Chapter 24: Network Assurance

Instructor Materials

CCNP Enterprise: Core Networking

Chapter 24 Content

This chapter covers the following content:

- **Network Diagnostic Tools -** This section covers the common use cases and operations of ping, traceroute, SNMP, and syslog.
- **Debugging -** This section describes the value of using debugging as a troubleshooting tool and provides basic configuration examples.
- **NetFlow and Flexible NetFlow -** This section examines the benefits and operations of NetFlow and Flexible NetFlow.
- **Switched Port Analyzer (SPAN Technologies) -** This section examines the benefits and operations of SPAN, RSPAN, and ERSPAN.
- **IP SLA -** This section covers IP SLA and the value of automated network probes and monitoring.
- **Cisco DNA Center Assurance -** This section provides a high-level overview of Cisco DNA Center Assurance and associated workflows for troubleshooting and diagnostics.

Network Diagnostic Tools

Many network diagnostic tools are readily available. This section covers some of the most common tools available and provides use cases and examples of when to use them.

Network Diagnostic Tools

Ping

Ping is one of the most useful troubleshooting.

The following troubleshooting flow is a quick way to check reachability and try to determine what the issue may be:

Step 1. Gather the facts.

Step 2. Test reachability by using the **ping** command.

Step 3. Record the outcome of the **ping** command and move to the next troubleshooting step. If **ping** is successful, then the issue isn't likely related to basic reachability. If **ping** is unsuccessful, the next step could be checking something more advanced, such as interface issues, routing issues, access lists, or intermediate firewalls.

Network Diagnostic Tools

Successful and Unsuccessful Pings

Example 24-1 illustrates a successful ping between R1 and R2. This example shows five 100-byte ICMP echo request packets sent to 10.1.12.2 with a 2-second timeout. The result is five exclamation points (!!!!!).

Example 24-1 *Successful ping Between R1 and R2*

```
R1# ping 10.1.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

It is important to illustrate what an unsuccessful ping looks like as well. Example 24-2 shows an unsuccessful ping to R2’s Ethernet0/0 interface with an IP address of 10.1.12.2.

Example 24-2 *Unsuccessful ping Between R1 and R2*

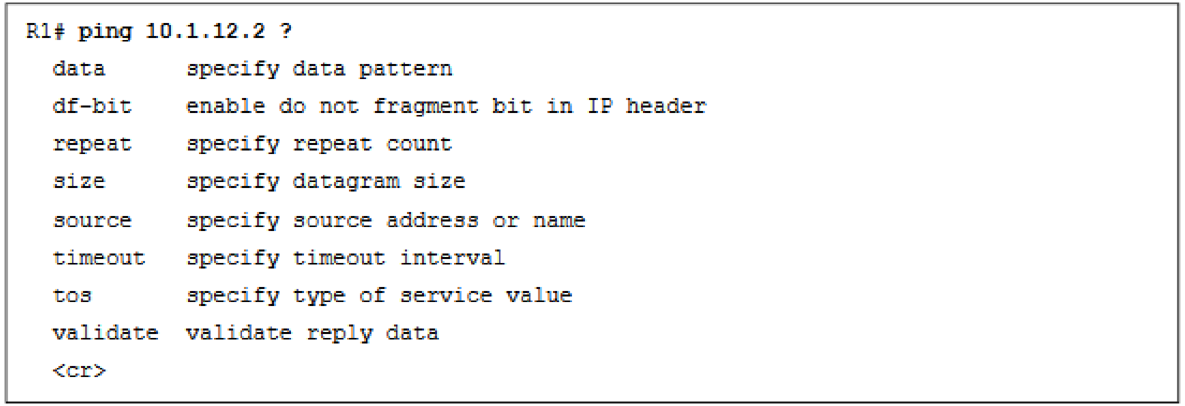
```
R1# ping 10.1.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.12.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

Network Diagnostic Tools

Ping Options

The ping command can be changed and manipulated to aid in troubleshooting. Example 24-3 shows some of the available options for the **ping** command on a Cisco device. These options can be seen by using the context sensitive help (?) after the IP address that follows the ping command. This section specifically focuses on the **repeat**, **size**, and **source** options.

Example 24-3 ping 10.1.12.2 *Options*



```
R1# ping 10.1.12.2 ?
  data      specify data pattern
  df-bit    enable do not fragment bit in IP header
  repeat    specify repeat count
  size      specify datagram size
  source    specify source address or name
  timeout   specify timeout interval
  tos       specify type of service value
  validate  validate reply data
  <cr>
```

Network Diagnostic Tools
Ping Size

Another very common use case for the **ping** command is to send different sizes of packets to a destination. An example might be to send 1500-byte packets with the DF bit set to make sure there are no MTU issues on the interfaces or to test different quality of service policies that restrict certain packet sizes. Example 24-5 shows a ping destined to R2’s Ethernet0/0 interface with an IP address 10.1.12.2 and a packet size of 1500 bytes.

Example 24-5 **ping 10.1.12.2 size 1500** *Command*

```
R1# ping 10.1.12.2 size 1500
Type escape sequence to abort.
Sending 5, 1500-byte ICMP Echos to 10.1.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Network Diagnostic Tools

Extended Ping Options

An extended ping can take advantage of the same options already discussed, as well as some more detailed options for troubleshooting. These options are listed in Table 24-2.

Option	Description
Protocol	IP, Novell, AppleTalk, CLNS, and so on; the default is IP
Target IP address	Destination IP address of ping packets
Repeat Count	Number of ping packets sent; the default is 5 packets
Datagram Size	Size of the ping packet; the default is 100 bytes
Timeout in seconds	How long a echo reply response is waited for
Extended Commands	Yes or No to use extended commands; the default is No, but if Yes is used, more options become available
Source Address or Interface	IP address of the source interface or the interface name

Network Diagnostic Tools

Extended Ping Options (Cont.)

Option	Description
Type of Service (ToS)	The Type of Service to be used for each probe; 0 is the default
Set DF bit in IP header	Sets the Do Not Fragment bit in the IP header; the default is No
Data Pattern	The data pattern used in the ping packets; the default is 0xABCD
Loose, Strict, Record, Timestamp, Verbose	The options set for the ping packets: **Loose -** Specifies hops that ping packets should traverse **Strict -** Same as Loose with the exception that packets can only traverse specified hops **Record -** Displays IP addresses of first nine hops that the ping packets traverse **Timestamp -** Displays the round-trip time to the destination for each ping **Verbose -** Default option that is automatically selected with any and all other options

Network Diagnostic Tools

Extended Ping with Multiple Options

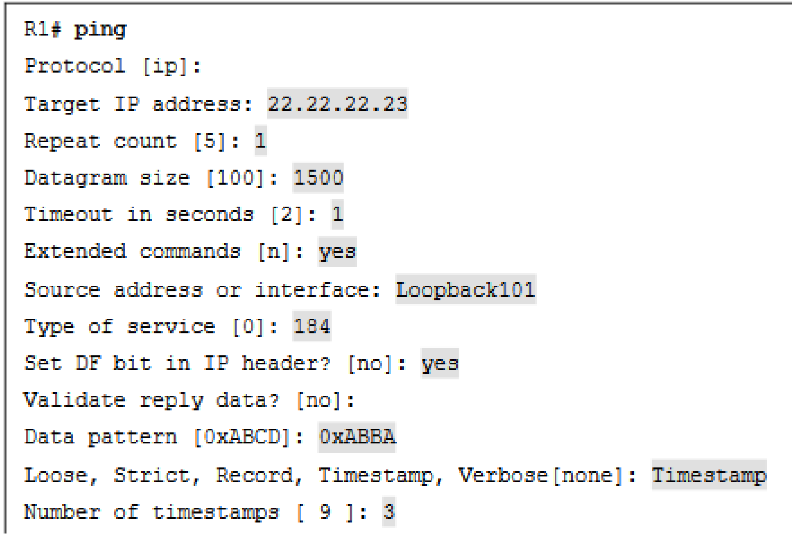
Setting the MTU in an extended ping and setting the DF bit in the IP header can help determine whether there are MTU settings in the path that are not set appropriately.

With tunneling it is important to account for the overhead of the tunnel technology, which can vary. Specifying a Type of Service of 184 in decimal translates to Expedited Forwarding or (EF) per-hop behavior (PHB). This can be useful when testing real-time quality of service (QoS) policies.

Setting Data Patterns can help when troubleshooting framing errors, line coding, or clock signaling issues on serial interfaces.

Finally, a timestamp is set in this example, in addition to the default Verbose output. This gives a clock timestamp of when the destination sent an echo reply message back to the source.

Example 24-7 *Extended* **ping** *with Multiple Options*



```
R1# ping
Protocol [ip]:
Target IP address: 22.22.22.23
Repeat count [5]: 1
Datagram size [100]: 1500
Timeout in seconds [2]: 1
Extended commands [n]: yes
Source address or interface: Loopback101
Type of service [0]: 184
Set DF bit in IP header? [no]: yes
Validate reply data? [no]:
Data pattern [0xABCD]: 0xABBA
Loose, Strict, Record, Timestamp, Verbose[none]: Timestamp
Number of timestamps [ 9 ]: 3
```

Network Diagnostic Tools

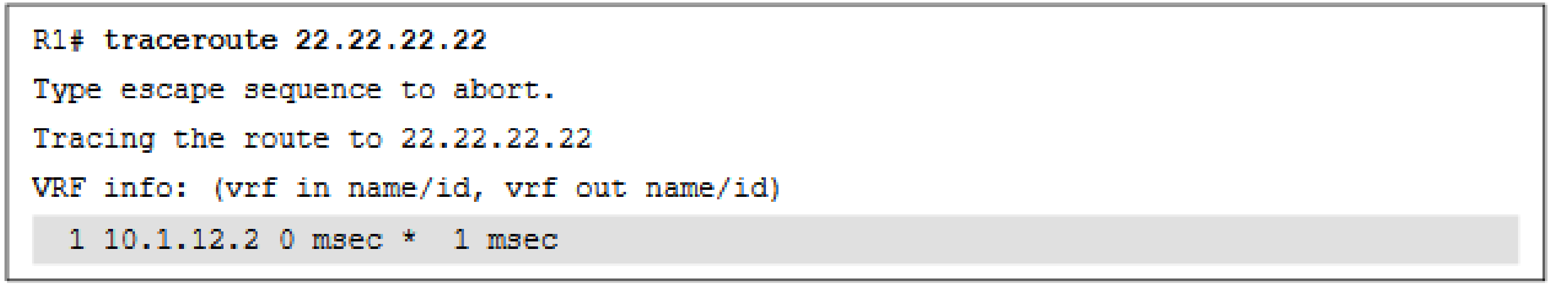
Traceroute

Traceroute is often used to troubleshoot when trying to determine where traffic is failing as well as what path traffic takes through-out the network.

Traceroute shows the IP addresses or DNS names of the hops between the source and destination.

It also shows how long it takes to reach the destination at each hop, measured in milliseconds. This tool is frequently used when more than one path is available to the destination or when there is more than one hop to the destination.

Example 24-8 *Basic* **traceroute** *to R2 Loopback102*

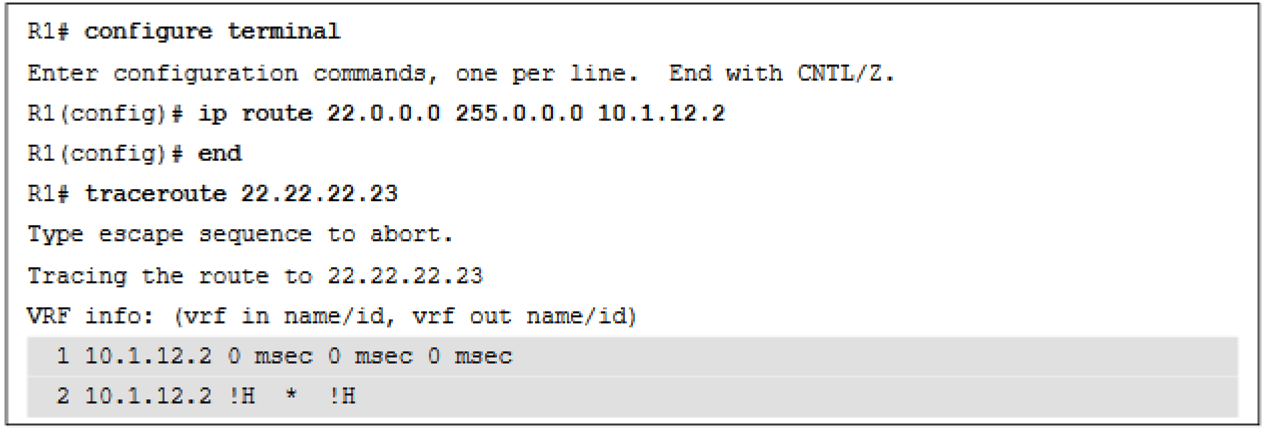


```
R1# traceroute 22.22.22.22
Type escape sequence to abort.
Tracing the route to 22.22.22.22
VRF info: (vrf in name/id, vrf out name/id)
  1 10.1.12.2 0 msec *  1 msec
```

Adding a Less Specific Route

A less specific route is added to R1 that points to 22.0.0.0/8 or 22.0.0.0 255.0.0.0, the traceroute returns a “host unreachable” message. This is because there is a route to the next hop, R2 (10.1.12.2), but once the traceroute gets to R2, there is no interface or route to 22.22.22.23/32, and the traceroute fails. Example 24-11 shows this scenario.

Example 24-11 *Adding a Less Specific Route on R1*



```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# ip route 22.0.0.0 255.0.0.0 10.1.12.2
R1(config)# end
R1# traceroute 22.22.22.23
Type escape sequence to abort.
Tracing the route to 22.22.22.23
VRF info: (vrf in name/id, vrf out name/id)
  1 10.1.12.2 0 msec 0 msec 0 msec
  2 10.1.12.2 !H  *  !H
```

Network Diagnostic Tools

Traceroute Options

Another benefit of **traceroute** is that it has options available. These options can also be discovered by leveraging the context-sensitive help (?) from the command-line interface. Example 24-14 shows the list of available options to the traceroute command.

Example 24-14 *Available* traceroute *Options*

```
R1# traceroute 22.22.22.23 ?
  numeric  display numeric address
  port     specify port number
  probe    specify number of probes per hop
  source   specify source address or name
  timeout  specify time out
  ttl      specify minimum and maximum ttl
  <cr>
```

There are times when using some of the options available with **traceroute** may be . There are also times when there might be a reason to send a different number of probes per hop with different timeout timers rather than the default of three probes.

Network Diagnostic Tools

Extended Traceroute Options

Much like the extended **ping** command covered earlier in this chapter, there is an extended **traceroute** command, and it has a number of detailed options available. Those options are listed in Table 24-3.

Option	Description
Protocol	IP, Novell, AppleTalk, CLNS, and so on; the default is IP
Target IP address	Destination IP address of ping packets
Numeric display	Shows only the numeric display rather than numeric and symbolic display
Timeout in Seconds	Time that is waited for a reply to a probe; the default is 3 seconds
Probe count	Number of probes sent at each hop; the default is 3
Source Address	IP address of the source interface

Network Diagnostic Tools

Extended Traceroute Options (Cont.)

Option	Description
Minimum Time-to-live	TTL value of the first set of probes; can be used to hide topology information or known hops
Maximum Time-to-live	Maximum number of hops; the default is 30
Port number	Destination port number of probes; the default is 33434
Loose, Strict, Record, Timestamp, Verbose	The options set for the traceroute probes: **Loose -** Specifies the hops that ping packets should traverse **Strict -** Same as Loose with the exception that packets can traverse only specified hops **Record -** Displays IP addresses of the first nine hops that the traceroute packets traverse **Timestamp -** Displays the round-trip time to the destination for each ping **Verbose -** Default option that is automatically selected with any and all other options

Debugging

- Debugging can be a very powerful part of troubleshooting complex issues in a network.
- One of the most common use cases for debugging is when there is a need to see things at a deeper level (such as when routing protocols are having adjacency issues).
- There is a normal flow that is taken from a troubleshooting perspective, depending on the routing protocol.

Debugging

Debugging Topology

Using the simple topology shown in Figure 24-2, in this section, debugging is used to fix a couple issues in the OSPF area 0.

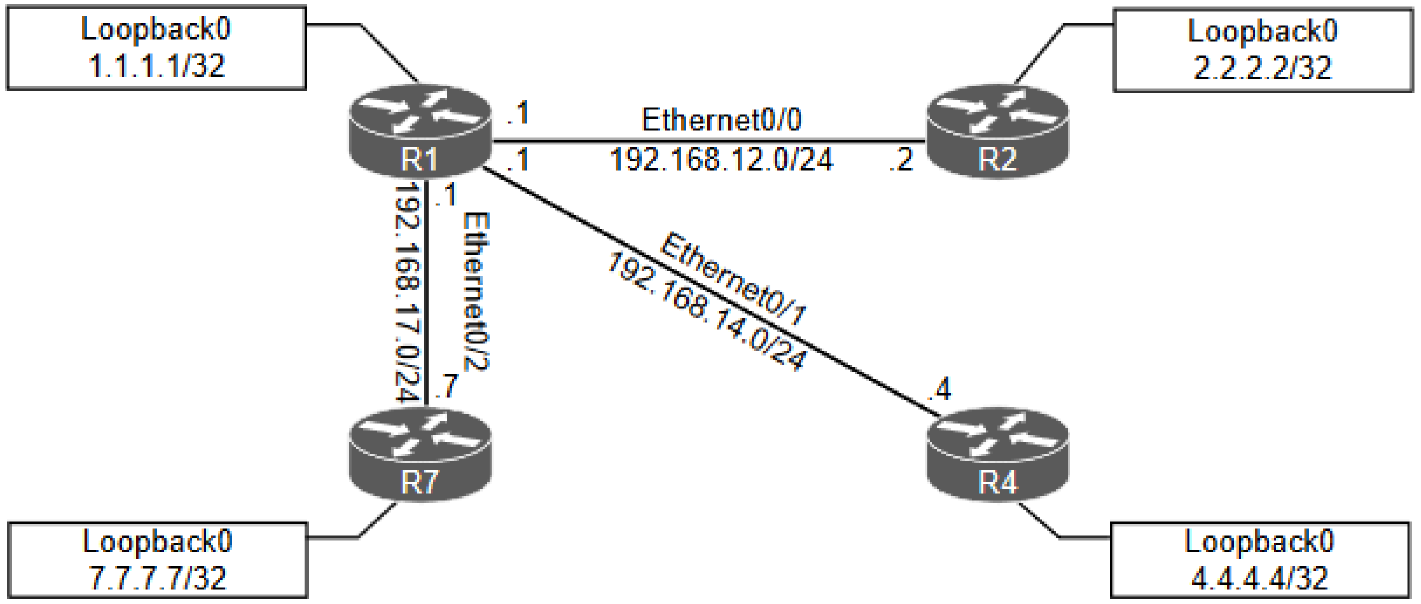


Figure 24-2 *Debugging Topology*

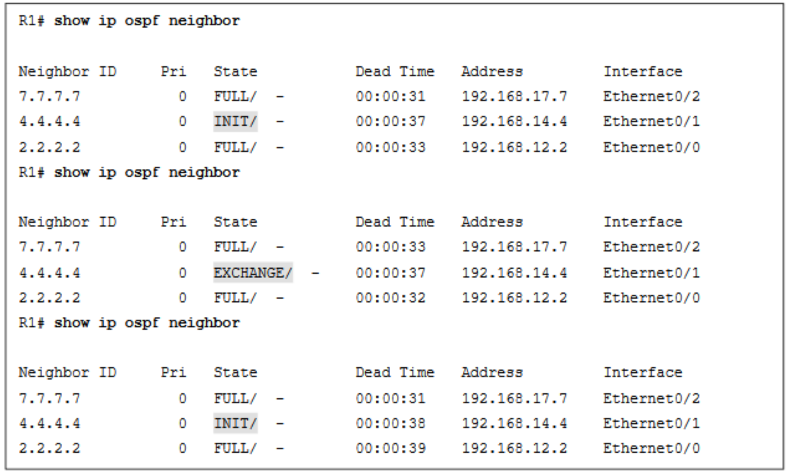
Debugging

OSPF Adjacency Issues

Some of the common OSPF adjacency issues such as MTU issues, incorrect interface types, and improperly configured network mask can be resolved by using debugging.

From the output of the **show ip ospf neighbor** command on R1 in Example 24-17, it can be seen that the neighbor adjacency to R4 is in the INIT state. If the command is run after a few seconds, the state changes to EXCHANGE but quickly cycles back to the INIT state when the command is run again.

Example 24-17 *Output of the* **show ip ospf neighbor** *Command*



```
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
7.7.7.7           0   FULL/  -        00:00:31    192.168.17.7    Ethernet0/2
4.4.4.4           0   INIT/  -        00:00:37    192.168.14.4    Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:33    192.168.12.2    Ethernet0/0
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
7.7.7.7           0   FULL/  -        00:00:33    192.168.17.7    Ethernet0/2
4.4.4.4           0   EXCHANGE/  -    00:00:37    192.168.14.4    Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:32    192.168.12.2    Ethernet0/0
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
7.7.7.7           0   FULL/  -        00:00:31    192.168.17.7    Ethernet0/2
4.4.4.4           0   INIT/  -        00:00:38    192.168.14.4    Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:39    192.168.12.2    Ethernet0/0
```

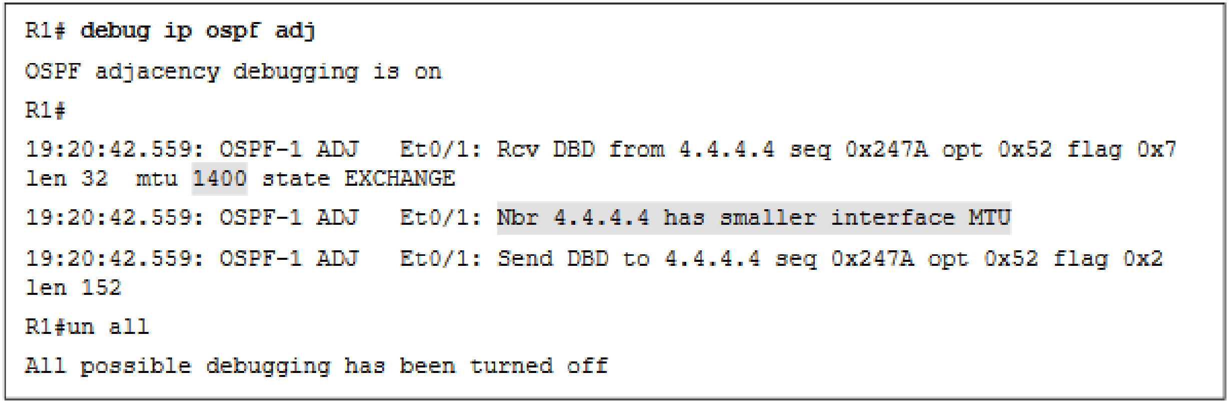
Debugging

Output of Debug IP OSPF ADJ Command

Debugging is used on R1 to try to determine what the issue is. Example 24-18 shows the output of the **debug ip ospf adj** command. This command is used to reveal messages that are exchanged during the OSPF adjacency process.

The output of the debug ip ospf adj command in Example 24-18 clearly states that it received a Database Descriptor packet from the neighbor 4.4.4.4, and that the neighbor 4.4.4.4 has a smaller interface MTU of 1400.

Example 24-18 *Output of the* **debug ip ospf adj** *Command on R1*

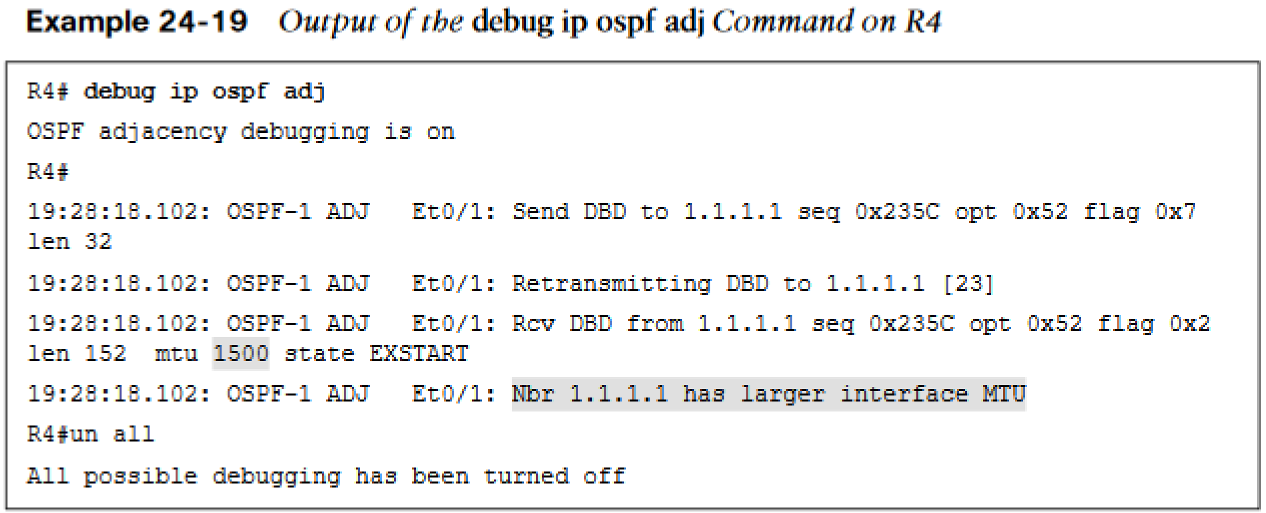


```
R1# debug ip ospf adj
OSPF adjacency debugging is on
R1#
19:20:42.559: OSPF-1 ADJ   Et0/1: Rcv DBD from 4.4.4.4 seq 0x247A opt 0x52 flag 0x7
len 32  mtu 1400 state EXCHANGE
19:20:42.559: OSPF-1 ADJ   Et0/1: Nbr 4.4.4.4 has smaller interface MTU
19:20:42.559: OSPF-1 ADJ   Et0/1: Send DBD to 4.4.4.4 seq 0x247A opt 0x52 flag 0x2
len 152
R1#un all
All possible debugging has been turned off
```

Debugging

Output of Debug IP OSPF ADJ Command (Cont.)

Example 24-19 shows the output of the **debug ip ospf adj** command on R4 with the relevant fields highlighted. The output shows that R1 has an MTU size of 1500, which is larger than the locally configured MTU of 1400 on R4. This is a really quick way of troubleshooting this type of issue with adjacency formation



Example 24-19 *Output of the* **debug ip ospf adj** *Command on R4*

```
R4# debug ip ospf adj
OSPF adjacency debugging is on
R4#
19:28:18.102: OSPF-1 ADJ   Et0/1: Send DBD to 1.1.1.1 seq 0x235C opt 0x52 flag 0x7
len 32
19:28:18.102: OSPF-1 ADJ   Et0/1: Retransmitting DBD to 1.1.1.1 [23]
19:28:18.102: OSPF-1 ADJ   Et0/1: Rcv DBD from 1.1.1.1 seq 0x235C opt 0x52 flag 0x2
len 152  mtu 1500 state EXSTART
19:28:18.102: OSPF-1 ADJ   Et0/1: Nbr 1.1.1.1 has larger interface MTU
R4#un all
All possible debugging has been turned off
```

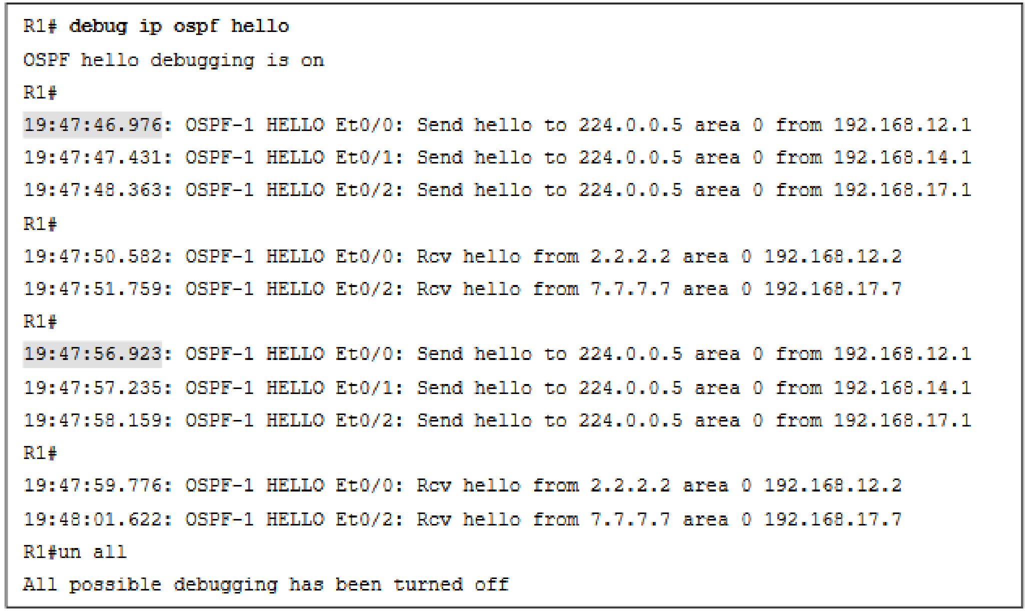
Debugging
Output of the Debug IP OSPF Hello Command

The issue with OSPF network type mismatch, which is a very common reason for neighbor adjacency issues. Often this is simply a misconfiguration issue when setting up the network.

When the **debug ip ospf hello** command is used on R1, everything appears to be normal: Hellos are sent to the multicast group 224.0.0.5 every 10 seconds.

Example 24-20 shows the output of the **debug** command on R1.

Example 24-20 *Output of the* **debug ip ospf hello** *Command on R1*



```
R1# debug ip ospf hello
OSPF hello debugging is on
R1#
19:47:46.976: OSPF-1 HELLO Et0/0: Send hello to 224.0.0.5 area 0 from 192.168.12.1
19:47:47.431: OSPF-1 HELLO Et0/1: Send hello to 224.0.0.5 area 0 from 192.168.14.1
19:47:48.363: OSPF-1 HELLO Et0/2: Send hello to 224.0.0.5 area 0 from 192.168.17.1
R1#
19:47:50.582: OSPF-1 HELLO Et0/0: Rcv hello from 2.2.2.2 area 0 192.168.12.2
19:47:51.759: OSPF-1 HELLO Et0/2: Rcv hello from 7.7.7.7 area 0 192.168.17.7
R1#
19:47:56.923: OSPF-1 HELLO Et0/0: Send hello to 224.0.0.5 area 0 from 192.168.12.1
19:47:57.235: OSPF-1 HELLO Et0/1: Send hello to 224.0.0.5 area 0 from 192.168.14.1
19:47:58.159: OSPF-1 HELLO Et0/2: Send hello to 224.0.0.5 area 0 from 192.168.17.1
R1#
19:47:59.776: OSPF-1 HELLO Et0/0: Rcv hello from 2.2.2.2 area 0 192.168.12.2
19:48:01.622: OSPF-1 HELLO Et0/2: Rcv hello from 7.7.7.7 area 0 192.168.17.7
R1#un all
All possible debugging has been turned off
```

Debugging
Output of the Debug IP OSPF Hello Command (Cont.)

Example 24-21 shows the issue output on R4.

Based on the output, we can see that the hello parameters are mismatched. The output shows that R4 is receiving a dead interval of 40, while it has a configured dead interval of 120. We can also see that the hello interval R4 is receiving is 10, and the configured hello interval is 30. By default, the dead interval is 4 times the hello interval.

Example 24-21 *Output of the* **debug ip ospf hello** *Command on R4*

```
R4# debug ip ospf hello
OSPF hello debugging is on
R4#
19:45:45.127: OSPF-1 HELLO Et0/1: Rcv hello from 1.1.1.1 area 0 192.168.14.1
19:45:45.127: OSPF-1 HELLO Et0/1: Mismatched hello parameters from 192.168.14.1
19:45:45.127: OSPF-1 HELLO Et0/1: Dead R 40 C 120, Hello R 10 C 30
19:45:45.259: OSPF-1 HELLO Et0/3: Rcv hello from 7.7.7.7 area 0 192.168.47.7
R4#
19:45:48.298: OSPF-1 HELLO Et0/0: Send hello to 224.0.0.5 area 0 from 192.168.34.4
19:45:48.602: OSPF-1 HELLO Et0/0: Rcv hello from 3.3.3.3 area 0 192.168.34.3
R4#un all
All possible debugging has been turned off
```

Debugging
Hello and Dead Intervals

Different network types have different hello intervals and dead intervals. Table 24-4 high-lights the different hello and dead interval times based on the different OSPF network types.

Table 24-4 OSPF Network Types and Hello/Dead Intervals

Network Type	Hello Interval (in seconds)	Dead Interval (in seconds)
Broadcast	10	40
Non-broadcast	30	120
Point-to-point	10	40
Point-to-Multipoint	30	120

Debugging

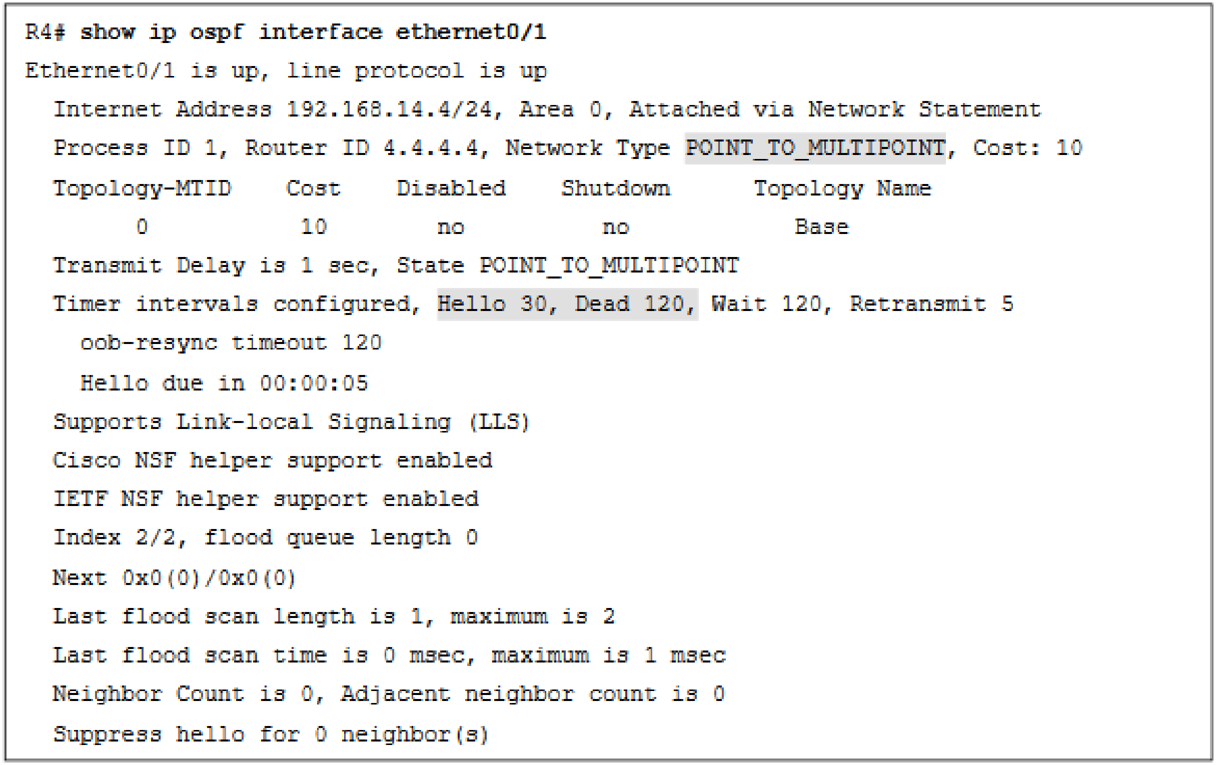
Output of the Show IP OSPF Interface

The issue could be simply mismatched network types or mismatched hello or dead intervals.

The **show ip ospf interface** command shows what the configured network types and hello and dead intervals are.

Example 24-22 shows the output of this command on R4.

Example 24-22 *Output of the* **show ip ospf interface** *Command on R4*



```
R4# show ip ospf interface ethernet0/1
Ethernet0/1 is up, line protocol is up
  Internet Address 192.168.14.4/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 4.4.4.4, Network Type POINT_TO_MULTIPOINT, Cost: 10
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           10        no          no            Base
  Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT
  Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
    oob-resync timeout 120
    Hello due in 00:00:05
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 1 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

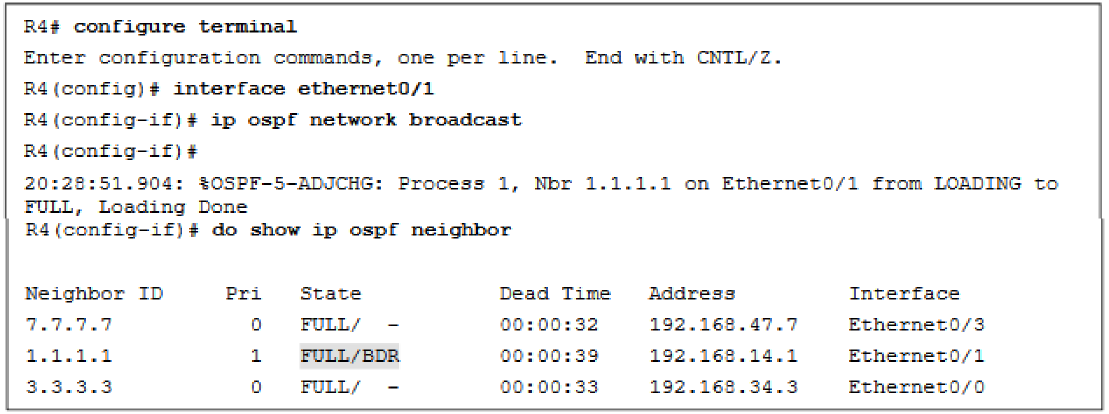
Debugging

Changing the Network Type

Simply changing the network type on R4 interface Ethernet0/1 back to the default of Broadcast fixes the adjacency issue in this case. This is because R1 is configured as Broadcast, and now the hello and dead intervals will match.

Example 24-23 shows the **ip ospf network-type broadcast** command issued to change the network type to Broadcast on the Ethernet0/1 interface and the neighbor adjacency coming up. It is also verified with the do **show ip ospf neighbor** command.

Example 24-23 *Changing the Network Type on R4*



```
R4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)# interface ethernet0/1
R4(config-if)# ip ospf network broadcast
R4(config-if)#
20:28:51.904: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on Ethernet0/1 from LOADING to
FULL, Loading Done
R4(config-if)# do show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
7.7.7.7           0   FULL/  -        00:00:32    192.168.47.7    Ethernet0/3
1.1.1.1           1   FULL/BDR        00:00:39    192.168.14.1    Ethernet0/1
3.3.3.3           0   FULL/  -        00:00:33    192.168.34.3    Ethernet0/0
```

Debugging

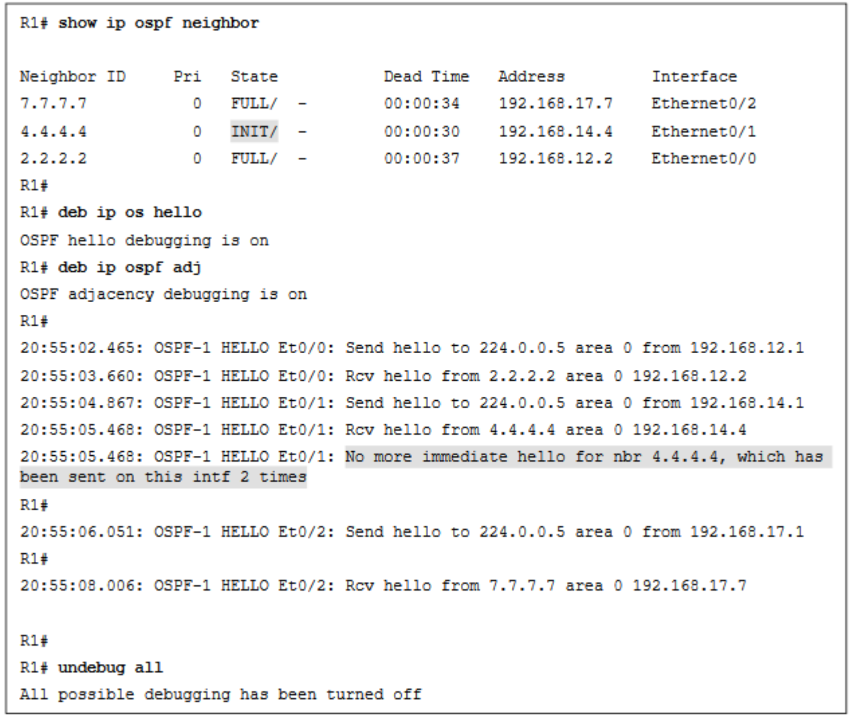
Show and Debug Commands on R1

The final use case for using debugging to solve OSPF adjacency issues involves improper configuration of IP addresses and subnet masks on an OSPF interface.

To troubleshoot this without having to look through running configurations or at a specific interface, use the **debug ip ospf hello** command covered earlier in this section.

Example 24-24 shows the output of running the **show ip ospf neighbor** command on R1. It indicates that there is no OSPF adjacency to R4 when there certainly should be one.

Example 24-24 show ip ospf neighbor, debug ip ospf hello, *and* debug ip ospf adj *Commands on R1*



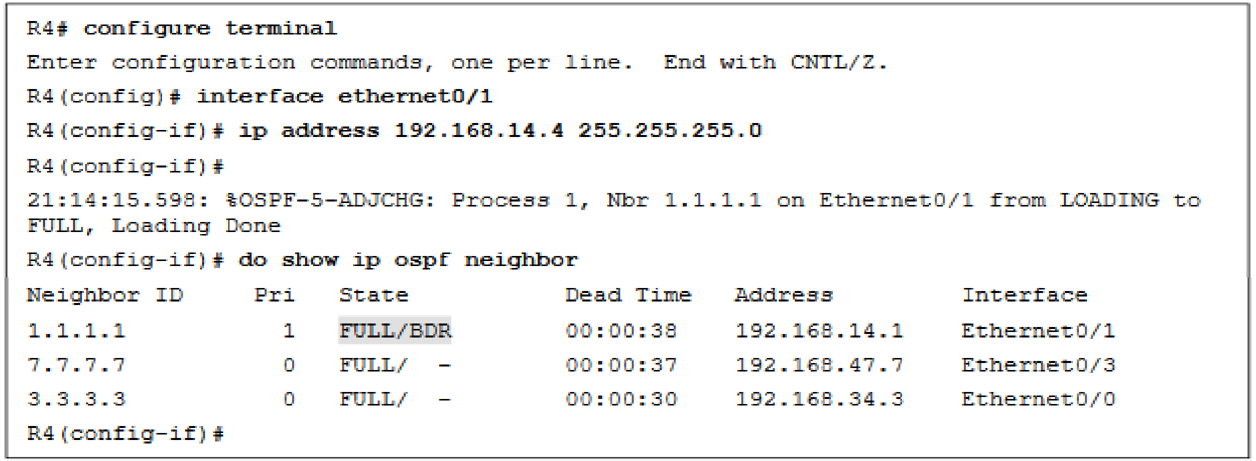
```
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
7.7.7.7           0   FULL/  -        00:00:34    192.168.17.7    Ethernet0/2
4.4.4.4           0   INIT/  -        00:00:30    192.168.14.4    Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:37    192.168.12.2    Ethernet0/0
R1#
R1# deb ip os hello
OSPF hello debugging is on
R1# deb ip ospf adj
OSPF adjacency debugging is on
R1#
20:55:02.465: OSPF-1 HELLO Et0/0: Send hello to 224.0.0.5 area 0 from 192.168.12.1
20:55:03.660: OSPF-1 HELLO Et0/0: Rcv hello from 2.2.2.2 area 0 192.168.12.2
20:55:04.867: OSPF-1 HELLO Et0/1: Send hello to 224.0.0.5 area 0 from 192.168.14.1
20:55:05.468: OSPF-1 HELLO Et0/1: Rcv hello from 4.4.4.4 area 0 192.168.14.4
20:55:05.468: OSPF-1 HELLO Et0/1: No more immediate hello for nbr 4.4.4.4, which has
been sent on this intf 2 times
R1#
20:55:06.051: OSPF-1 HELLO Et0/2: Send hello to 224.0.0.5 area 0 from 192.168.17.1
R1#
20:55:08.006: OSPF-1 HELLO Et0/2: Rcv hello from 7.7.7.7 area 0 192.168.17.7


R1#
R1# undebug all
All possible debugging has been turned off
```

Debugging
Ping

The network mask on the Ethernet0/1 interface of R4 needs to be changed to match the one that R1 has configured and is sending to R4 through OSPF hellos.

Example 24-26 shows the network mask being changed on the R4 Ethernet0/1 interface and the OSPF adjacency coming up. This is then verified with the **do show ip ospf neighbor** command.

Example 24-26 *Network Mask Change and* **show ip ospf neighbor** *on R4*



```
R4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)# interface ethernet0/1
R4(config-if)# ip address 192.168.14.4 255.255.255.0
R4(config-if)#
21:14:15.598: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on Ethernet0/1 from LOADING to
FULL, Loading Done
R4(config-if)# do show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           1   FULL/BDR        00:00:38    192.168.14.1    Ethernet0/1
7.7.7.7           0   FULL/  -        00:00:37    192.168.47.7    Ethernet0/3
3.3.3.3           0   FULL/  -        00:00:30    192.168.34.3    Ethernet0/0
R4(config-if)#
```

Conditional Debugging

Conditional debugging can be used to limit the scope of the messages that are being returned to the console or syslog server. A great example of this is the **debug ip packet** command. Issuing this command on a router that is in production could send back a tremendous number of messages.

One way to alleviate this issue is to attach an access list to the **debug** command to limit the scope of messages to the source or destination specified within the access list. This can be done using standard or extended access lists.

The options for the **debug ip packet** command are as follows:

- **<1-199>**: Standard access list
- **<1300-2699>**: Access list with expanded range
- **detail**: More debugging detail

Debugging on a Specific Interface

Another common method of conditional debugging is to debug on a specific interface. This is extremely useful when trying to narrow down a packet flow between two hosts.

Imagine that a network engineer is trying to debug a traffic flow between R1’s Ethernet0/1 interface with source IP address 192.168.14.1/24 that is destined to R4’s Loopback0 interface with IP address 4.4.4.4/32.

One way to do this would certainly be to change the access list 100 to reflect these source and destination IP addresses. However, because the access list is looking for any traffic sourced or destined to the 192.168.14.0/24 network, this traffic flow would fall into matching that access list. Using conditional debugging on the Loopback0 interface of R4 would be a simple way of meeting these requirements.

Even if all debugging has been turned off using the undebug all command, the interface conditions set for Loopback0 on R4 remain. The way to remove this condition is to use the undebug interface loopback0 command on R4.

Debugging

Simple Network Management Protocol (SNMP)

The typical tool for reactive alerting from network devices is Simple Network Management Protocol (SNMP).

SNMP sends unsolicited traps to an SNMP collector or network management system (NMS). These traps are in response to something that happened in the network.

For example, traps may be generated for link status events, improper user authentication, and power supply failures. These events are defined in the SNMP Management Information Base (MIB).

The MIB can be thought of as a repository of device parameters that can be used to trigger alerts.

Debugging

SNMP Versions

There are currently three versions of SNMP. Table 24-5 lists the versions and their differences.

Table 24-5 SNMP Version Comparison

Version	Level	Authentication	Encryption	Result
SNMPv1	noAuthNoPriv	Community string	No	Uses a community string match for authentication.
SNMPv2c	noAuthNoPriv	Community string	No	Uses a community string match for authentication.
SNMPv3	noAuthNoPriv	Username	No	Uses a username match for authentication.
SNMPv3	authNoPriv	Message Digest 5 (MD5) or Secure Hash Algorithm (SHA)	No	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms.

Debugging

SNMP Versions (Cont.)

Version	Level	Authentication	Encryption	Result
SNMPv3	authPriv (requires the cryptographic software image)	MD5 or SHA	No	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Allows specifying the User-based Security Model (USM) with these encryption algorithms:DES 56-bit encryption in addition to authentication based on the CBC-DES (DES-56) standard.3DES 168-bit encryptionAES 128-bit, 192-bit, or 256-bit encryption

SNMP Operations

Using SNMP is considered best practice in production. SNMPv1 and SNMPv2c use access lists and a community password or string.

These community strings can be read-only (RO) or read/write (RW). It is critical to limit SNMP access to these devices by using access lists.

By default, if no version is specified in configuration, SNMPv1 is used. However, to better show how SNMP works, this chapter focuses on SNMPv2c.

Operation	Description
get-request	Retrieves a value from a specific variable
get-next-request	Retrieves a value from a variable within a table
get-bulk-request	Retrieves large blocks of data, such as multiple rows in a table
get-response	Replies to a get request, get next request, and set request sent by an NMS
set-request	Stores a value in a specific variable
trap	Sends an unsolicited message from an SNMP agent to an SNMP manager when some event has occurred

Debugging
MIBs

It is important to look at a MIB to understand some of the information or values that can be polled or send traps from SNMP.

The SNMPv2-MIB.my file shows what values can be polled in the MIB and to illustrate sending traps from SNMP. To see a list of available Cisco MIBs, visit https://mibs.cloudapps.cisco.com/ITDIT/MIBS/servlet/index.

Although configuring an NMS is not covered in this chapter, the device side that points to an NMS is covered in this section.

The following list shows a handful of measures involved in setting up SNMP on a device to allow the device to be polled and send traps to an NMS:

- Define the SNMP host or the NMS to send traps to
- Create an access list to restrict access via SNMP
- Define the read-only community string
- Define the read/write community string
- Define the SNMP location
- Define the SNMP contact

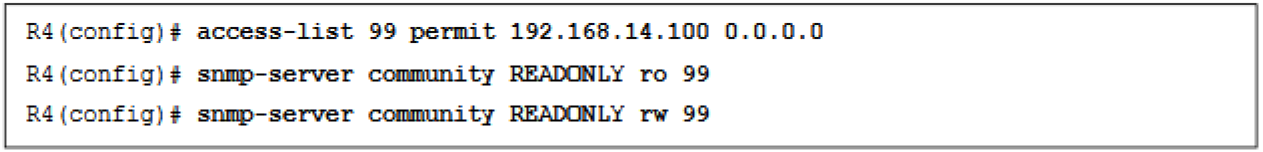
Debugging
MIBs (Cont.)

These settings do not need to be configured in any particular order. It is best practice to configure the access list first and then the read-only and read/write strings to have security in place.

On R1, a standard access list is configured to only permit access from an NMS host on the 192.168.14.0/24 subnet, 192.168.14.100. Once the access list is configured, the read-only and read/write community strings are configured and bound to that access list.

It is important to try to use SNMP strings that are not easy to guess from a security perspective.

Example 24-30 *SNMP Access List on R1*



```
R4(config)# access-list 99 permit 192.168.14.100 0.0.0.0
R4(config)# snmp-server community READONLY ro 99
R4(config)# snmp-server community READONLY rw 99
```

At this point, the device is configured to be polled from an NMS host with the IP address 192.168.14.100.

Debugging

SNMP Traps

To send SNMP traps to an NMS, traps first must be enabled on the device. All available traps can be enabled by issuing the **snmp-server enable traps** command.

- However, this may enable unnecessary traps that have no significance to the network operations team. It might be more appropriate to be selective about which traps to enable.
- The traps that are available to be enabled is platform specific.
- A common approach to determining what traps are available is to look at the documentation for the device. It may be easier to simply issue the **snmp-server enable traps** command followed by **?** to leverage the context-sensitive help and determine what traps are available on the device.

A significant number of traps can be enabled to send to an NMS.

Syslog

Devices can generate useful information to the console, to the logging buffer, and to off-box syslog collectors. In fact, all three can be sent the same or different message types.

It is critical to note that prior to configuring any device to send log information, the date and time of the clock must be properly configured for accurate time.

Level Keyword	Level	Description	Syslog Definition
emergencies	0	System unstable	LOG_EMERG
alerts	1	Immediate action needed	LOG_ALERT
critical	2	Critical conditions	LOG_CRIT
errors	3	Error conditions	LOG_ERR
warnings	4	Warning conditions	LOG_WARNING
notifications	5	Normal but significant conditions	LOG_NOTICE
informational	6	Informational messages only	LOG_INFO
debugging	7	Debugging message	LOG_DEBUG

Debugging

Syslog (Cont.)

Having syslog configured doesn’t mean that an issue will be found. It still takes the proper skill to be able to look at the messages and determine the root cause of the issue.

The logging buffer is the first area to focus on. You can enable logging to the buffer as follows:

1. Enable logging to the buffer.
2. Set the severity level of syslog messages to send to the buffer.
3. Set the logging buffer to a larger size.

The **logging buffered ?** command is issued from the global configuration mode to see the available options. It is important to note that the severity level can be configured by simply specifying the level with a number from 0 to 7 or the name of the severity (listed next to the severity level number).

The default size of the logging buffer is 4096 bytes. This can get overwritten quite quickly. It is good practice to expand the buffer size so you can capture more logging information.

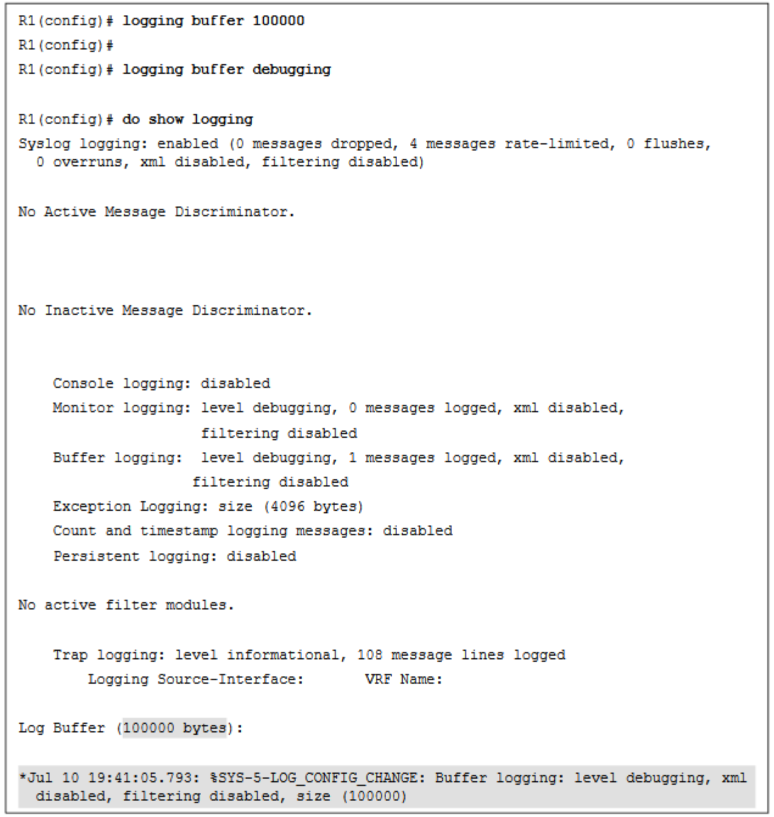
Debugging

Logging Buffer Size and Severity Level

Debugging or severity 7 is the level that will be configured in this example; with this configuration, any debugging can be sent to the logging buffer instead of the console.

In Example 24-34, the logging is configured to the debugging level, 7, and it is set to 100000 bytes.

Example 24-34 *Configuring the Logging Buffer Size and Severity Level on R1*



```
R1(config)# logging buffer 100000
R1(config)#
R1(config)# logging buffer debugging

R1(config)# do show logging
Syslog logging: enabled (0 messages dropped, 4 messages rate-limited, 0 flushes,
  0 overruns, xml disabled, filtering disabled)

No Active Message Discriminator.



No Inactive Message Discriminator.


    Console logging: disabled
    Monitor logging: level debugging, 0 messages logged, xml disabled,
                     filtering disabled
    Buffer logging:  level debugging, 1 messages logged, xml disabled,
                    filtering disabled
    Exception Logging: size (4096 bytes)
    Count and timestamp logging messages: disabled
    Persistent logging: disabled

No active filter modules.

    Trap logging: level informational, 108 message lines logged
        Logging Source-Interface:       VRF Name:

Log Buffer (100000 bytes):

*Jul 10 19:41:05.793: %SYS-5-LOG_CONFIG_CHANGE: Buffer logging: level debugging, xml
  disabled, filtering disabled, size (100000)
```

Sending Logging to a Host for Debugging

Sending these same logs to an off-box collector, that could be configured as well. By default, these messages are sent to the logging host through UDP port 514, but this can be changed if necessary.

Configuring logging to a host is very similar to configuring logging on the console or buffer. In this case, it is configured by using the following steps:

1. Enable logging to host 192.168.14.100.

2. Set the severity level of syslog messages to send to host.

Syslog can be used to notify of power supply failures, CPU spikes, and a variety of other things.

It is important not to underestimate the level of granularity and detail that can be achieved by setting up proper notification policies in a network. It is ultimately up to the network operations team to determine how deep is appropriate to meet the business’s needs.

NetFlow and Flexible NetFlow

- Gathering statistical information on traffic flows is necessary for a number of reasons.
- NetFlow is very versatile and provides a wealth of information without much configuration burden.
- NetFlow has two components that must be configured: NetFlow Data Capture and NetFlow Data Export.

NetFlow and Flexible NetFlow

NetFlow Ingress/Egress Collected Traffic Types

NetFlow captures traffic on ingress and egress—that is, traffic that is coming into the devices as well as traffic that is leaving them.

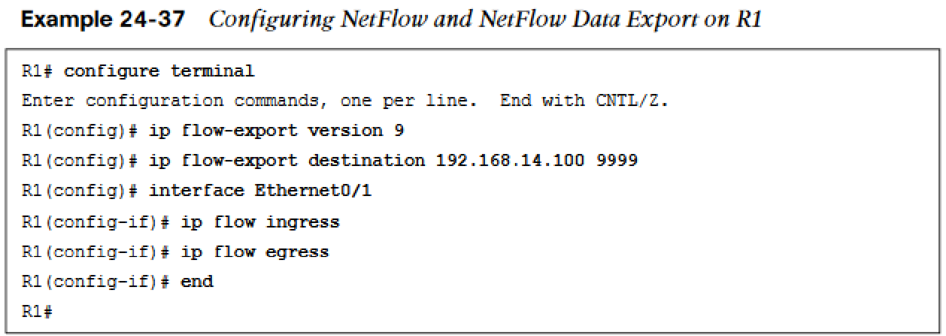
NetFlow collects traffic based on flows. A flow is a unidirectional traffic stream that contains a combination of the following key fields:

- Source IP address
- Destination IP address
- Source port number
- Destination port number
- Layer 3 protocol type
- Type of service (ToS)
- Input logical interface

NetFlow and Flexible NetFlow

Enable NetFlow

R1’s Ethernet0/1 interface for NetFlow Data Capture and exporting the data to the 192.168.14.100 collector. Example 24-37 illustrates the process of configuring NetFlow Data Capture and NetFlow Data Export on R1.



Example 24-37 *Configuring NetFlow and NetFlow Data Export on R1*

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# ip flow-export version 9
R1(config)# ip flow-export destination 192.168.14.100 9999
R1(config)# interface Ethernet0/1
R1(config-if)# ip flow ingress
R1(config-if)# ip flow egress
R1(config-if)# end
R1#
```

To verify that NetFlow and NetFlow Data Export were configured properly, a few commands can be run. The first is **show ip flow interface**, which shows the interfaces that are configured for NetFlow. The second is **show ip flow**, which shows the destination for the NetFlow data to be exported to. Finally, **show ip cache flow** shows the traffic flows that NetFlow is capturing.

NetFlow and Flexible NetFlow

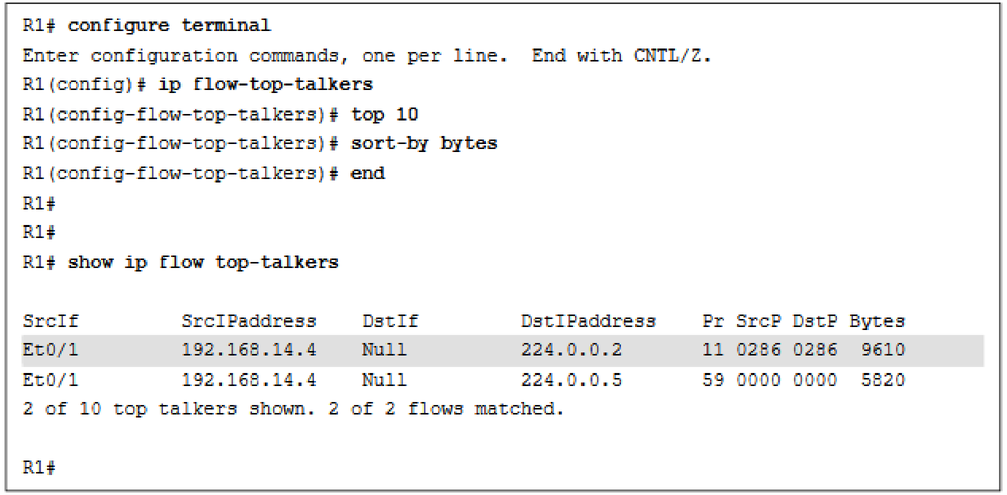
Configuring and Verifying the Top Talkers on R1

NetFlow is able to configure the top specified number of talkers on the network.

A very useful and quick configuration allows you to gain a great snapshot of what is going on in a device from a flow perspective.

This view can be enabled by issuing the global configuration mode command **ip flow-top-talkers** and configuring the **top** command for the number of talkers (1–200) and the **sort-by** command to sort by bytes or packets, depending on the use case.

Example 24-39 *Configuring and Verifying the Top Talkers on R1*



```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# ip flow-top-talkers
R1(config-flow-top-talkers)# top 10
R1(config-flow-top-talkers)# sort-by bytes
R1(config-flow-top-talkers)# end
R1#
R1#
R1# show ip flow top-talkers

SrcIf         SrcIPaddress    DstIf         DstIPaddress    Pr SrcP DstP Bytes
Et0/1         192.168.14.4    Null          224.0.0.2       11 0286 0286  9610
Et0/1         192.168.14.4    Null          224.0.0.5       59 0000 0000  5820
2 of 10 top talkers shown. 2 of 2 flows matched.

R1#
```

Flexible NetFlow

Flexible NetFlow was created to aid in more complex traffic analysis configuration than is possible with traditional NetFlow.

Flexible NetFlow allows for the use and reuse of configuration components.

Flexible NetFlow allows for the use of multiple flow monitors on the same traffic at the same time. This means that multiple different flow policies can be applied to the same traffic as it flows through a device.

Table 24-9 Flexible NetFlow Components

Component Name	Description
Flow Records	Combination of key and non-key fields. There are predefined and user-defined records.
Flow Monitors	Applied to the interface to perform network traffic monitor
Flow Exporters	Exports NetFlow Version 9 data from the Flow Monitor cache to a remote host or NetFlow collector.
Flow Samplers	Samples partial NetFlow data rather than analyzing all NetFlow data.

Sampled NetFlow Data Trade-offs

There are trade-offs in using sampled NetFlow data.

The biggest one is that there is a reduced load on the device in terms of memory and CPU. However, by sampling NetFlow data only at specific intervals, something could be missed as the accuracy goes down with sampling compared to when gathering all data.

Security has been a huge driver in the adoption of Flexible NetFlow due to its ability to track all parts of the IP header, as well as the packet and normalize it into flows.

- Flexible NetFlow can dynamically create individual caches for each type of flow.
- Flexible NetFlow can filter ingress traffic destined to a single destination.

You can use the **collect** and **match** commands to create a customized flow record.

To create a custom flow record, certain key and non-key fields must be matched so the flow record is usable. The **match** command is used to select key fields, and the **collect** command is used to select non-key fields.

Flow Record Key and Non-Key Fields

Table 24-10 shows a list of the key and non-key fields that can be used to mimic the original NetFlow capabilities when building a custom flow record.

Table 24-10 Flow Record Key and Non-Key Fields

Field	Key or Non-Key Field	Definition
IP ToS	Key	Value in the type of service (ToS)
IP ToS	Key	Value in the IP protocol field
IP source address	Key	IP source address
Transport source port	Key	IP destination address
Transport destination port	Key	Value of the transport layer source port field
Interface input	Key	Value of the transport layer destination port
Flow sampler ID	Key	ID number of the flow sampler (if flow sampling is enabled)

NetFlow and Flexible NetFlow

Flow Record Key and Non-Key Fields (Cont.)

Field	Key or Non-Key Field	Definition
IP source AS	Non-key	Source autonomous system
IP destination AS	Non-key	Destination autonomous system number
IP next-hop address	Non-key	IP address of the next hop
IP source mask	Non-key	Mask for the IP source address
IP destination mask	Non-key	Mask for the IP destination address
TCP flags	Non-key	Value in the TCP flag
Interface output	Non-key	Interface on which the traffic is transmitted
Counter bytes	Non-key	Number of bytes seen in the flow
Counter packets	Non-key	Number of packets seen in the flow
Time stamp system uptime first	Non-key	System uptime (time, in milliseconds)
Time stamp system uptime last	Non-key	System uptime (time, in milliseconds)

Configuring Flow Records

Configuring flow records is an important step in enabling Flexible NetFlow. because the flow record defines what type of traffic will be analyzed or monitored.

- There are predefined flow records, and you can also create custom flow records.
- Custom flow records can have hundreds of different combinations to meet the exact needs of the business.

Configuring a custom flow record involves the following steps:

1. Define the flow record name.

2. Set a useful description of the flow record.

3. Set match criteria for key fields.

4. Define non-key fields to be collected.

NetFlow and Flexible NetFlow

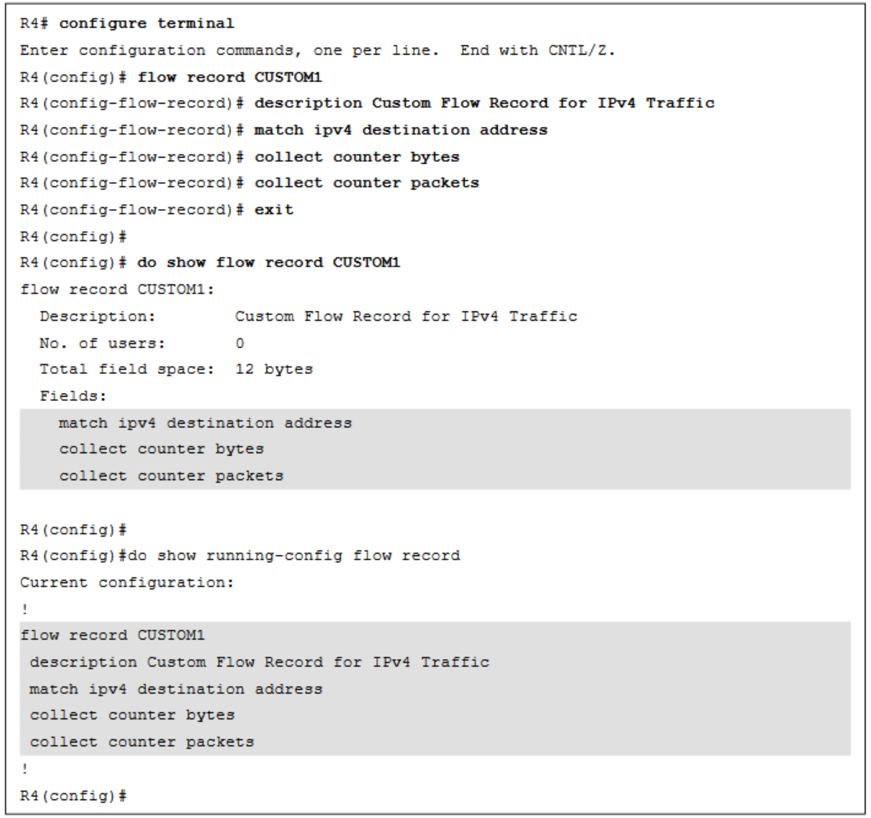
Configuring the Custom Flow Record

Although many of the predefined flow records that are available may be suitable for many use cases, there are too many of them to cover here.

Having the ability to build a custom flow record for a specific and unique use case makes it extremely powerful.

Example 24-40 shows a custom flow record called CUSTOM1.

Example 24-40 *Configuring and Verifying the Custom Flow Record on R4*



```
R4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)# flow record CUSTOM1
R4(config-flow-record)# description Custom Flow Record for IPv4 Traffic
R4(config-flow-record)# match ipv4 destination address
R4(config-flow-record)# collect counter bytes
R4(config-flow-record)# collect counter packets
R4(config-flow-record)# exit
R4(config)#
R4(config)# do show flow record CUSTOM1
flow record CUSTOM1:
  Description:        Custom Flow Record for IPv4 Traffic
  No. of users:       0
  Total field space:  12 bytes
  Fields:
    match ipv4 destination address
    collect counter bytes
    collect counter packets

R4(config)#
R4(config)#do show running-config flow record
Current configuration:
!
flow record CUSTOM1
 description Custom Flow Record for IPv4 Traffic
 match ipv4 destination address
 collect counter bytes
 collect counter packets
!
R4(config)#
```

NetFlow and Flexible NetFlow
Configuring the Custom Flow Exporter

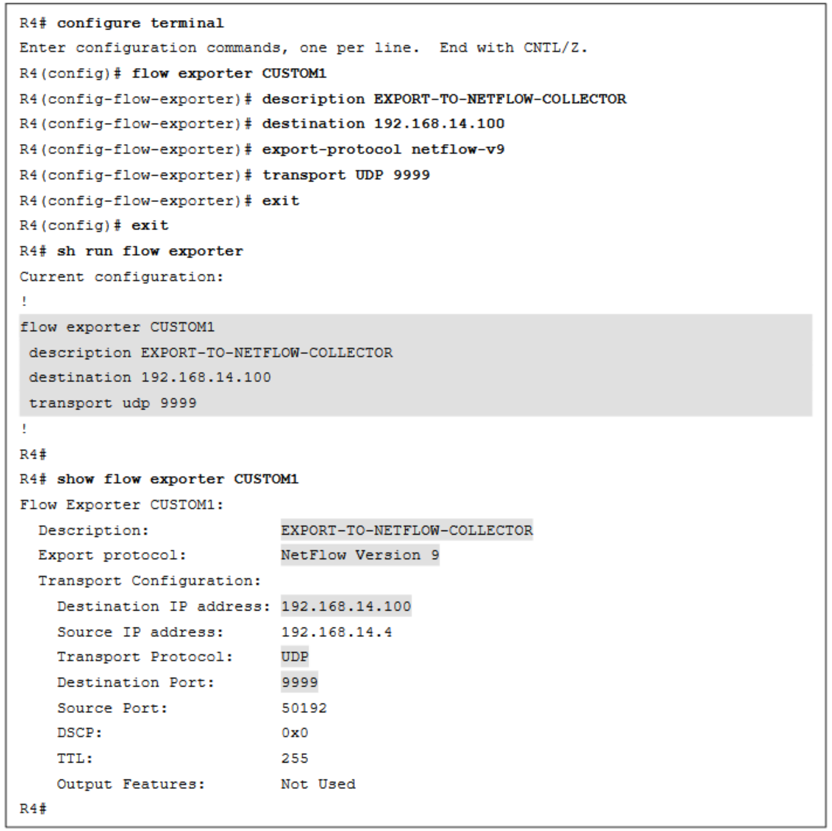
Now that a custom flow record has been configured, the flow exporter can be created.

There are a few important steps to complete when building a flow exporter:

1. Define the flow exporter name.
2. Set a useful description of the flow exporter.
3. Specify the destination of the flow exporter to be used.
4. Specify NetFlow version to export.
5. Specify the UDP port.

Example 24-41 illustrates the configuration of the flow exporter as well as how to verify the configuration.

Example 24-41 *Configuring and Verifying the Custom Flow Exporter on R4*



```
R4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)# flow exporter CUSTOM1
R4(config-flow-exporter)# description EXPORT-TO-NETFLOW-COLLECTOR
R4(config-flow-exporter)# destination 192.168.14.100
R4(config-flow-exporter)# export-protocol netflow-v9
R4(config-flow-exporter)# transport UDP 9999
R4(config-flow-exporter)# exit
R4(config)# exit
R4# sh run flow exporter
Current configuration:
!
flow exporter CUSTOM1
 description EXPORT-TO-NETFLOW-COLLECTOR
 destination 192.168.14.100
 transport udp 9999
!
R4#
R4# show flow exporter CUSTOM1
Flow Exporter CUSTOM1:
  Description:              EXPORT-TO-NETFLOW-COLLECTOR
  Export protocol:          NetFlow Version 9
  Transport Configuration:
    Destination IP address: 192.168.14.100
    Source IP address:      192.168.14.4
    Transport Protocol:     UDP
    Destination Port:       9999
    Source Port:            50192
    DSCP:                   0x0
    TTL:                    255
    Output Features:        Not Used
R4#
```

Configure a Flow Monitor

Now that a custom flow exporter has been configured, the flow monitor must be created.

- Each flow monitor requires a flow record to be assigned to it.
- Each flow monitor has its own cache, and the flow record provides the layout and how to carve up the cache for the defined traffic defined in the flow record.

To configure a flow monitor, the following high-level steps must be taken:

1. Define the flow monitor name.

2. Set a useful description of the flow monitor.

3. Specify the flow record to be used.

4. Specify a cache timeout of 60 for active connections.

5. Assign the exporter to the monitor.

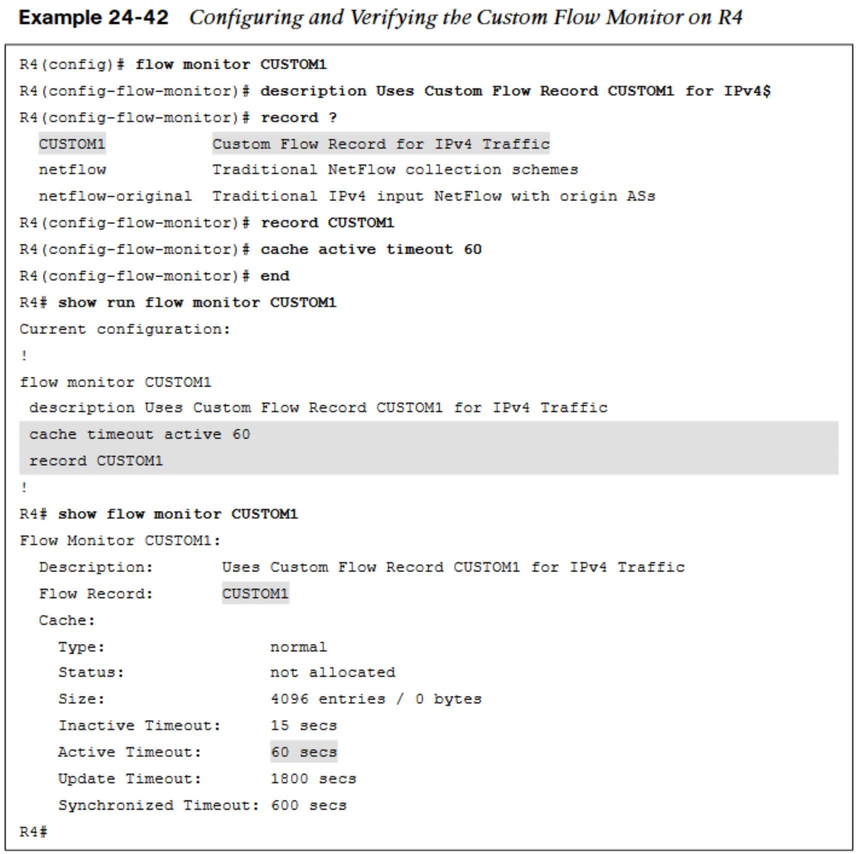
The cache timeout tells the device to export the cache to the collector every 60 seconds. It is important when creating a flow monitor for the description of the flow monitor to be useful and to map back to the flow record.

Configuring the Custom Flow Monitor

When configuring QoS, it is nice to have the descriptions self-document the intent of what the policy is doing.

This helps when configuring the flow monitor and when using context sensitive help, as the description that is configured shows in the output.

Example 24-42 shows this as well as the configuration and verification for the flow monitor called CUSTOM1.


Example 24-42 *Configuring and Verifying the Custom Flow Monitor on R4*

```
R4(config)# flow monitor CUSTOM1
R4(config-flow-monitor)# description Uses Custom Flow Record CUSTOM1 for IPv4$
R4(config-flow-monitor)# record ?
  CUSTOM1            Custom Flow Record for IPv4 Traffic
  netflow            Traditional NetFlow collection schemes
  netflow-original   Traditional IPv4 input NetFlow with origin ASs
R4(config-flow-monitor)# record CUSTOM1
R4(config-flow-monitor)# cache active timeout 60
R4(config-flow-monitor)# end
R4# show run flow monitor CUSTOM1
Current configuration:
!
flow monitor CUSTOM1
 description Uses Custom Flow Record CUSTOM1 for IPv4 Traffic
 cache timeout active 60
 record CUSTOM1
!
R4# show flow monitor CUSTOM1
Flow Monitor CUSTOM1:
  Description:       Uses Custom Flow Record CUSTOM1 for IPv4 Traffic
  Flow Record:       CUSTOM1
  Cache:
    Type:                 normal
    Status:               not allocated
    Size:                 4096 entries / 0 bytes
    Inactive Timeout:     15 secs
    Active Timeout:       60 secs
    Update Timeout:       1800 secs
    Synchronized Timeout: 600 secs
R4#
```

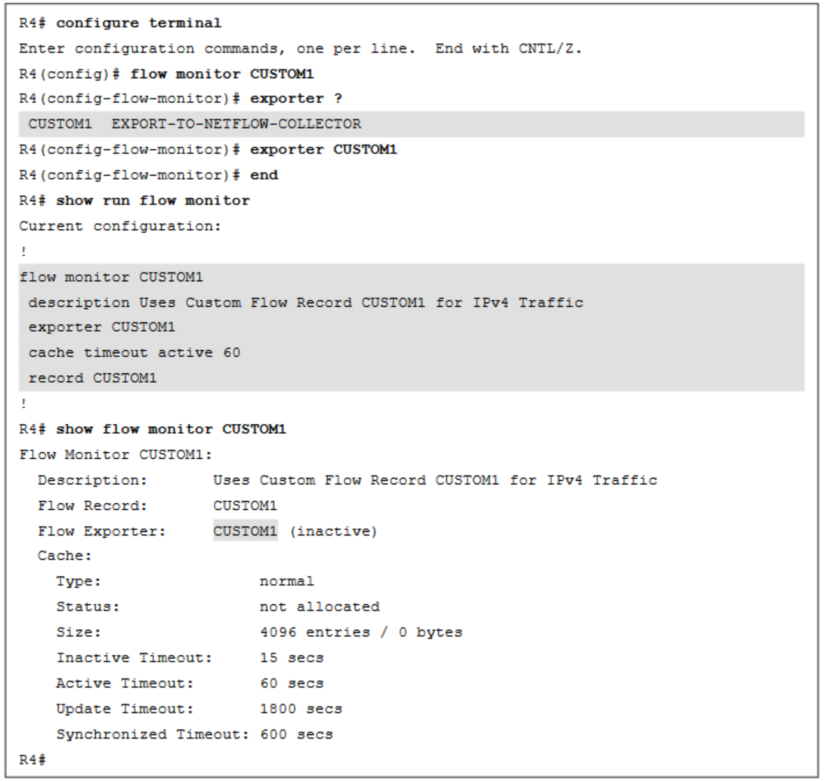
NetFlow and Flexible NetFlow
Configuring the Flow Exporter Mapping

The next step is to map the flow exporter CUSTOM1 to the flow monitor CUSTOM1.

You need to essentially map the two together so the traffic that is being collected by the flow record can be exported to the NetFlow collector at 192.168.14.100.

Example 24-43 shows the process and verification for adding the flow exporter CUSTOM1 to the flow monitor CUSTOM1 on R4.

Example 24-43 *Configuring and Verifying the Flow Exporter Mapping to the Flow Monitor on R4*



```
R4# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)# flow monitor CUSTOM1
R4(config-flow-monitor)# exporter ?
 CUSTOM1  EXPORT-TO-NETFLOW-COLLECTOR
R4(config-flow-monitor)# exporter CUSTOM1
R4(config-flow-monitor)# end
R4# show run flow monitor
Current configuration:
!
flow monitor CUSTOM1
 description Uses Custom Flow Record CUSTOM1 for IPv4 Traffic
 exporter CUSTOM1
 cache timeout active 60
 record CUSTOM1
!
R4# show flow monitor CUSTOM1
Flow Monitor CUSTOM1:
  Description:       Uses Custom Flow Record CUSTOM1 for IPv4 Traffic
  Flow Record:       CUSTOM1
  Flow Exporter:     CUSTOM1 (inactive)
  Cache:
    Type:                 normal
    Status:               not allocated
    Size:                 4096 entries / 0 bytes
    Inactive Timeout:     15 secs
    Active Timeout:       60 secs
    Update Timeout:       1800 secs
    Synchronized Timeout: 600 secs
R4#
```

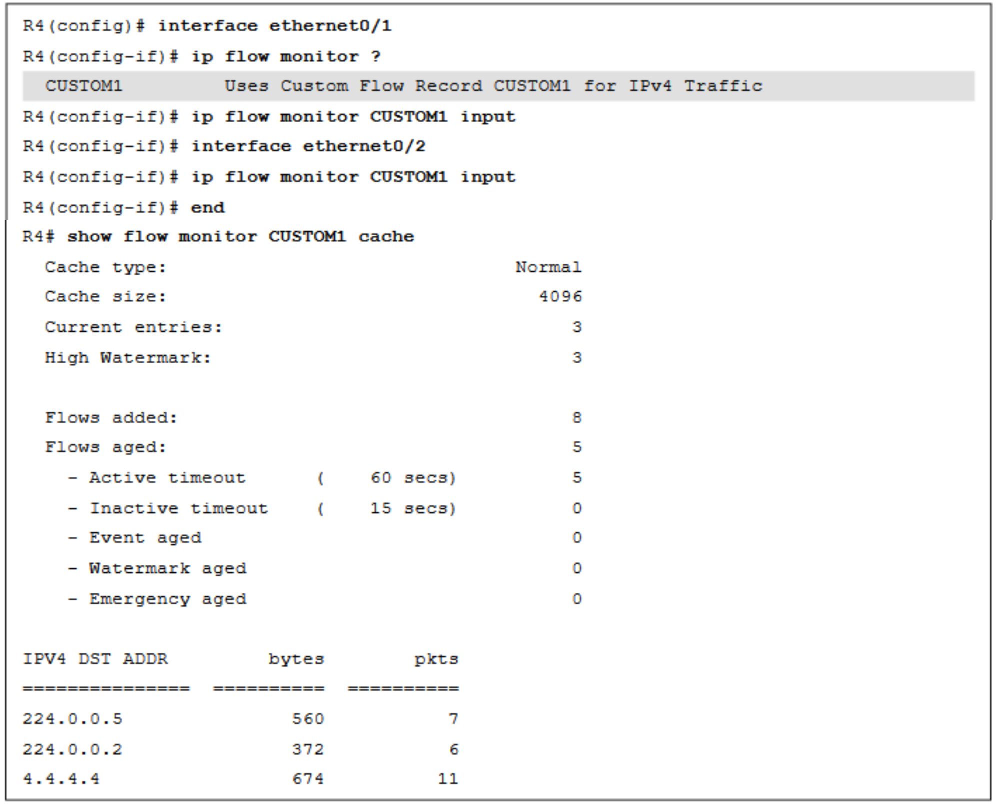
Configuring the Flow Monitor Interface

The final step necessary in enabling Flexible NetFlow is to apply the flow monitor to the interfaces.

This step turns on the collection of NetFlow statistics, and it can be enabled for ingress or egress or both.

Example 24-44 illustrates the process as well as how to verify that Flexible NetFlow is working by issuing the **show ip flow monitor CUSTOM1 cache** command.

Example 24-44 *Configuring and Verifying the Flow Monitor Interface Commands on R4*



```
R4(config)# interface ethernet0/1
R4(config-if)# ip flow monitor ?
  CUSTOM1          Uses Custom Flow Record CUSTOM1 for IPv4 Traffic
R4(config-if)# ip flow monitor CUSTOM1 input
R4(config-if)# interface ethernet0/2
R4(config-if)# ip flow monitor CUSTOM1 input
R4(config-if)# end
R4# show flow monitor CUSTOM1 cache
  Cache type:                               Normal
  Cache size:                                 4096
  Current entries:                               3
  High Watermark:                                3

  Flows added:                                   8
  Flows aged:                                    5
    - Active timeout       (     60 secs)        5
    - Inactive timeout     (     15 secs)        0
    - Event aged                                 0
    - Watermark aged                             0
    - Emergency aged                             0

IPV4 DST ADDR          bytes       pkts
===============   ==========  ==========
224.0.0.5                560           7
224.0.0.2                372           6
4.4.4.4                  674          11
```

Switched Port Analyzer (SPAN) Technologies

When the problem appears to be a Layer 2 issue, there are a few options:

- Insert a splitter between the devices.
- Configure the network device to mirror the packets.
- Insert a switch between the two devices and then configure the switch to mirror the transient traffic to a traffic analyzer.

Catalyst switches provide the Switched Port Analyzer (SPAN), which makes it possible to capture packets using the second two options above by using the following techniques:

Switched Port Analyzer (SPAN) Technologies

Sample Topology for Packet Captures

Figure 24-4 shows a sample topology with four computers (PC-A, PC-B, PC-C, and PC-D) spread across three switches and a traffic analyzer connected to SW1. PC-A, PC-B, and PC-C are all connected to VLAN 123 on the 10.123.1.0/24 network, and PC-D is connected to VLAN 34, which is on the 10.34.1.0/24 network. This topology is used to demonstrate the concepts of SPAN, RSPAN, and ERSPAN.

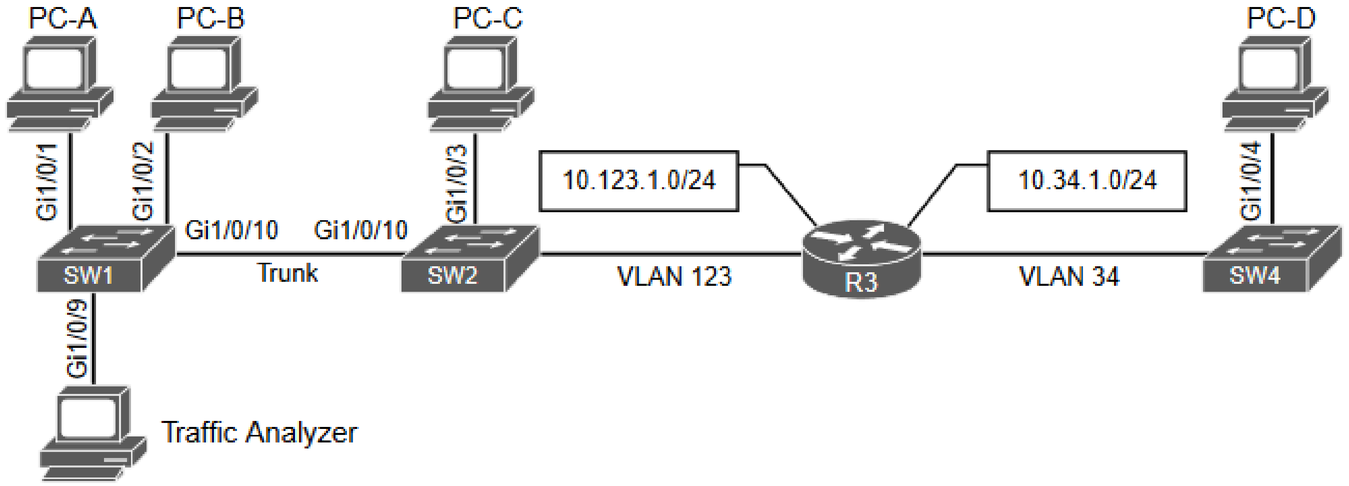


Figure 24-4 *Sample Topology for Packet Captures*

Switched Port Analyzer (SPAN) Technologies

Local SPAN

A local SPAN session is the most basic form of packet capture as all the configuration occurs on a single switch. The destination of the mirrored traffic can be one or more local ports. The source of the packet capture can be only one of the following:

- One or more specific switch ports
- A port channel (also known as an EtherChannel)
- A VLAN

Also consider the following:

- Most switches support at least two SPAN sessions, but newer hardware can support more than two sessions.
- The source port cannot be reused between two different SPAN sessions.
- Source ports can be switched or routed ports.
- The destination cannot be reused between two different SPAN sessions.
- It is possible to saturate the destination port if the source ports are receiving more data than the destination port can transmit.

Switched Port Analyzer (SPAN) Technologies
Specifying the Source Ports

The source ports are defined with the global configuration command **monitor session** *session-id* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**rx** | **tx** | **both**]. The SPAN *session-id* allows for the switch to correlate the source ports to specific destination ports.

The direction of the traffic can be specified as part of the configuration. With the optional **rx** keyword you capture only traffic received on that source, with the optional **tx** key word you capture traffic sent by that source, and with the **both** keyword you capture all traffic.

You can specify a trunk port as a source port to capture traffic for all VLANs that traverse that port. This might provide too much data and add noise to the traffic analysis tool. The VLANs can be filtered on the capture with the command **monitor session** *session-id* **filter vlan** *vlan-range*.

Specifying the Destination Ports

The destination port is specified with the global configuration command:

```
monitor session session-id destination interface interface-id [encapsulation
{dot1q [ingress {dot1q vlan vlan-id | untagged vlan vlan-id | vlan vlan-id}
| replicate [ingress {dot1q vlan vlan-id | untagged vlan vlan-id]}} |
ingress]
```

As you can see, there are a lot of different nested options.

A SPAN session normally copies the packets without including any 802.1Q VLAN tags or Layer 2 protocols. Using the **encapsulation replicate** keywords includes that information. The full global configuration command is:

```
monitor session session-id destination interface interface-id [encapsulation
replicate]
```

Switched Port Analyzer (SPAN) Technologies

Specifying the Destination Ports (Cont.)

If the traffic analyzer is a Windows PC and is accessed using RDP, the port must be able to send and receive traffic for the Windows PC in addition to the traffic from the SPAN session. Situations like this require the following global configuration command:

```
monitor session session-id destination interface interface-id ingress {dot1q
vlan vlan-id | untagged vlan vlan-id}
```

Selecting the **dot1q** keyword requires the packets to be encapsulated with the specified VLAN ID. Selecting the **untagged** keyword accepts incoming packets and associates them to the specified VLAN ID.

STP is disabled on the destination port to prevent extra BPDUs from being included in the network analysis. Great care should be taken to prevent a forwarding loop on this port.

Local SPAN Configuration Examples

Example 24-45 shows how to monitor both PC-A's and PC-B's communication on SW1 and send it toward the local traffic analyzer.

Example 24-45 *Enabling a SPAN Session on SW1*

```
SW1(config)# monitor session 1 source interface gi1/0/1 - 2
SW1(config)# monitor session 1 destination interface gi1/0/9
```

A specific SPAN session can be viewed, or the output can be restricted to the local SPAN session, as shown in Example 24-46.

Example 24-46 *Verifying the Configured SPAN Session*

```
SW1# show monitor session local
Session 1
---------
Type                          : Local Session
Source Ports                  :
    Both                      : Gi1/0/1-2
Destination Ports             : Gi1/0/9
    Encapsulation             : Native
          Ingress             : Disabled
```

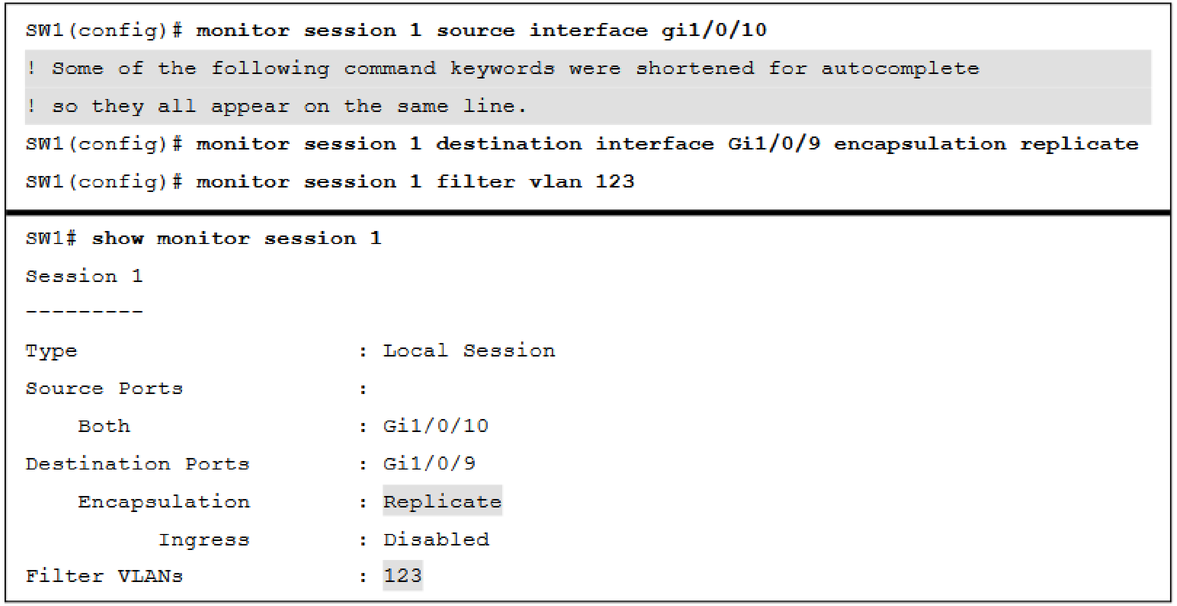
Switched Port Analyzer (SPAN) Technologies

Local SPAN Configuration Examples (Cont.)

The next example illustrates monitoring the trunk port Gi1/0/10 and provides the output to PC-B for PC-A and PC-B communication on SW1 and sending it toward the local traffic analyzer.

Example 24-47 shows the commands that are entered on SW1 and then shows the configuration verified by examining the SPAN session.

Example 24-47 *Configuring and Verifying SPAN for the SW1 Gi1/0/10 Source*



```
SW1(config)# monitor session 1 source interface gi1/0/10
! Some of the following command keywords were shortened for autocomplete
! so they all appear on the same line.
SW1(config)# monitor session 1 destination interface Gi1/0/9 encapsulation replicate
SW1(config)# monitor session 1 filter vlan 123
```

```
SW1# show monitor session 1
Session 1
---------
Type                     : Local Session
Source Ports             :
    Both                 : Gi1/0/10
Destination Ports        : Gi1/0/9
    Encapsulation        : Replicate
          Ingress        : Disabled
Filter VLANs             : 123
```

Switched Port Analyzer (SPAN) Technologies

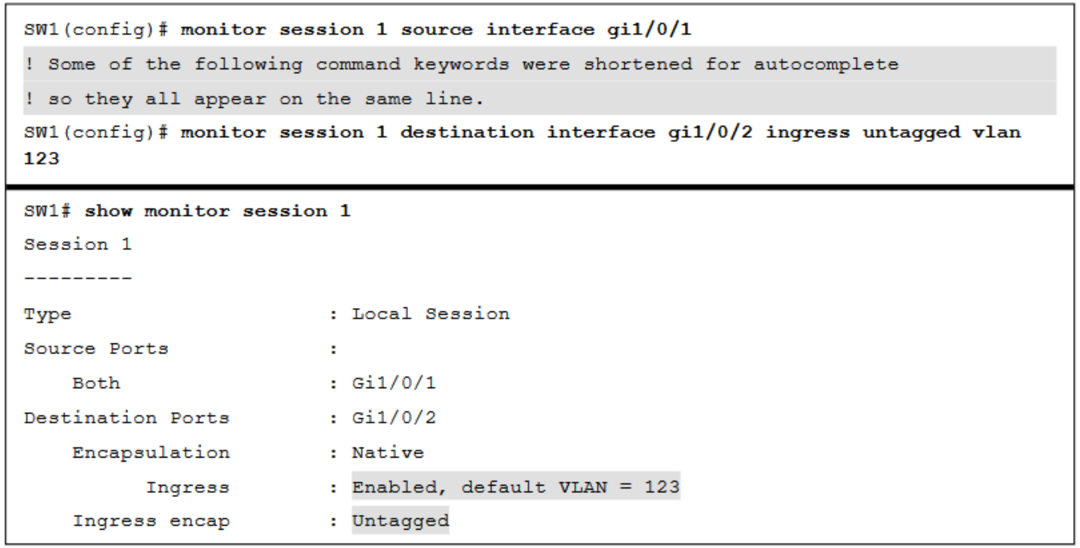
Local SPAN Configuration Examples (Cont.)

In the last scenario, the switch is configured to monitor PC-A’s traffic, and it uses an already installed network traffic analysis tool on PC-B.

When the switch is configured, PC-B can be accessed remotely to view the network traffic by using RDP.

Example 24-48 lists the commands that are entered on SW1 to capture the ingress traffic and shows the configuration being verified.

Example 24-48 *Configuring and Verifying SPAN for the SW1 Gi1/0/1 Source*



```
SW1(config)# monitor session 1 source interface gi1/0/1
! Some of the following command keywords were shortened for autocomplete
! so they all appear on the same line.
SW1(config)# monitor session 1 destination interface gi1/0/2 ingress untagged vlan
123
```

```
SW1# show monitor session 1
Session 1
---------
Type                      : Local Session
Source Ports              :
    Both                  : Gi1/0/1
Destination Ports         : Gi1/0/2
    Encapsulation         : Native
          Ingress         : Enabled, default VLAN = 123
    Ingress encap         : Untagged
```

Switched Port Analyzer (SPAN) Technologies

Remote SPAN (RSPAN)

In large environments, it might be not be possible to move a network analyzer to other parts of the network. Example 24-49 shows the RSPAN VLAN being created on SW1 and SW2.

Example 24-49 *Creating the RSPAN VLAN*

```
SW1(config)# vlan 99
SW1(config-vlan)# name RSPAN_VLAN
SW1(config-vlan)# remote-span
```

```
SW2(config)# vlan 99
SW2(config-vlan)# name RSPAN_VLAN
SW2(config-vlan)# remote-span
```

Example 24-50 shows the configuration of RSPAN on the source switch, SW2. Traffic from PC-C is sent to SW1 for analysis.

Example 24-50 *Configuring a Source RSPAN Switch*

```
SW2(config)# monitor session 1 source interface gi1/0/3
SW2(config)# monitor session 1 destination remote vlan 99
```

Switched Port Analyzer (SPAN) Technologies

Configuration of RSPAN on the Destination Switch

Example 24-51 shows the configuration of RSPAN on the destination switch, SW1. The traffic is sent to the traffic analyzer for analysis.

Example 24-51 *Configuring a Destination RSPAN Switch*

```
SW1(config)# monitor session 1 source remote vlan 99
SW1(config)# monitor session 1 destination interface gi1/0/9
```

Example 24-52 verifies the configuration of RSPAN on both SW1 and SW2.

Example 24-52 *Verifying the RSPAN Settings*

```
SW1# show monitor session 1
Session 1
---------
Type                    : Remote Destination Session
Source RSPAN VLAN       : 99
Destination Ports       : Gi1/0/9
    Encapsulation       : Native
          Ingress       : Disabled
```

```
SW2# show monitor session remote
Session 1
---------
Type                    : Remote Source Session
Source Ports            :
    Both                : Gi1/0/3
Dest RSPAN VLAN         : 99
```

Switched Port Analyzer (SPAN) Technologies

Encapsulated Remote SPAN (ERSPAN)

In large environments, it might not be possible to move a network analyzer to other parts of the network. ERSPAN provides the ability to monitor traffic in one area of the network and route the SPAN traffic to a traffic analyzer in another area of the network through Layer 3 routing.

Specifying the Source Ports

A source and destination must be configured. To configure a source, the following command is issued: **monitor session** *span-session-number* **type erspan-source**. This defines the session number as well as the session type, **erspan-source**.

Once the initial session is created, the source must be defined in the session. This is accomplished by issuing the **source** { **interface** *type number* | **vlan** *vlan-ID* } [, | - | *both* | *rx* | *tx*] command.

Switched Port Analyzer (SPAN) Technologies

Encapsulated Remote SPAN (ERSPAN) (Cont.)

When the source has been configured, it is necessary to configure the destination of the ERSPAN session. To enter the destination subconfiguration mode, the **destination** command is used. The rest of the commands will be issued in the destination subconfiguration mode to specify the destination of the ERSPAN session as well as any parameters associated with the configuration of the destination.

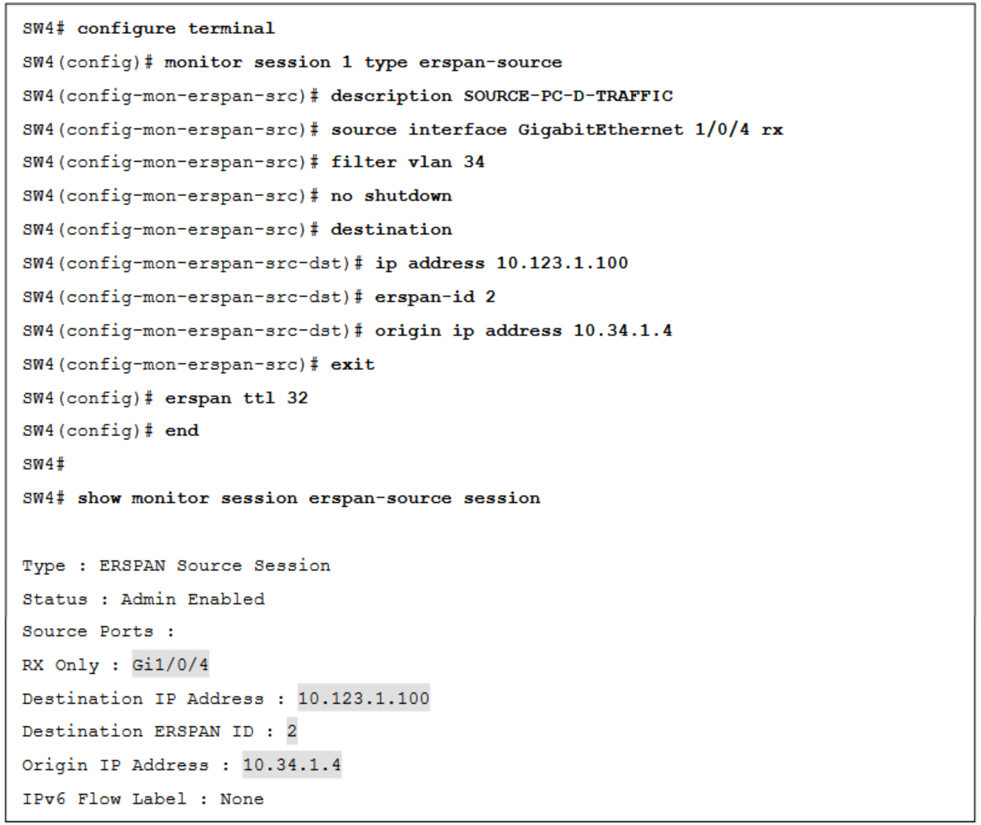
The next step is to identify the IP address of the destination for the ERSPAN session. Because this is a Layer 3 SPAN session, this IP address is where the traffic will be sent to be analyzed. The command to configure this action is simply **ip address** *ip-address*.

The final step is to assign a ToS or TTL to the ERSPAN traffic. This is done with the **erspan** { **tos** *tos-value* | **ttl** t*tl-value* } command from global configuration mode.

Switched Port Analyzer (SPAN) Technologies

ERSPAN Process

Example 24-53 illustrates this whole process. In addition, to verify the configured sessions, the **show monitor session erspan-source session** is issued on SW1.


Example 24-53 *Configuring ERSPAN on SW1*

```
SW4# configure terminal
SW4(config)# monitor session 1 type erspan-source
SW4(config-mon-erspan-src)# description SOURCE-PC-D-TRAFFIC
SW4(config-mon-erspan-src)# source interface GigabitEthernet 1/0/4 rx
SW4(config-mon-erspan-src)# filter vlan 34
SW4(config-mon-erspan-src)# no shutdown
SW4(config-mon-erspan-src)# destination
SW4(config-mon-erspan-src-dst)# ip address 10.123.1.100
SW4(config-mon-erspan-src-dst)# erspan-id 2
SW4(config-mon-erspan-src-dst)# origin ip address 10.34.1.4
SW4(config-mon-erspan-src)# exit
SW4(config)# erspan ttl 32
SW4(config)# end
SW4#
SW4# show monitor session erspan-source session

Type : ERSPAN Source Session
Status : Admin Enabled
Source Ports :
RX Only : Gi1/0/4
Destination IP Address : 10.123.1.100
Destination ERSPAN ID : 2
Origin IP Address : 10.34.1.4
IPv6 Flow Label : None
```

IP SLA

IP SLA is a tool built into Cisco IOS software that allows for the continuous monitoring of various aspects of the network.

IP SLA

IP SLA and Typical Service Provider SLA

Typically, any SLA received from a service provider only monitors or guarantees the traffic as it flows across the service provider's network. Figure 24-5 shows this scenario and illustrates why IP SLA provides more visibility that a typical service provider SLA.

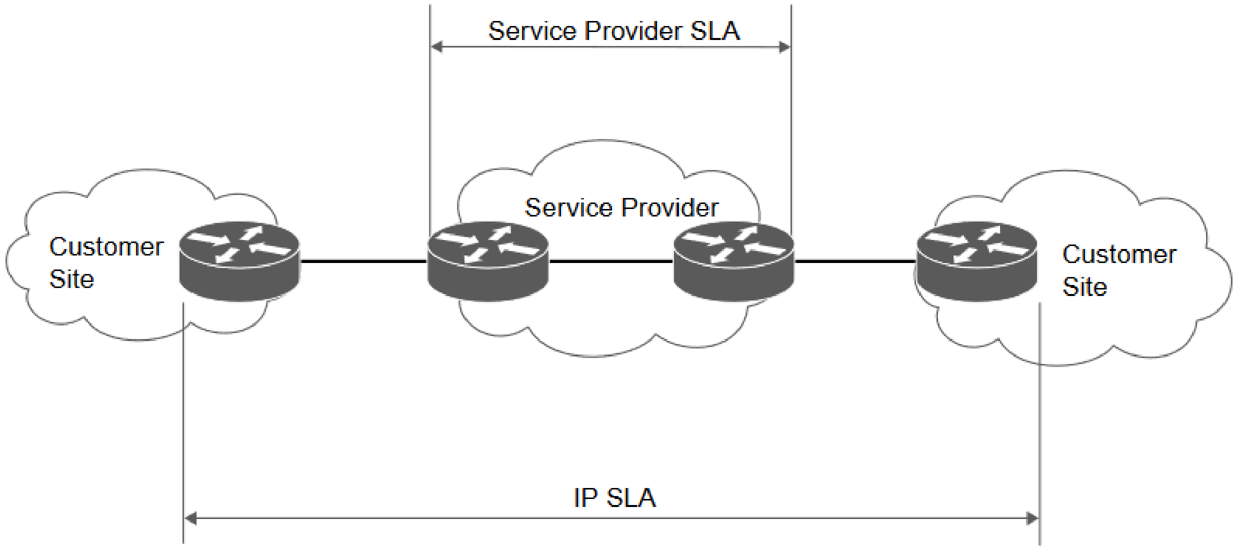


Figure 24-5 *IP SLA and Typical Service Provider SLA*

IP SLA Echo Operation

Although there are many different options and probes available for IP SLA, this section focuses only on the ICMP echo and HTTP operations of IP SLA. The ICMP echo operation can functionally be thought of as testing reachability by leveraging ICMP echo and echo replies or pings. Figure 24-6 illustrates how the ICMP echo operation works in IP SLA.

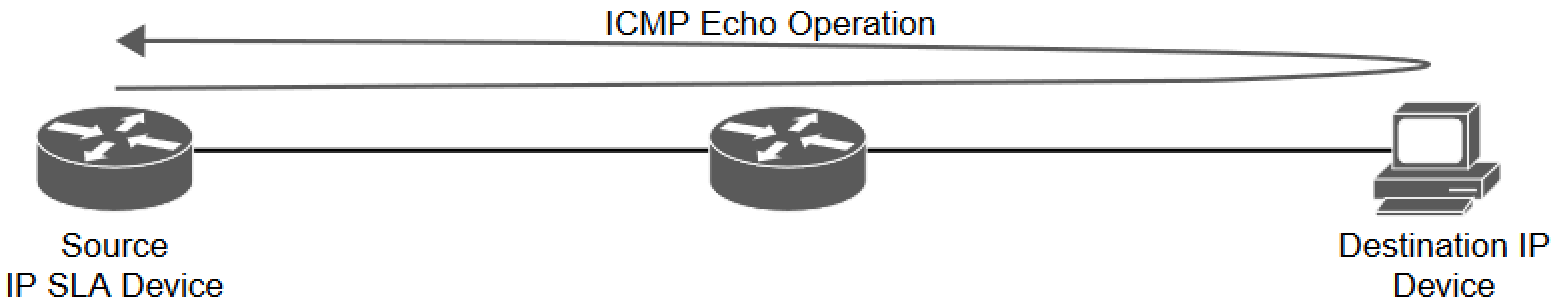


Figure 24-6 *IP SLA Echo Operation*

Configuring IP SLA ICMP Echo Operation on R1

To configure any IP SLA operation, the **ip sla** *operation-number* command must be used to enter IP SLA configuration mode, where *operation-number* is the configuration for the individual IP SLA probe. Once in IP SLA configuration mode, the command **icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-name*] is used to configure the destination IP address of the device or host to be monitored.

The next step is to specify how often the ICMP echo operation should run. This is accomplished by issuing the **frequency** *seconds* command. Example 24-54 shows the process covered so far on R1.

Example 24-54 *Configuring IP SLA ICMP Echo Operation on R1*

```
R1(config)# ip sla 1
R1(config-ip-sla)# icmp-echo 192.168.14.100 source-interface Loopback0
R1(config-ip-sla-echo)# frequency 300
R1(config-ip-sla-echo)# end
R1(config)#
```

IP SLA
Scheduling IP SLA 1 on R1

When the IP SLA configuration is complete, an important step is to schedule and activate the IP SLA operation that has been configured. This is where the **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh:mm:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}] [**ageout** *seconds*] [**recurring**] command comes into play.

When the IP SLA operation is scheduled, it can be verified with the **show ip sla configuration** command.

Example 24-55 illustrates the configuration steps to schedule the IP SLA 1 operation with a start time of now and a lifetime of forever.

Example 24-55 *Scheduling IP SLA 1 on R1*

```
R1(config)# ip sla schedule 1 life forever start-time now
R1(config)# do show ip sla configuration 1
IP SLAs Infrastructure Engine-III
Entry number: 1
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source interface: 192.168.14.100/Loopback0
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
Vrf Name:
Schedule:
   Operation frequency (seconds): 300  (not considered if randomly scheduled)
   Next Scheduled Start Time: Start Time already passed
   Group Scheduled : FALSE
   Randomly Scheduled : FALSE
   Life (seconds): Forever
   Entry Ageout (seconds): never
   Recurring (Starting Everyday): FALSE
   Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Distribution Statistics:
   Number of statistic hours kept: 2
   Number of statistic distribution buckets kept: 1
   Statistic distribution interval (milliseconds): 20
Enhanced History:
History Statistics:
   Number of history Lives kept: 0
   Number of history Buckets kept: 15
   History Filter Type: None
```

Configuring the IP SLA HTTP GET Operation

Another very common use case for IP SLA is to monitor HTTP destinations for operation. This can be done by using the HTTP GET operation of IP SLA. In order to configure this type of monitor, the **ip sla** *operation-number* command must be used to enter IP SLA configuration mode.

When the operation number is specified, the next step is to configure the HTTP GET probe by issuing the command **http** {**get** | **raw**} *url*[**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*].

When the probe is configured, as with any other IP SLA operation, this operation needs to be scheduled by using the command **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh:mm:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}] [**ageout** *seconds*] [**recurring**].

Cisco DNA Center Assurance

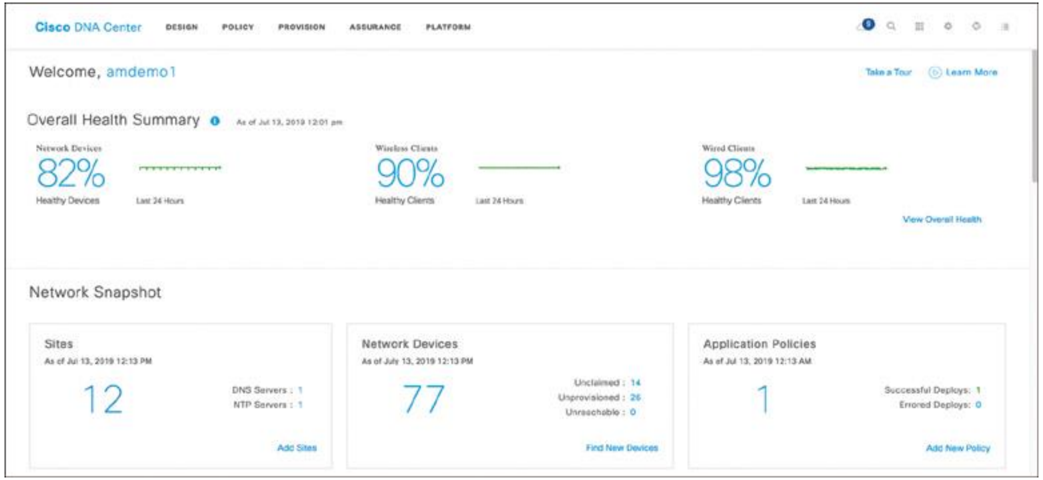
- Security has become one the most important pieces of the network, and users expect a better experience.
- Customers demand a simple way to manage Day 0–2 operations and require a scalable and simple approach to running the net-work.
- Cisco DNA Center Assurance provides a tool for handling the most relevant customer requirements.

Cisco DNA Center Assurance
Cisco DNA Center

Typically, when an issue arises in the network, a helpdesk ticket is created. However, by the time the network operations team gets the ticket assigned, the issue is either resolved on its own or the information provided in the ticket to assist with troubleshooting the issue is stale or out of date.

Cisco DNA Center Assurance has Network Time Travel. Network Time Travel acts as a digital video recorder (DVR) for the network. Network Time Travel records what is going on in the environment using streaming telemetry and can play back something that happened in the past.

Figure 24-7 shows the main Cisco DNA Center page.



Welcome, amdemo1

Overall Health Summary As of Jul 13, 2019 12:01 pm

Network Devices 82% Healthy Devices — Last 24 Hours

Wireless Clients 90% Healthy Clients — Last 24 Hours

Wired Clients 98% Healthy Clients — Last 24 Hours

Network Snapshot

Sites
As of Jul 13, 2019 12:13 PM
12
DNS Servers : 1
NTP Servers : 1

Network Devices
As of July 13, 2019 12:13 PM
77
Unclaimed : 14
Unprovisioned : 26
Unreachable : 0

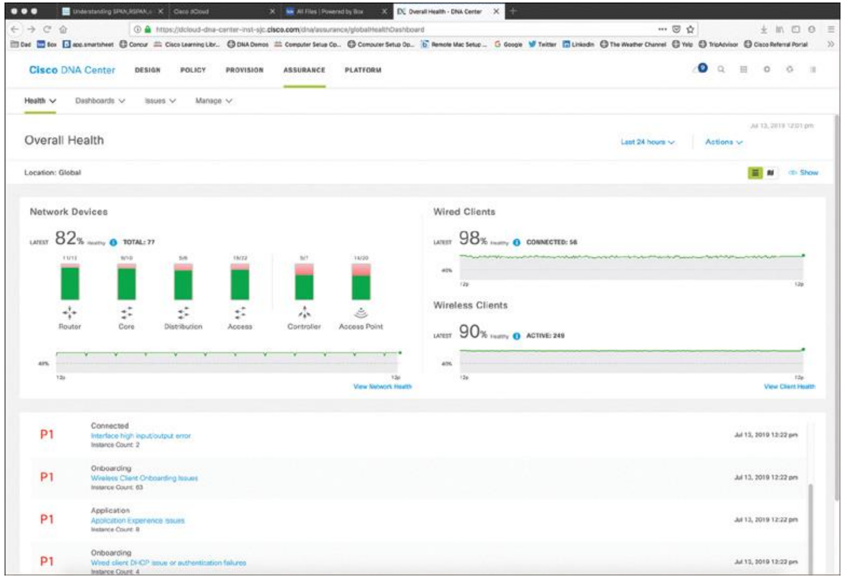
Application Policies
As of Jul 13, 2019 12:13 AM
1
Successful Deploys: 1
Errored Deploys: 0

Cisco DNA Center Assurance

Cisco DNA Assurance

Cisco DNA Assurance is part of Cisco DNA Center.

- Assurance takes 30+ years of Cisco Technical Assistance Center (TAC) experience and puts it into a tool that uses machine learning to diagnose issues within a network.
- In addition to finding and diagnosing the issues, Assurance gives guided remediation steps to fix the issue. The Assurance tab is shown in Figure 24-8.



P1	Connected Interface high input/output error Instance Count: 2	Jul 13, 2019 12:22 pm
P1	Onboarding Wireless Client Onboarding Issues Instance Count: 63	Jul 13, 2019 12:22 pm
P1	Application Application Experience issues Instance Count: 8	Jul 13, 2019 12:22 pm
P1	Onboarding Wired client DHCP issue or authentication failures Instance Count: 4	Jul 13, 2019 12:22 pm

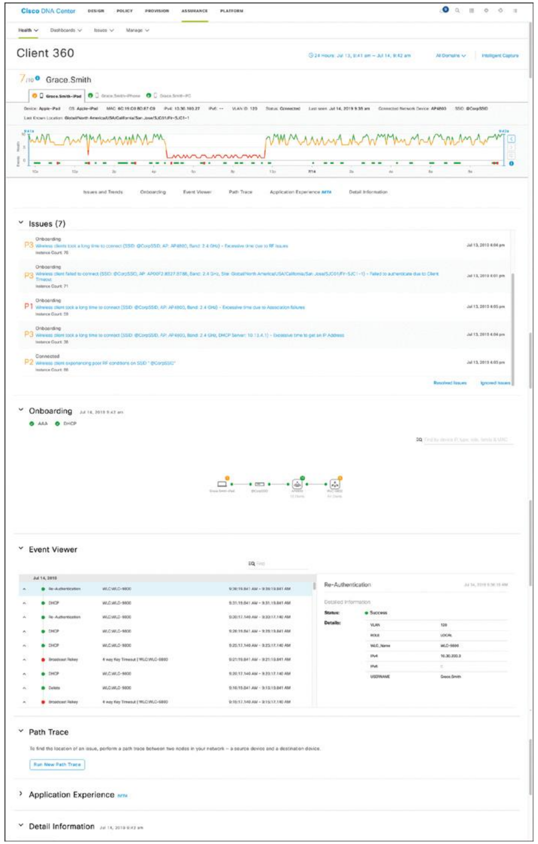
Cisco DNA Center Assurance

Cisco DNA Center Client 360 View

From this view, you can do many different things.

- You can click the user's name to see details related to that specific user.
- You can click each device to see specifics about that device in the Client 360 view.

Figure 24-10 shows the entire Client 360 view for the user Grace Smith.



Device: Apple-iPad OS: Apple-iPad MAC: 6C:19:C0:8D:87:C9 IPv4: 10.30.160.27 IPv6: -- VLAN ID: 120 Status: Connected Last seen: Jul 14, 2019 9:38 am Connected Network Device: AP4800 SSID: @CorpSSID

Last Known Location: Global/North America/USA/California/San Jose/SJC01/Flr-SJC1-1

Issues (7)

P3 Onboarding
Wireless clients took a long time to connect (SSID: @CorpSSID, AP: AP4800, Band: 2.4 GHz) - Excessive time due to RF issues
Instance Count: 76 — Jul 13, 2019 4:04 pm

P3 Onboarding
Wireless client failed to connect (SSID: @CorpSSID, AP: AP00F2.8B27.B786, Band: 2.4 GHz, Site: Global/North America/USA/California/San Jose/SJC01/Flr-SJC1-1) - Failed to authenticate due to Client Timeout
Instance Count: 71 — Jul 13, 2019 4:01 pm

P1 Onboarding
Wireless client took a long time to connect (SSID: @CorpSSID, AP: AP4800, Band: 2.4 GHz) - Excessive time due to Association failures
Instance Count: 29 — Jul 13, 2019 4:05 pm

P3 Onboarding
Wireless client took a long time to connect (SSID: @CorpSSID, AP: AP4800, Band: 2.4 GHz, DHCP Server: 10.13.4.1) - Excessive time to get an IP Address
Instance Count: 38 — Jul 13, 2019 4:04 pm

P2 Connected
Wireless client experiencing poor RF conditions on SSID "@CorpSSID"
Instance Count: 86 — Jul 13, 2019 4:05 pm

Resolved Issues Ignored Issues

Onboarding Jul 14, 2019 9:42 am
● AAA ● DHCP

Event Viewer

Jul 14, 2019		
Re-Authentication	WLC:WLC-9800	9:36:15.841 AM - 9:36:15.841 AM
DHCP	WLC:WLC-9800	9:31:15.841 AM - 9:31:15.841 AM
Re-Authentication	WLC:WLC-9800	9:30:17.140 AM - 9:30:17.140 AM
DHCP	WLC:WLC-9800	9:26:15.841 AM - 9:26:15.841 AM
DHCP	WLC:WLC-9800	9:25:17.140 AM - 9:25:17.140 AM
Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:21:15.841 AM - 9:21:15.841 AM
DHCP	WLC:WLC-9800	9:20:17.140 AM - 9:20:17.140 AM
Delete	WLC:WLC-9800	9:16:15.841 AM - 9:15:15.841 AM
Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:15:17.140 AM - 9:15:17.140 AM

Re-Authentication

Detailed Information

Status: ● Success

Details:

VLAN	120
ROLE	LOCAL
WLC_Name	WLC-9800
IPv4	10.30.200.3
IPv6	::
USERNAME	Grace.Smith

Path Trace

To find the location of an issue, perform a path trace between two nodes in your network – a source device and a destination device.

Run New Path Trace

Application Experience BETA

Detail Information Jul 14, 2019 9:42 am

Cisco DNA Center Search Results

The amount of information that this screen provides is tremendous. The following pieces of information have been gathered automatically:

- Device type
- OS version
- MAC address
- IPv4 address
- VLAN ID
- Connectivity status
- When the device was last seen on the network
- What device it is connected to
- Wireless SSID
- Last known location

The timeline in the Client 360 view shows issues. This is also a Network Time Travel capability. Since Assurance records the telemetry, it is possible to search back in time to see exactly what has affected the user.

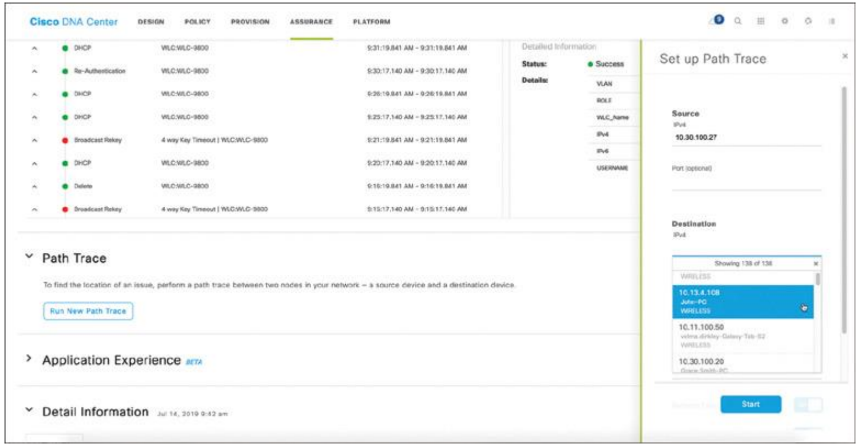
Cisco DNA Center Assurance

Path Trace

Assurance has a tool called Path Trace. Path Trace is a visual traceroute and diagnostic tool that can be run periodically or continuously, with a specific refresh interval.

The path trace output shows a topology view of the traceroute, and in this instance, Path Trace has also detected that there is an access control list (ACL) blocking the traffic from Grace's iPad to John's PC (see Figure 24-12).

Figure 24-11 *Cisco DNA Center Assurance Client 360 Path Trace*



DHCP	WLC:WLC-9800	9:31:19.841 AM - 9:31:19.841 AM
Re-Authentication	WLC:WLC-9800	9:30:17.140 AM - 9:30:17.140 AM
DHCP	WLC:WLC-9800	9:26:19.841 AM - 9:26:19.841 AM
DHCP	WLC:WLC-9800	9:25:17.140 AM - 9:25:17.140 AM
Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:21:19.841 AM - 9:21:19.841 AM
DHCP	WLC:WLC-9800	9:20:17.140 AM - 9:20:17.140 AM
Delete	WLC:WLC-9800	9:16:19.841 AM - 9:16:19.841 AM
Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:15:17.140 AM - 9:15:17.140 AM

Detailed Information

Status: ● Success

Details: VLAN, ROLE, WLC_Name, IPv4, IPv6, USERNAME

Path Trace

To find the location of an issue, perform a path trace between two nodes in your network – a source device and a destination device.

Run New Path Trace

Application Experience BETA

Detail Information Jul 14, 2019 9:42 am

Set up Path Trace

Source
IPv4
10.30.100.27

Port (optional)

Destination
IPv4

Showing 138 of 138

WIRELESS

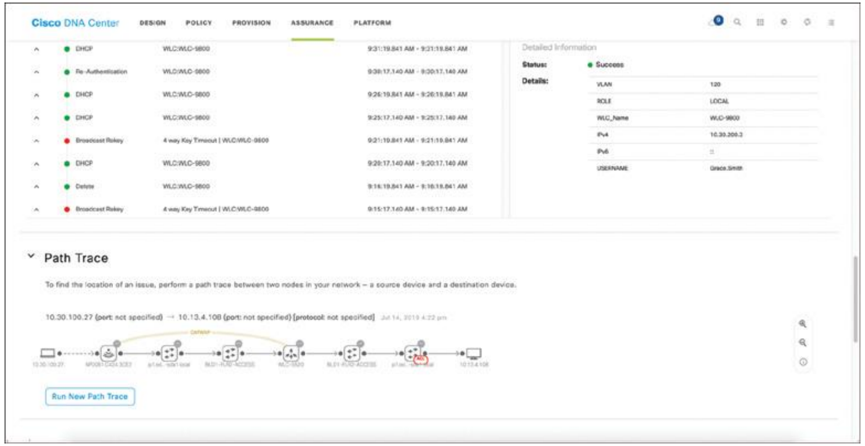
10.13.4.108
John-PC
WIRELESS

10.11.100.50
velma.dinkley-Galaxy-Tab-S2
WIRELESS

10.30.100.20
Grace.Smith-PC

Start

Figure 24-12 *Cisco DNA Center Assurance Client 360 Path Trace Output*



DHCP	WLC:WLC-9800	9:31:19.841 AM - 9:31:19.841 AM
Re-Authentication	WLC:WLC-9800	9:30:17.140 AM - 9:30:17.140 AM
DHCP	WLC:WLC-9800	9:26:19.841 AM - 9:26:19.841 AM
DHCP	WLC:WLC-9800	9:25:17.140 AM - 9:25:17.140 AM
Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:21:19.841 AM - 9:21:19.841 AM
DHCP	WLC:WLC-9800	9:20:17.140 AM - 9:20:17.140 AM
Delete	WLC:WLC-9800	9:16:19.841 AM - 9:16:19.841 AM
Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:15:17.140 AM - 9:15:17.140 AM

Detailed Information

Status: ● Success

Details:	
VLAN	120
ROLE	LOCAL
WLC_Name	WLC-9800
IPv4	10.30.200.3
IPv6	::
USERNAME	Grace.Smith

Path Trace

To find the location of an issue, perform a path trace between two nodes in your network – a source device and a destination device.

10.30.100.27 (port: not specified) → 10.13.4.108 (port: not specified) [protocol: not specified] Jul 14, 2019 4:22 pm

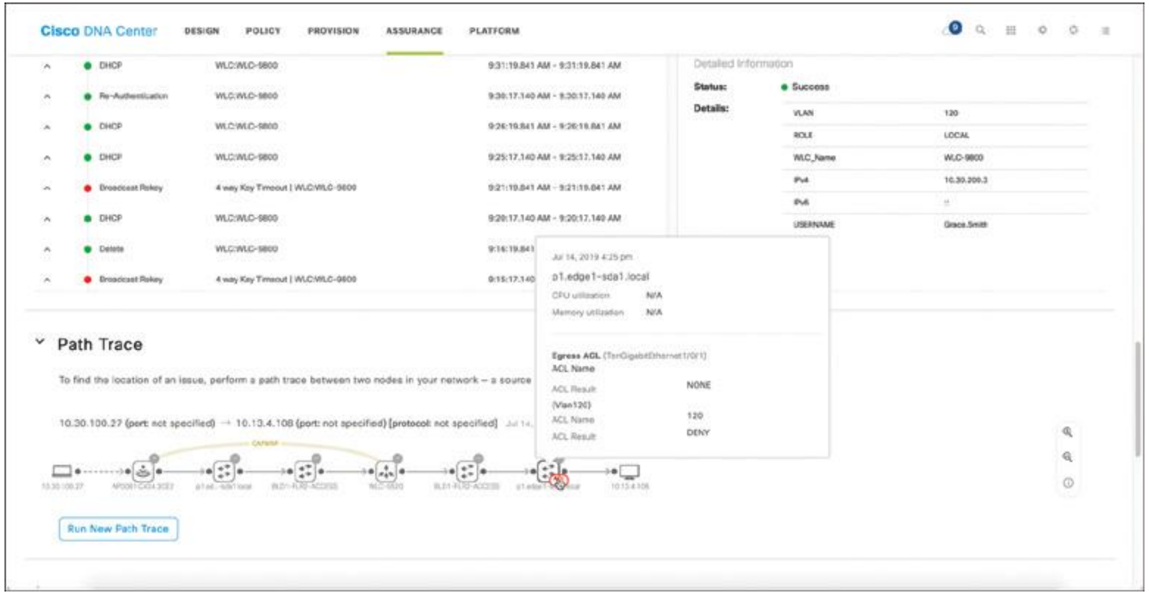
Run New Path Trace

Cisco DNA Center Assurance
Path Trace ACL Information

By hovering over the ACL entry, the following information can be seen:

- The ACL's name
- The interface the ACL is applied to
- The direction (ingress or egress)
- The ACL result (permit or deny)

Figure 24-13 shows the access list information found in this example.



● DHCP	WLC:WLC-9800	9:31:19.841 AM - 9:31:19.841 AM
● Re-Authentication	WLC:WLC-9800	9:30:17.140 AM - 9:30:17.140 AM
● DHCP	WLC:WLC-9800	9:26:19.841 AM - 9:26:19.841 AM
● DHCP	WLC:WLC-9800	9:25:17.140 AM - 9:25:17.140 AM
● Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:21:19.841 AM - 9:21:19.841 AM
● DHCP	WLC:WLC-9800	9:20:17.140 AM - 9:20:17.140 AM
● Delete	WLC:WLC-9800	9:16:19.841
● Broadcast Rekey	4 way Key Timeout | WLC:WLC-9800	9:15:17.140

Detailed Information

Status: ● Success

Details:

VLAN	120
ROLE	LOCAL
WLC_Name	WLC-9800
IPv4	10.30.200.3
IPv6	::
USERNAME	Grace.Smith

Path Trace

To find the location of an issue, perform a path trace between two nodes in your network – a source

10.30.100.27 (port: not specified) → 10.13.4.108 (port: not specified) [protocol: not specified] Jul 14,

Jul 14, 2019 4:25 pm

p1.edge1-sda1.local

CPU utilization	N/A
Memory utilization	N/A

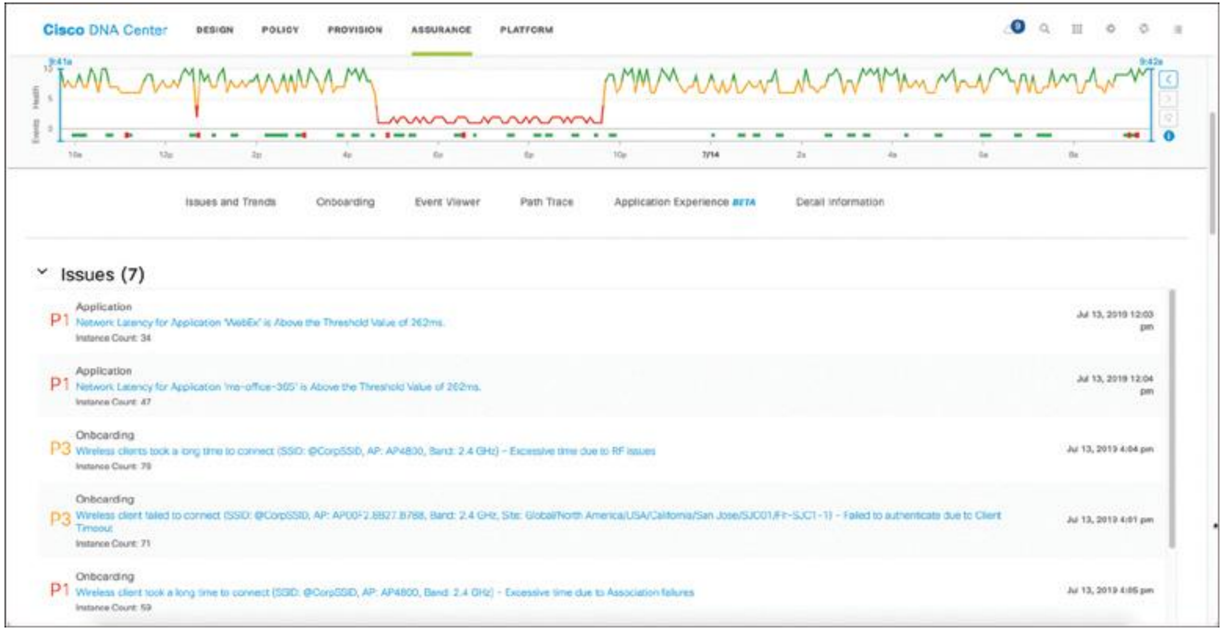
Egress ACL (TenGigabitEthernet1/0/1)

ACL Name	
ACL Result	NONE
(Vlan120)	
ACL Name	120
ACL Result	DENY

Cisco DNA Center Assurance
Client 360 Issues

By clicking on one of the issues listed under Grace’s Client 360 view, such as the P1 Onboarding issue, a user can investigate the root cause of the issue.

Figure 24-14 shows the issues that are impacting Grace.



Issues (7)

P1 Application
Network Latency for Application 'WebEx' is Above the Threshold Value of 262ms.
Instance Count: 34
Jul 13, 2019 12:03 pm

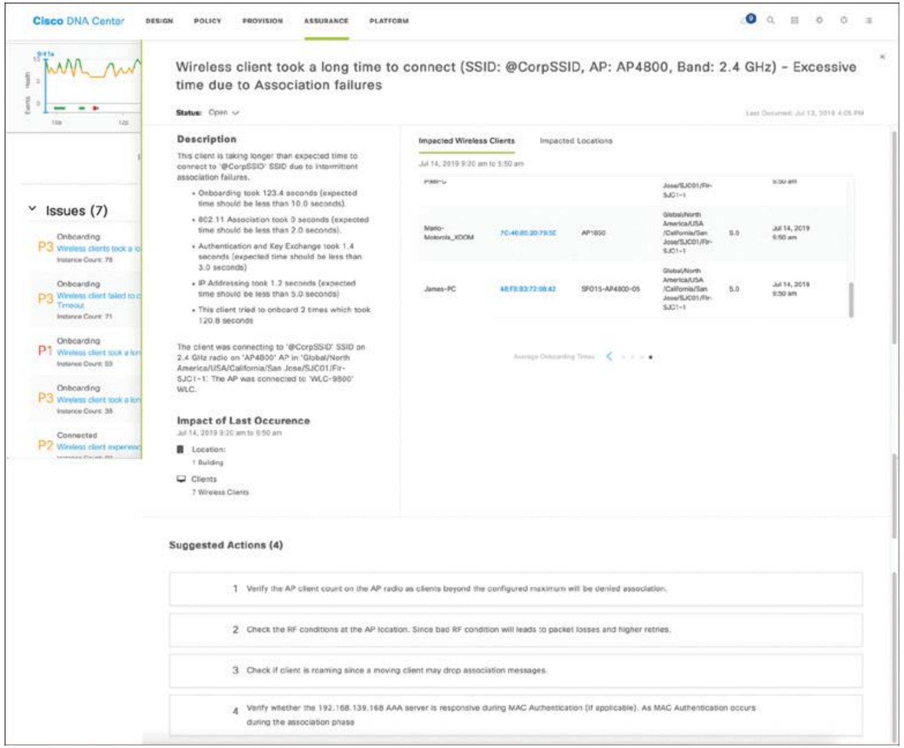
P1 Application
Network Latency for Application 'ms-office-365' is Above the Threshold Value of 262ms.
Instance Count: 47
Jul 13, 2019 12:04 pm

P3 Onboarding
Wireless clients took a long time to connect (SSID: @CorpSSID, AP: AP4800, Band: 2.4 GHz) - Excessive time due to RF issues
Instance Count: 79
Jul 13, 2019 4:04 pm

P3 Onboarding
Wireless client failed to connect (SSID: @CorpSSID, AP: AP00F2.8B27.B788, Band: 2.4 GHz, Site: Global/North America/USA/California/San Jose/SJC01/Flr-SJC1-1) - Failed to authenticate due to Client Timeout
Instance Count: 71
Jul 13, 2019 4:01 pm

P1 Onboarding
Wireless client took a long time to connect (SSID: @CorpSSID, AP: AP4800, Band: 2.4 GHz) - Excessive time due to Association failures
Instance Count: 59
Jul 13, 2019 4:05 pm

Cisco DNA Center Assurance
Client 360 Root Cause and Remediation Steps



Wireless client took a long time to connect (SSID: @CorpSSID, AP: AP4800, Band: 2.4 GHz) - Excessive time due to Association failures

Status: Open

Last Occurred: Jul 13, 2019 4:05 PM

Issues (7)

- Onboarding P3 Wireless clients took a lo Instance Count: 78
- Onboarding P3 Wireless client failed to c Timeout Instance Count: 71
- Onboarding P1 Wireless client took a lon Instance Count: 53
- Onboarding P3 Wireless client took a lon Instance Count: 38
- Connected P2 Wireless client experienc

Description

This client is taking longer than expected time to connect to '@CorpSSID' SSID due to intermittent association failures.

- Onboarding took 123.4 seconds (expected time should be less than 10.0 seconds).
- 802.11 Association took 0 seconds (expected time should be less than 2.0 seconds).
- Authentication and Key Exchange took 1.4 seconds (expected time should be less than 3.0 seconds)
- IP Addressing took 1.2 seconds (expected time should be less than 5.0 seconds)
- This client tried to onboard 2 times which took 120.8 seconds

The client was connecting to '@CorpSSID' SSID on 2.4 GHz radio on 'AP4800' AP in 'Global/North America/USA/California/San Jose/SJC01/Flr-SJC1-1'. The AP was connected to 'WLC-9800' WLC.

Impact of Last Occurence

Jul 14, 2019 9:20 am to 9:50 am

Location:
1 Building

Clients
7 Wireless Clients

Impacted Wireless Clients | Impacted Locations

Jul 14, 2019 9:20 am to 9:50 am

Pixel-C			Jose/SJC01/Flr-SJC1-1		9:50 am
Mario-Motorola_XOOM	7C:46:85:20:79:5E	AP1850	Global/North America/USA /California/San Jose/SJC01/Flr-SJC1-1	5.0	Jul 14, 2019 9:50 am
James-PC	48:F8:B3:72:08:42	SF015-AP4800-05	Global/North America/USA /California/San Jose/SJC01/Flr-SJC1-1	5.0	Jul 14, 2019 9:30 am

Average Onboarding Times

Suggested Actions (4)

1. Verify the AP client count on the AP radio as clients beyond the configured maximum will be denied association.
2. Check the RF conditions at the AP location. Since bad RF condition will leads to packet losses and higher retries.
3. Check if client is roaming since a moving client may drop association messages.
4. Verify whether the 192.168.139.168 AAA server is responsive during MAC Authentication (if applicable). As MAC Authentication occurs during the association phase

Figure 24-15 *Cisco DNA Center Assurance Client 360 Root Cause and Guided Remediation Steps*

Prepare for the Exam

Prepare for the Exam

Key Topics for Chapter 24

Description	
Using tools such as **ping** and extended **ping**	Leveraging NetFlow information to analyze traffic statistics
Using tools such as **traceroute** and extended **traceroute**	Understanding tools such as SPAN, RSPAN and ERSPAN for capturing network traffic
Troubleshooting using debugging and conditional debugging	Configuring tools such as SPAN, RSPAN, and ERSPAN to capture network traffic
OSPF Network Types and Hello/Dead Intervals	Leveraging on-box monitoring tools such as IP SLA to validate network and application performance
Using SNMP for monitoring and troubleshooting	Using DNA Center enhanced workflows to simplify design, provisioning, and troubleshooting of a network

Prepare for the Exam
Key Terms for Chapter 24

Key Terms
ERSPAN
IP SLA
NetFlow
Path Trace
RSPAN
Simple Network Management Protocol (SNMP)
SPAN
syslog