server enable traps entity
snmp-server enable traps ip local pool
snmp-server enable traps cpu threshold
snmp-server enable traps auth-framework sec-violation
snmp-server enable traps atm subif
snmp-server enable traps frame-relay
snmp-server enable traps frame-relay subif
snmp-server enable traps bgp state-changes all backward-trans limited updown-limited
snmp-server enable traps bgp threshold prefix
snmp-server enable traps bgp cbgp2 state-changes all backward-trans limited updown-limited
snmp-server enable traps bgp cbgp2 threshold prefix
snmp-server enable traps pim neighbor-change rp-mapping-change invalid-pim-message
snmp-server enable traps ipmulticast
snmp-server enable traps msdp
snmp-server enable traps mvpn
snmp-server enable traps rsvp
snmp-server enable traps isis
snmp-server enable traps dhcp
snmp-server enable traps nhrp nhs
snmp-server enable traps nhrp nhc
snmp-server enable traps nhrp nhp
snmp-server enable traps nhrp quota-exceeded
snmp-server enable traps ipsla
snmp-server enable traps bfd
snmp-server enable traps cnpd
snmp-server enable traps event-manager
snmp-server enable traps dlsw
snmp-server enable traps ospfv3 state-change
snmp-server enable traps ospfv3 errors
snmp-server enable traps pppoe
snmp-server enable traps l2tun session
snmp-server enable traps l2tun pseudowire status
snmp-server enable traps l2tun tunnel
snmp-server enable traps pki
snmp-server enable traps pimstdmib neighbor-loss invalid-register invalid-join-prune rp-mapping-change
interface-election
snmp-server enable traps adslline
snmp-server enable traps entity-diag boot-up-fail hm-test-recover hm-thresh-reached scheduled-test-fail
snmp-server enable traps vdsl2line
snmp-server enable traps vtp
snmp-server enable traps vlancreate
snmp-server enable traps vlandelete
snmp-server enable traps port-security
snmp-server enable traps isdn call-information
snmp-server enable traps isdn layer2
snmp-server enable traps isdn chan-not-avail
snmp-server enable traps isdn ietf
snmp-server enable traps c3g
snmp-server enable traps LTE
snmp-server enable traps lisp
```

```
snmp-server enable traps firewall serverstatus
snmp-server enable traps ike policy add
snmp-server enable traps ike policy delete
snmp-server enable traps ike tunnel start
snmp-server enable traps ike tunnel stop
snmp-server enable traps ipsec cryptomap add
snmp-server enable traps ipsec cryptomap delete
snmp-server enable traps ipsec cryptomap attach
snmp-server enable traps ipsec cryptomap detach
snmp-server enable traps ipsec tunnel start
snmp-server enable traps ipsec tunnel stop
snmp-server enable traps ipsec too-many-sas
snmp-server enable traps gdoi gm-start-registration
snmp-server enable traps gdoi gm-registration-complete
snmp-server enable traps gdoi gm-re-register
snmp-server enable traps gdoi gm-rekey-rcvd
snmp-server enable traps gdoi gm-rekey-fail
snmp-server enable traps gdoi ks-rekey-pushed
snmp-server enable traps gdoi gm-incomplete-cfg
snmp-server enable traps gdoi ks-no-rsa-keys
snmp-server enable traps gdoi ks-new-registration
snmp-server enable traps gdoi ks-reg-complete
snmp-server enable traps gdoi ks-role-change
snmp-server enable traps gdoi ks-gm-deleted
snmp-server enable traps gdoi ks-peer-reachable
snmp-server enable traps gdoi ks-peer-unreachable
snmp-server enable traps mpls rfc ldp
snmp-server enable traps mpls ldp
snmp-server enable traps mpls rfc traffic-eng
snmp-server enable traps mpls traffic-eng
snmp-server enable traps mpls fast-reroute protected
snmp-server enable traps otn
snmp-server enable traps pw vc
snmp-server enable traps frame-relay multilink bundle-mismatch
snmp-server enable traps dial
snmp-server enable traps dsp card-status
snmp-server enable traps dsp oper-state
snmp-server enable traps dsp video-usage
snmp-server enable traps dsp video-out-of-resource
snmp-server enable traps syslog
snmp-server enable traps sbc adj-status
snmp-server enable traps sbc blacklist
snmp-server enable traps sbc congestion-alarm
snmp-server enable traps sbc h248-ctrlr-status
snmp-server enable traps sbc media-source
snmp-server enable traps sbc radius-conn-status
snmp-server enable traps sbc sla-violation
snmp-server enable traps sbc sla-violation-rev1
snmp-server enable traps sbc svc-state
snmp-server enable traps sbc qos-statistics
snmp-server enable traps bulkstat collection transfer
snmp-server enable traps ethernet cfm alarm
snmp-server enable traps alarms informational
snmp-server enable traps transceiver all
snmp-server enable traps rf
snmp-server enable traps vrfmib vrf-up vrf-down vnet-trunk-up vnet-trunk-down
snmp-server enable traps ccme
snmp-server enable traps srst
snmp-server enable traps mpls vpn
snmp-server enable traps mpls rfc vpn
snmp-server enable traps voice
snmp-server host 192.168.99.10 vrf MGMT version 3 priv labmon udp-port 1162
snmp-server host 192.168.99.10 vrf MGMT version 3 priv labmon
tacacs server LAB-TAC
 address ipv4 192.168.99.10
 key LabTacacsKey123
!
!
!
!
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
```

```
!
!
!
!
banner login ^C
******************************************************************************
                          AUTHORISED ACCESS ONLY

  Access to this device is restricted to authorised personnel. If you are not
  an authorised user, disconnect now.

  All activity is monitored, logged and audited. Continued use of this system
  constitutes consent to that monitoring.

  Unauthorised access or use may result in disciplinary action and civil or
  criminal penalties.
******************************************************************************
^C
!
line con 0
 exec-timeout 0 0
 activation-character 13
 logging synchronous
 stopbits 1
line aux 0
 activation-character 13
line vty 0 4
 access-class VTY-MGMT in vrf-also
 exec-timeout 0 0
 activation-character 13
 transport input ssh
line vty 5 15
 access-class VTY-MGMT in vrf-also
 exec-timeout 0 0
 activation-character 13
 transport input ssh
!
ntp source GigabitEthernet4
ntp server vrf MGMT 192.168.99.10
!
!
!
!
!
!
netconf-yang
restconf
end
```

R3 — running config

```
Building configuration...

Current configuration : 19832 bytes
!
! Last configuration change at 23:21:14 UTC Mon Sep 7 2026 by lab
!
version 17.15
service timestamps debug datetime msec
service timestamps log datetime msec show-timezone
service sequence-numbers
platform qfp utilization monitor load 80
platform sslvpn use-pd
platform console serial
!
hostname c8000v-r3
!
boot-start-marker
boot-end-marker
!
!
vrf definition MGMT
 description out-of-band management
 !
 address-family ipv4
 exit-address-family
!
aaa new-model
!
!
```

```
aaa group server tacacs+ LABTACGRP
 server name LAB-TAC
 ip vrf forwarding MGMT
 ip tacacs source-interface GigabitEthernet4
!
aaa authentication login default group LABTACGRP local
aaa authentication enable default group LABTACGRP enable
aaa authorization exec default group LABTACGRP local if-authenticated
aaa accounting exec default start-stop group LABTACGRP
aaa accounting commands 15 default start-stop group LABTACGRP
!
!
aaa session-id common
!
!
!
!
!
!
!
!
!
!
!
!
ip domain name lab.local
!
!
!
login on-success log
!
!
subscriber templating
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
crypto pki trustpoint TP-self-signed-1394225539
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-1394225539
 revocation-check none
 rsakeypair TP-self-signed-1394225539
 hash sha512
!
crypto pki trustpoint SLA-TrustPoint
 enrollment pkcs12
 revocation-check crl
 hash sha512
!
!
crypto pki certificate chain TP-self-signed-1394225539
 certificate self-signed 01
  30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 0D050030
  31312F30 2D060355 04030C26 494F532D 53656C66 2D536967 6E65642D 43657274
  69666963 6174652D 31333934 32323535 3339301E 170D3236 30393037 32323134
  31345A17 0D333630 39303632 32313431 345A3031 312F302D 06035504 030C2649
  4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D31 33393432
  32353533 39308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
  0A028201 01009A72 1ABC8E0C 1072AA3A FC85A8A4 F55F1158 86CF558A 9797A864
  25ADAB27 09CEDE1F 69BA396E 076D1EB5 1FB18AD2 8BC8F432 D68FA7E1 D31CE5A2
  68609CD7 962FFD33 3079835F 1E692B04 7B476846 85B6AB56 C1149552 09ACBCC7
  F7CC6723 6A93AF71 12478A64 38AC2CFA 0E8B0E0A 23FCC8EA 7EDA498E 8AEB8561
  17118926 F930366A CAD27EC2 1C8F0312 4637F83B 1AC605CA 0C3CAC05 8553A775
  81A29BE3 4CC15CB9 CDE88881 B696A9A7 99596CB9 8C8E0E6B 0581BFCD 16AA1EDF
  C037C482 B7BE1108 AFDBFC42 5D101BA2 B3AF8A5C C8C5A51F 6AABF787 B9874536
  9C44B46F 2160F9EA 6E0B349C 4B3232EE 4109D8FC F15C76F1 C77EAFA8 DA61BA95
  30F50494 0D1F0203 010001A3 53305130 1D060355 1D0E0416 0414AE7B 0DEF0D53
  9A2DFBB8 2A7F4857 8DDF095E A4C3301F 0603551D 23041830 168014AE 7B0DEF0D
  539A2DFB B82A7F48 578DDF09 5EA4C330 0F060355 1D130101 FF040530 030101FF
  300D0609 2A864886 F70D0101 0D050003 82010100 65426ED5 210C76B1 913676FF
```

```
  D92847C4 DB87D6F8 C7D468A2 D1BB826A 822083B9 88DDD430 2DFA57EA FD22715D
  D73197D0 5A6C3582 5D12968B 56DE28B1 1D162D61 119BB282 E2239093 D96D95DD
  D1122D35 0BF5780D 0FD3EB53 EF40D3D1 61693953 E97694CD C6F369F8 6B010182
  D4978C4B 9316184D FDCDF993 82047F48 557B580A 8AFDB4D8 AB1CBD94 80E67D03
  EB61EACC 075A9CDF F272A80F 02544535 24886FBF 500A61CC D2F56993 9457B80D
  C3C63E80 359E03A4 1256F1C9 7F905BBA 20E341AD B99A8BCC 02C5B9FC 96C55D7B
  66EE9989 ABC1C984 101DE474 631A5848 E41FB71A 9654FF7A 0302C615 EF5E298B
  A2C2F138 17AE6A7D 9B630B20 26159088 5AF665AF
        quit
crypto pki certificate chain SLA-TrustPoint
 certificate ca 01
  30820321 30820209 A0030201 02020101 300D0609 2A864886 F70D0101 0B050030
  32310E30 0C060355 040A1305 43697363 6F312030 1E060355 04031317 43697363
  6F204C69 63656E73 696E6720 526F6F74 20434130 1E170D31 33303533 30313934
  3834375A 170D3338 30353330 31393438 34375A30 32310E30 0C060355 040A1305
  43697363 6F312030 1E060355 04031317 43697363 6F204C69 63656E73 696E6720
  526F6F74 20434130 82012230 0D06092A 864886F7 0D010101 05000382 010F0030
  82010A02 82010100 A6BCBD96 131E05F7 145EA72C 2CD686E6 17222EA1 F1EFF64D
  CBB4C798 212AA147 C655D8D7 9471380D 8711441E 1AAF071A 9CAE6388 8A38E520
  1C394D78 462EF239 C659F715 B98C0A59 5BBB5CBD 0CFEBEA3 700A8BF7 D8F256EE
  4AA4E80D DB6FD1C9 60B1FD18 FFC69C96 6FA68957 A2617DE7 104FDC5F EA2956AC
  7390A3EB 2B5436AD C847A2C5 DAB553EB 69A9A535 58E9F3E3 C0BD23CF 58BD7188
  68E69491 20F320E7 948E71D7 AE3BCC84 F10684C7 4BC8E00F 539BA42B 42C68BB7
  C7479096 B4CB2D62 EA2F505D C7B062A4 6811D95B E8250FC4 5D5D5FB8 8F27D191
  C55F0D76 61F9A4CD 3D992327 A8BB03BD 4E6D7069 7CBADF8B DF5F4368 95135E44
  DFC7C6CF 04DD7FD1 02030100 01A34230 40300E06 03551D0F 0101FF04 04030201
  06300F06 03551D13 0101FF04 05300301 01FF301D 0603551D 0E041604 1449DC85
  4B3D31E5 1B3E6A17 606AF333 3D3B4C73 E8300D06 092A8648 86F70D01 010B0500
  03820101 00507F24 D3932A66 86025D9F E838AE5C 6D4DF6B0 49631C78 240DA905
  604EDCDE FF4FED2B 77FC460E CD636FDB DD44681E 3A5673AB 9093D3B1 6C9E3D8B
  D98987BF E40CBD9E 1AECA0C2 2189BB5C 8FA85686 CD98B646 5575B146 8DFC66A8
  467A3DF4 4D565700 6ADF0F0D CF835015 3C04FF7C 21E878AC 11BA9CD2 55A9232C
  7CA7B7E6 C1AF74F6 152E99B7 B1FCF9BB E973DE7F 5BDDEB86 C71E3B49 1765308B
  5FB0DA06 B92AFE7F 494E8A9E 07B85737 F3A58BE1 1A48A229 C37C1E69 39F08678
  80DDCD16 D6BACECA EEBC7CF9 8428787B 35202CDC 60E4616A B623CDBD 230E3AFB
  418616A9 4093E049 4D10AB75 27E86F73 932E35B5 8862FDAE 0275156F 719BB2F0
  D697DF7F 28
        quit
!
!
!
!
!
!
!
!
!
license udi pid C8000V sn 98WSPSI3CQ2
license boot level network-premier addon dna-premier
memory free low-watermark processor 31774
diagnostic bootup level minimal
!
!
spanning-tree extend system-id
!
!
enable secret 9 $9$Bw47UP1ye/.yVU$K5CSpZUsnABYFZykCttzeySotiNrRBY/frbuYNtoXY2
!
username lab privilege 15 secret 9 $9$nTmPdPNMf5C6Nk$TZUyweyM6Pgquc3KoKrRbcfdLyeESXbTbt75p43gz7g
!
redundancy
!
!
!
crypto ikev2 proposal LAB-PROP
 encryption aes-cbc-256
 integrity sha256
 group 14
!
crypto ikev2 policy LAB-POL
 proposal LAB-PROP
!
crypto ikev2 keyring LAB-KR
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key LabPreSharedKey123
 !
!
!
crypto ikev2 profile LAB-PROF
 match identity remote address 0.0.0.0
```

```
 authentication remote pre-share
 authentication local pre-share
 keyring local LAB-KR
!
!
!
!
!
!
!
!
!
!
!
!
!
crypto ipsec transform-set LAB-TS esp-aes 256 esp-sha256-hmac
 mode transport
!
crypto ipsec profile LAB-IPSEC
 set transform-set LAB-TS
 set ikev2-profile LAB-PROF
!
!
!
!
!
!
!
!
!
!
interface Loopback0
 description Protected endpoint
 ip address 172.16.3.1 255.255.255.255
!
interface Loopback1
 description BGP-advertised prefix
 ip address 10.20.3.1 255.255.255.255
!
interface Tunnel0
 description DMVPN spoke
 ip address 172.20.0.3 255.255.255.0
 no ip redirects
 ip nat outside
 ip nhrp authentication LabNhrp
 ip nhrp network-id 100
 ip nhrp holdtime 300
 ip nhrp nhs 172.20.0.1 nbma 100.64.0.1 multicast
 ip tcp adjust-mss 1360
 bfd interval 500 min_rx 500 multiplier 3
 tunnel source GigabitEthernet2
 tunnel mode gre multipoint
 tunnel key 100
 tunnel protection ipsec profile LAB-IPSEC
!
interface GigabitEthernet1
 description MGMT - QEMU user-mode net (DHCP)
 ip address dhcp
 negotiation auto
!
interface GigabitEthernet2
 description WAN - shared provider segment, DMVPN underlay
 ip address 100.64.0.3 255.255.255.0
 negotiation auto
!
interface GigabitEthernet3
 description LAN toward the local host
 ip address 192.168.30.1 255.255.255.0
 ip nat inside
 negotiation auto
!
interface GigabitEthernet4
 description OOB management - NTP, syslog, SNMP
 vrf forwarding MGMT
 ip address 192.168.99.3 255.255.255.0
 negotiation auto
!
router bgp 65003
 bgp router-id 172.16.3.1
 bgp log-neighbor-changes
```

```
 neighbor 172.20.0.1 remote-as 65001
 neighbor 172.20.0.1 password LabBgpSecret
 neighbor 172.20.0.1 timers 10 30
 neighbor 172.20.0.1 fall-over bfd
 !
 address-family ipv4
  network 10.20.3.1 mask 255.255.255.255
  network 10.30.3.0 mask 255.255.255.0
  network 192.168.30.0
  neighbor 172.20.0.1 activate
  neighbor 172.20.0.1 send-community both
  neighbor 172.20.0.1 route-map RM-IN-R1 in
  neighbor 172.20.0.1 route-map RM-OUT-R1 out
  neighbor 172.20.0.1 maximum-prefix 15 80
 exit-address-family
!
ip forward-protocol nd
!
ip bgp-community new-format
ip community-list standard CL-VALID permit 65001:1
ip community-list standard CL-VALID permit 65001:2
ip community-list standard CL-VALID permit 65001:3
ip community-list standard CL-VALID permit 65002:1
ip community-list standard CL-VALID permit 65002:2
ip community-list standard CL-VALID permit 65002:3
ip community-list standard CL-VALID permit 65003:1
ip community-list standard CL-VALID permit 65003:2
ip community-list standard CL-VALID permit 65003:3
ip as-path access-list 10 permit ^65001$
ip as-path access-list 10 permit ^65001_65002$
no ip http server
ip http secure-server
ip route 10.30.3.0 255.255.255.0 Null0
ip nat pool SITE-POOL 10.30.3.100 10.30.3.129 prefix-length 24
ip nat inside source static 192.168.30.10 10.30.3.10 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.11 10.30.3.11 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.12 10.30.3.12 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.13 10.30.3.13 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.14 10.30.3.14 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.15 10.30.3.15 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.16 10.30.3.16 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.17 10.30.3.17 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.18 10.30.3.18 route-map NAT-TO-DOMAIN
ip nat inside source static 192.168.30.19 10.30.3.19 route-map NAT-TO-DOMAIN
ip nat inside source list NAT-POOL-SRC pool SITE-POOL
ip ssh bulk-mode 131072
ip ssh server algorithm authentication password
!
ip prefix-list PL-OWN-LAN seq 5 permit 192.168.30.0/24
!
ip prefix-list PL-OWN-LO seq 5 permit 10.20.3.1/32
!
ip prefix-list PL-OWN-NAT seq 5 permit 10.30.3.0/24
!
ip access-list standard VTY-MGMT
 10 remark out-of-band management network
 10 permit 192.168.99.0 0.0.0.255
 20 remark hypervisor user-mode NAT: how the harness reaches these devices
 20 permit 10.0.2.0 0.0.0.255
 30 deny any log
!
ip access-list extended NAT-DOMAIN
 10 permit ip host 192.168.30.10 10.30.0.0 0.0.255.255
 20 permit ip host 192.168.30.11 10.30.0.0 0.0.255.255
 30 permit ip host 192.168.30.12 10.30.0.0 0.0.255.255
 40 permit ip host 192.168.30.13 10.30.0.0 0.0.255.255
 50 permit ip host 192.168.30.14 10.30.0.0 0.0.255.255
 60 permit ip host 192.168.30.15 10.30.0.0 0.0.255.255
 70 permit ip host 192.168.30.16 10.30.0.0 0.0.255.255
 80 permit ip host 192.168.30.17 10.30.0.0 0.0.255.255
 90 permit ip host 192.168.30.18 10.30.0.0 0.0.255.255
 100 permit ip host 192.168.30.19 10.30.0.0 0.0.255.255
ip access-list extended NAT-POOL-SRC
 10 permit ip 192.168.30.64 0.0.0.31 10.30.0.0 0.0.255.255
logging source-interface GigabitEthernet4 vrf MGMT
logging host 192.168.99.10 vrf MGMT
route-map RM-OUT-R1 permit 10
 description R3's own LO, tagged 65003:1
 match ip address prefix-list PL-OWN-LO
 set community 65003:1
!
```

```
route-map RM-OUT-R1 permit 20
 description R3's own NAT, tagged 65003:2
 match ip address prefix-list PL-OWN-NAT
 set community 65003:2
!
route-map RM-OUT-R1 permit 30
 description R3's own LAN, tagged 65003:3
 match ip address prefix-list PL-OWN-LAN
 set community 65003:3
!
route-map NAT-TO-DOMAIN permit 10
 match ip address NAT-DOMAIN
!
route-map RM-IN-R1 permit 10
 description accept only known communities on an AS path R1 can produce
 match as-path 10
 match community CL-VALID
!
snmp-server group LABGRP v3 priv read LABVIEW notify LABVIEW
snmp-server view LABVIEW iso included
snmp-server trap-source GigabitEthernet4
snmp-server enable traps snmp authentication linkdown linkup coldstart warmstart
snmp-server enable traps vrrp
snmp-server enable traps flowmon
snmp-server enable traps pfr
snmp-server enable traps ds1
snmp-server enable traps sdwan security policy system omp bfd
snmp-server enable traps entity-perf throughput-notif
snmp-server enable traps call-home message-send-fail server-fail
snmp-server enable traps tty
snmp-server enable traps ospf state-change
snmp-server enable traps ospf errors
snmp-server enable traps ospf retransmit
snmp-server enable traps ospf lsa
snmp-server enable traps ospf cisco-specific state-change nssa-trans-change
snmp-server enable traps ospf cisco-specific state-change shamlink interface
snmp-server enable traps ospf cisco-specific state-change shamlink neighbor
snmp-server enable traps ospf cisco-specific errors
snmp-server enable traps ospf cisco-specific retransmit
snmp-server enable traps ospf cisco-specific lsa
snmp-server enable traps eigrp
snmp-server enable traps casa
snmp-server enable traps xgcp
snmp-server enable traps cef resource-failure peer-state-change peer-fib-state-change inconsistency
snmp-server enable traps smart-license
snmp-server enable traps diameter
snmp-server enable traps entity-qfp mem-res-thresh throughput-notif
snmp-server enable traps entity-state
snmp-server enable traps ethernet cfm cc mep-up mep-down cross-connect loop config
snmp-server enable traps ethernet cfm crosscheck mep-missing mep-unknown service-up
snmp-server enable traps ether-oam
snmp-server enable traps ethernet evc status create delete
snmp-server enable traps aaa_server
snmp-server enable traps config-copy
snmp-server enable traps config
snmp-server enable traps config-ctid
snmp-server enable traps memory bufferpeak
snmp-server enable traps fru-ctrl
snmp-server enable traps entity-sensor
snmp-server enable traps resource-policy
snmp-server enable traps flash insertion removal lowspace
snmp-server enable traps hsrp
snmp-server enable traps entity
snmp-server enable traps ip local pool
snmp-server enable traps cpu threshold
snmp-server enable traps auth-framework sec-violation
snmp-server enable traps atm subif
snmp-server enable traps frame-relay
snmp-server enable traps frame-relay subif
snmp-server enable traps bgp state-changes all backward-trans limited updown-limited
snmp-server enable traps bgp threshold prefix
snmp-server enable traps bgp cbgp2 state-changes all backward-trans limited updown-limited
snmp-server enable traps bgp cbgp2 threshold prefix
snmp-server enable traps pim neighbor-change rp-mapping-change invalid-pim-message
snmp-server enable traps ipmulticast
snmp-server enable traps msdp
snmp-server enable traps mvpn
snmp-server enable traps rsvp
snmp-server enable traps isis
snmp-server enable traps dhcp
snmp-server enable traps nhrp nhs
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snmp-server enable traps nhrp nhc
snmp-server enable traps nhrp nhp
snmp-server enable traps nhrp quota-exceeded
snmp-server enable traps ipsla
snmp-server enable traps bfd
snmp-server enable traps cnpd
snmp-server enable traps event-manager
snmp-server enable traps dlsw
snmp-server enable traps ospfv3 state-change
snmp-server enable traps ospfv3 errors
snmp-server enable traps pppoe
snmp-server enable traps l2tun session
snmp-server enable traps l2tun pseudowire status
snmp-server enable traps l2tun tunnel
snmp-server enable traps pki
snmp-server enable traps pimstdmib neighbor-loss invalid-register invalid-join-prune rp-mapping-change
interface-election
snmp-server enable traps adslline
snmp-server enable traps entity-diag boot-up-fail hm-test-recover hm-thresh-reached scheduled-test-fail
snmp-server enable traps vdsl2line
snmp-server enable traps vtp
snmp-server enable traps vlancreate
snmp-server enable traps vlandelete
snmp-server enable traps port-security
snmp-server enable traps isdn call-information
snmp-server enable traps isdn layer2
snmp-server enable traps isdn chan-not-avail
snmp-server enable traps isdn ietf
snmp-server enable traps c3g
snmp-server enable traps LTE
snmp-server enable traps lisp
snmp-server enable traps firewall serverstatus
snmp-server enable traps ike policy add
snmp-server enable traps ike policy delete
snmp-server enable traps ike tunnel start
snmp-server enable traps ike tunnel stop
snmp-server enable traps ipsec cryptomap add
snmp-server enable traps ipsec cryptomap delete
snmp-server enable traps ipsec cryptomap attach
snmp-server enable traps ipsec cryptomap detach
snmp-server enable traps ipsec tunnel start
snmp-server enable traps ipsec tunnel stop
snmp-server enable traps ipsec too-many-sas
snmp-server enable traps gdoi gm-start-registration
snmp-server enable traps gdoi gm-registration-complete
snmp-server enable traps gdoi gm-re-register
snmp-server enable traps gdoi gm-rekey-rcvd
snmp-server enable traps gdoi gm-rekey-fail
snmp-server enable traps gdoi ks-rekey-pushed
snmp-server enable traps gdoi gm-incomplete-cfg
snmp-server enable traps gdoi ks-no-rsa-keys
snmp-server enable traps gdoi ks-new-registration
snmp-server enable traps gdoi ks-reg-complete
snmp-server enable traps gdoi ks-role-change
snmp-server enable traps gdoi ks-gm-deleted
snmp-server enable traps gdoi ks-peer-reachable
snmp-server enable traps gdoi ks-peer-unreachable
snmp-server enable traps mpls rfc ldp
snmp-server enable traps mpls ldp
snmp-server enable traps mpls rfc traffic-eng
snmp-server enable traps mpls traffic-eng
snmp-server enable traps mpls fast-reroute protected
snmp-server enable traps otn
snmp-server enable traps pw vc
snmp-server enable traps frame-relay multilink bundle-mismatch
snmp-server enable traps dial
snmp-server enable traps dsp card-status
snmp-server enable traps dsp oper-state
snmp-server enable traps dsp video-usage
snmp-server enable traps dsp video-out-of-resource
snmp-server enable traps syslog
snmp-server enable traps sbc adj-status
snmp-server enable traps sbc blacklist
snmp-server enable traps sbc congestion-alarm
snmp-server enable traps sbc h248-ctrlr-status
snmp-server enable traps sbc media-source
snmp-server enable traps sbc radius-conn-status
snmp-server enable traps sbc sla-violation
snmp-server enable traps sbc sla-violation-rev1
snmp-server enable traps sbc svc-state
snmp-server enable traps sbc qos-statistics
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snmp-server enable traps bulkstat collection transfer
snmp-server enable traps ethernet cfm alarm
snmp-server enable traps alarms informational
snmp-server enable traps transceiver all
snmp-server enable traps rf
snmp-server enable traps vrfmib vrf-up vrf-down vnet-trunk-up vnet-trunk-down
snmp-server enable traps ccme
snmp-server enable traps srst
snmp-server enable traps mpls vpn
snmp-server enable traps mpls rfc vpn
snmp-server enable traps voice
snmp-server host 192.168.99.10 vrf MGMT version 3 priv labmon udp-port 1162
snmp-server host 192.168.99.10 vrf MGMT version 3 priv labmon
tacacs server LAB-TAC
 address ipv4 192.168.99.10
 key LabTacacsKey123
!
!
!
!
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
!
!
banner login ^C
******************************************************************************
                           AUTHORISED ACCESS ONLY

  Access to this device is restricted to authorised personnel. If you are not
  an authorised user, disconnect now.

  All activity is monitored, logged and audited. Continued use of this system
  constitutes consent to that monitoring.

  Unauthorised access or use may result in disciplinary action and civil or
  criminal penalties.
******************************************************************************
^C
!
line con 0
 exec-timeout 0 0
 activation-character 13
 logging synchronous
 stopbits 1
line aux 0
 activation-character 13
line vty 0 4
 access-class VTY-MGMT in vrf-also
 exec-timeout 0 0
 activation-character 13
 transport input ssh
line vty 5 15
 access-class VTY-MGMT in vrf-also
 exec-timeout 0 0
 activation-character 13
 transport input ssh
!
ntp source GigabitEthernet4
ntp server vrf MGMT 192.168.99.10
!
!
!
!
!
!
netconf-yang
restconf
end
```