Discovery 10: Migrate a CDM Device

Introduction

In this activity, you will learn how to migrate a device to a new version of a NED. You will migrate a Cisco IOS router from the NED version 6.21 to 6.85. In addition, you will learn how to modify a service to work with the new NED ID.

After completing this activity, you will be able to meet these objectives:

- Migrate a device to a new NED.
- Update an existing service for it to work with the new NED.

Job Aid

The following job aid is available to help you complete the lab activities:

- This Lab Guide

The following table contains passwords that you might need.

Device	Username	Password
student-vm	student	1234QWer
nso-server	student	1234QWer

Lab Topology Information

Your lab session is your own personal sandbox. Whatever you do in your session will not be reflected in anyone else's session. Your lab environment is a Linux server (Student-VM) acting as a jumphost and a Linux server (NSO-server) acting as a NSO server. NSO server includes a NetSIM router. This will be the network that you will orchestrate with your NSO.

Required Resources

The following resources and equipment are required for completing the activities in this lab guide:

- PC or laptop with a web browser
- Access to the internet

Command List

The following are the most common commands that you will need:

Linux Shell:

Command	Comment
source /opt/ncs/	Source NSO environmental variable in Docker container.

Command	Comment
ncs-6.1/ncsrc	
ls|ll	Display contents of the current directory.
cd	Move directly to user home directory.
cd ..	Exit out of current directory.
cd test	Move into the "test" folder which is a subfolder of the current directory.
cd /home/student	Move into the "nso300" folder by specifying the direct path to it starting from the root of the directory system.
ncs_cli -C	Log in to NSO CLI directly from local server.

NSO CLI:

Command	Comment
switch cli	Change CLI style.
show ?	Display all command options for current mode.
configure	Enter configuration mode.
commit	Commit new configuration (configuration mode only command).
show configuration	Display new configuration that has not yet been committed (configuration mode only command).

Makefile commands for Docker environment:

Command	Comment
make build	Builds the main NSO Docker image.
make testenv-start	Starts the NSO Docker environment.
make testenv-stop	Stops the NSO Docker environment.
make testenv-build	Recompiles and reloads the NSO packages.
make testenv-cli	Enters the NSO CLI of the NSO Docker container.
make testenv-shell	Enters the Linux shell of the NSO Docker container.
make dev-shell	Enters the Linux shell of the NSO Docker development container.

Command Syntax Reference

This lab guide uses the following conventions for **command syntax**:

Formatting	Description and Examples
show running config	Commands in steps use this formatting.
Example	Type **show running config**

Formatting	Description and Examples
Example	Use the **name** command.
`show running config`	Commands in CLI outputs and configurations use this formatting.
highlight	CLI output that is important is highlighted.
Example	`student@student-vm:~$ ncs --version` `6.1`
Example	Save your current configuration as the default **startup config**. `Router Name# copy running startup`
brackets ([ ])	Indicates optional element. You can choose one of the options.
Example:	`(config-if)# frame-relay lmi-type {ansi|cisco|q933a}`
italics font	Arguments for which you supply values.
Example	Open file **ip tcp window-size** *bytes*
angle brackets (<>)	In contexts that do not allow italics, arguments for which you supply values are enclosed in angle brackets [<>]. Do not type the brackets when entering the command.
Example	If the command syntax is **ping** <*ip_address*>, you enter ping *10.0.0.102*
string	A non-quoted set of characters. Type the characters as-is.
Example	(config)# **hostname MyRouter**
vertical line (|)	Indicates that you enter one of the choices. The vertical line separates choices. Do not type the vertical line when entering the command.
Example	If the command syntax is **show ip route|arp**, you enter either **show ip route** or **show ip arp**, but not both.

Lab Topology Information

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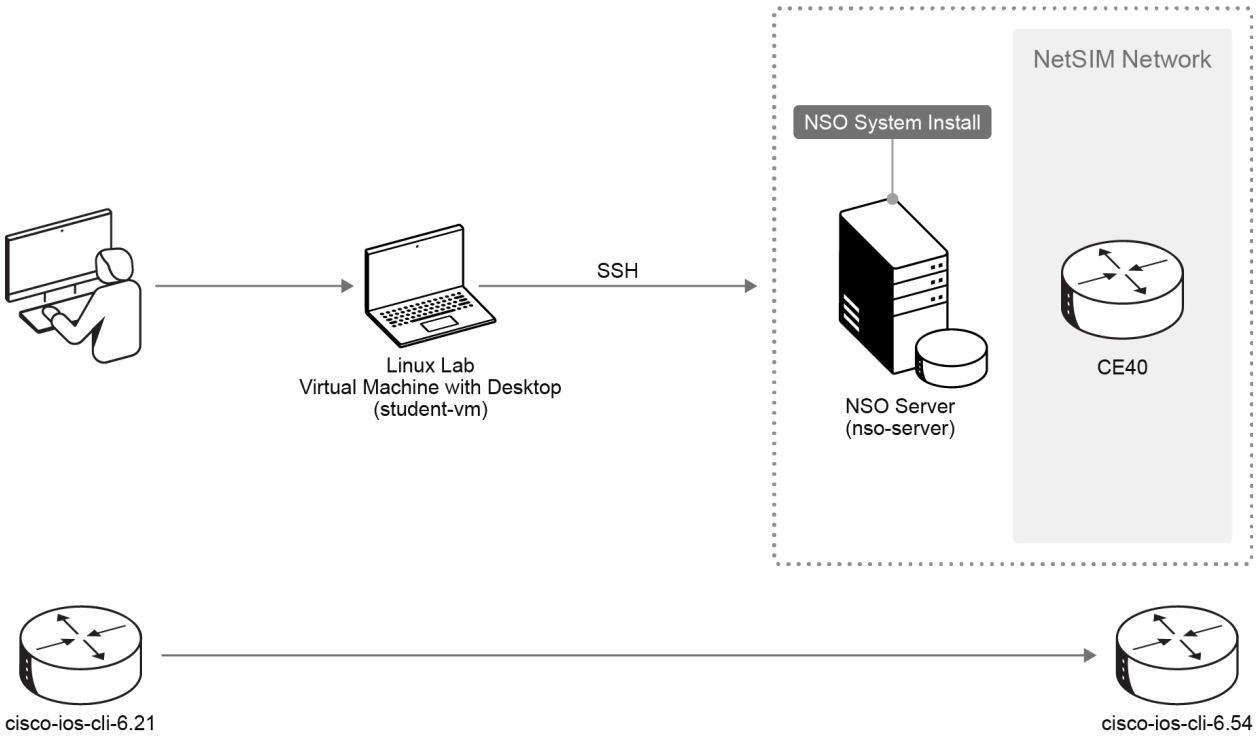
Topology



Task 1: Migrate a Device to a New NED

In this task, you will deploy a NetFlow service instance to a Cisco IOS device using an older version of a NED. You will then examine the implications of a NED migration for this service.

Activity

Complete these steps:

Step 1

Connect to the Student-VM.

You can connect to the server either by choosing the **Student-VM** from the device list or by clicking on the **Student-VM** icon in the topology map.

Step 2

Open the terminal window.

Open the terminal window by clicking the **Terminal** icon in the bottom bar.

```
student@student-vm:~$
```

Step 3

Connect to the **nso-server** NSO server.

Connect to the **nso-server** NSO server with the **student** user using the SSH client.

The authentication is already preconfigured with public key authentication, therefore the password is not needed. The prompt will change, stating that you are now connected to the nso-server.

```
student@student-vm:~$ ssh student@nso-server
Last login: Tue Oct  3 09:14:42 2023 from 10.0.0.102
student@nso-server:~$
```

Step 4

Connect to the NSO CLI.

Use the **ncs_cli -C** command.

```
student@nso-server:~$ ncs_cli -C

User student last logged in 2024-02-05T09:52:53.80762+00:00, to nso-
server, from 100.64.0.11 using cli-ssh
student connected from 100.64.0.11 using ssh on nso-server
student@ncs#
```

Step 5

Display the list of devices. Verify that the CE40 device is using an older version of the Cisco IOS NED, **cisco-ios.cli-6.21**.

Use the **show devices list** command.

```
student@ncs# show devices list
NAME  ADDRESS    DESCRIPTION  NED ID              ADMIN STATE
-------------------------------------------------------------
CE40  127.0.0.1  -            cisco-ios-cli-6.21  unlocked
student@ncs#
```

Step 6

Exit the NSO CLI.

Use the **exit** command.

```
admin@ncs# exit
student@student-vm:~$
```

Step 7

Copy the **netflow** package from **~/packages** to the **packages** folder inside the NSO running directory **/var/opt/ncs/packages**. Compile the package after you have copied it.

Use the commands provided in the following output.

```
student@nso-server:~$ cp -r packages/netflow /var/opt/ncs/packages/
student@nso-server:~$ make -C /var/opt/ncs/packages/netflow/src/
make: Entering directory '/var/opt/ncs/packages/netflow/src'
mkdir -p ../load-dir
/opt/ncs/current/bin/ncsc  `ls netflow-ann.yang  > /dev/null 2>&1 &&
echo "-a netflow-ann.yang"` \
              -c -o ../load-dir/netflow.fxs yang/netflow.yang
make: Leaving directory '/var/opt/ncs/packages/netflow/src'
student@nso-server:~$
```

Step 8

Inspect the service YANG model.

This is how the contents of the file should appear when you open it. You can see that the package is used to create a service that exports NetFlow data to a specific destination.

```
student@nso-server:~$ cat /var/opt/ncs/packages/netflow/src/yang/
netflow.yang
module netflow {
  namespace "http://cisco.com/example/netflow";
  prefix netflow;

  import ietf-inet-types {
    prefix inet;
  }
  import tailf-ncs {
    prefix ncs;
  }
  import tailf-common {
    prefix tailf;
  }
  augment /ncs:services {
    list netflow {
      description "Export NetFlow service";
      key device;

      uses ncs:service-data;
      ncs:servicepoint "netflow";

      leaf device {
        tailf:info "Device to export NetFlow data from";
        type leafref {
          path "/ncs:devices/ncs:device/ncs:name";
        }
      }

      leaf destination {
        tailf:info "Address to export NetFlow data to";
        type inet:ipv4-address;
      }
    }
  }
```

```
}
student@nso-server :~$
```

Step 9

Connect to the NSO CLI and reload the packages.

Use the **ncs_cli -C** command to connect and the **packages reload** command to reload the packages.

```
student@nso-server:~$ ncs_cli -C

User student last logged in 2024-02-05T11:01:18.91634+00:00, to nso-
server, from 100.64.0.11 using cli-ssh
student connected from 100.64.0.11 using ssh on nso-server
student@ncs# packages reload

>>> System upgrade is starting.
>>> Sessions in configure mode must exit to operational mode.
>>> No configuration changes can be performed until upgrade has
completed.
>>> System upgrade has completed successfully.
reload-result {
    package cisco-ios-cli-6.21
    result true
}
reload-result {
    package netflow
    result true
}
student@ncs#
System message at 2024-02-05 11:04:14...
    Subsystem stopped: ncs-dp-1-cisco-ios-cli-6.21:IOSDp
student@ncs#
System message at 2024-02-05 11:04:14...
    Subsystem started: ncs-dp-2-cisco-ios-cli-6.21:IOSDp
student@ncs#
```

Step 10

Deploy a NetFlow service instance on the **CE40** device. Use the **10.100.0.1** address as the destination address.

Use the commands provided in the following output.

```
student@ncs# config
Entering configuration mode terminal
student@ncs(config)# services netflow CE40 destination 10.100.0.1
student@ncs(config-netflow-CE40)#
```

Step 11

Display the **dry-run** of the changes applied and then commit the transaction. Exit the NSO CLI after that.

Use the commands provided in the following output.

```
student@ncs(config-netflow-CE40)# commit dry-run
cli {
    local-node {
        data  devices {
                  device CE40 {
                      config {
                          ip {
                              flow-export {
                                  source {
              +                       GigabitEthernet 1/0;
                                  }
              +                   version 5;
                                  destination {
              +                       ip 10.100.0.1;
                                  }
                              }
                          }
                          interface {
              +               GigabitEthernet 1/0 {
              +               }
                          }
                      }
                  }
               }
               services {
              +    netflow CE40 {
              +        destination 10.100.0.1;
              +    }
               }
    }
}
student@ncs(config-netflow-CE40)# commit
Commit complete.
student@ncs(config-netflow-CE40)# exit
student@ncs# exit
student@nso-server:~$
```

Step 12

Copy the new Cisco IOS NED (version 6.85) from **~/neds** to the **packages** folder in NSO running directory.

Use the **cp** command.

```
student@nso-server:~$ cp -r neds/cisco-ios-cli-6.85 /var/opt/ncs/
packages/
student@nso-server:~$
```

Step 13

Enter the NSO CLI and reload the packages.

You will notice that the NetFlow package fails to reload now, which triggers an alarm.

The conflict occurs in the NetFlow package template, since the new NED handles the NetFlow configuration differently than the old one.

```
student@nso-server:~$ ncs_cli -C

User student last logged in 2024-02-05T11:30:45.478459+00:00, to nso-
server, from 100.64.0.11 using cli-ssh
student connected from 100.64.0.11 using ssh on nso-server
student@ncs# packages reload

>>> System upgrade is starting.
>>> Sessions in configure mode must exit to operational mode.
>>> No configuration changes can be performed until upgrade has
completed.
>>> System upgrade has completed successfully.
reload-result {
    package cisco-ios-cli-6.21
    result true
}
reload-result {
    package cisco-ios-cli-6.85
    result true
}
reload-result {
    package netflow
    result false
    info netflow-template.xml:12 the tag: version is different for ned-
ids: cisco-ios-cli-6.21:cisco-ios-cli-6.21, cisco-ios-cli-6.85:cisco-
ios-cli-6.85
}
student@ncs#
System message at 2024-02-05 11:34:16...
    Subsystem stopped: ncs-dp-1-cisco-ios-cli-6.21:IOSDp
student@ncs#
System message at 2024-02-05 11:34:16...
    Subsystem started: ncs-dp-2-cisco-ios-cli-6.21:IOSDp
student@ncs#
System message at 2024-02-05 11:34:16...
    Subsystem started: ncs-dp-3-cisco-ios-cli-6.85:IOSDp
student@ncs# *** ALARM package-load-failure: netflow-template.xml:12
the tag: version is different for ned-ids: cisco-ios-cli-6.21:cisco-
ios-cli-6.21, cisco-ios-cli-6.85:cisco-ios-cli-6.85
student@ncs#
```


You can display the changes to a NED by studying the change log, located in the **CHANGES** file within each NED.

Step 14

Observe the differences between two NEDs by using the **dry-run** of the **migrate** command.

Find the changes that happen for the NetFlow configuration.

```
student@ncs# devices migrate device [ CE40 ] old-ned-id cisco-ios-
cli-6.21 new-ned-id cisco-ios-cli-6.85 verbose dry-run
migrate-result {
    device CE40
    result true
}
modified-path {
    path /ios:spd/headroom
    info leaf/leaf-list type has changed
}
modified-path {
    path /ios:transceiver/type/all/monitoring/interval
    info leaf/leaf-list type has changed from uint16 to uint32
}

...
...

modified-path {
    path /ios:platform/punt-policer/rate
    info leaf/leaf-list type has changed
}
modified-path {
    path /ios:foobar
    info sub-tree has been deleted
}
student@ncs#
```

There are many changes between the two device model versions. To find the changes that affect the Netflow configuration, you must first interpret the package reload error message from the previous step:

```
netflow-template.xml:12 the tag: version is different for ned-ids:
cisco-ios-cli-6.21:cisco-ios-cli-6.21, cisco-ios-cli-6.85:cisco-ios-
cli-6.85
```

The error message tells you that there is an error in the line 12 of the configuration template netflow-template.xml. This is related to the **flow-export** configuration, so you may choose only the lines that are starting with **<flow-export>** XML tag, as defined in the configuration template:

```
01 <?xml version="1.0"?>
02 <config-template xmlns="http://tail-f.com/ns/config/1.0"
          servicepoint="netflow">
03  <devices xmlns="http://tail-f.com/ns/ncs">
04    <device>
05      <name>{/device}</name>
06      <config>
07        <ip xmlns="urn:ios">
08          <flow-export>
```

```
09            <source>
10              <GigabitEthernet>1/0</GigabitEthernet>
11            </source>
12            <version>5</version>
13            <destination>
14              <ip>{/destination}</ip>
15            </destination>
16          </flow-export>
17        </ip>
18        <interface xmlns="urn:ios">
19          <GigabitEthernet>
20            <name>1/0</name>
21          </GigabitEthernet>
22        </interface>
23      </config>
24    </device>
25  </devices>
26 </config-template>
```

Step 15

Run the dry-run of the migrate command again, with an additional condition "**begin flow-export**," which will display the lines beginning with a line that includes the "flow-export" statement.

The "destination" node has been changed from a non-presence container to a list and the "version" node has been changed from a leaf to a non-presence container. Also, "ip" and "port" nodes have been modified. These changes are usually incompatible with the older configuration.

```
student@ncs# devices migrate device [ CE40 ] old-ned-id cisco-ios-
cli-6.21 new-ned-id cisco-ios-cli-6.85 verbose dry-run | begin flow-
export | more
    path /ios:ip/flow-export/destination/ip
    info leaf is now a list key
}
modified-path {
    path /ios:ip/flow-export/destination/port
    info leaf is now a list key
}
modified-path {
    path /ios:ip/flow-export/destination
    info node type has changed from non-presence container to list
}
modified-path {
    path /ios:ip/flow-export/version
    info node type has changed from leaf to non-presence container
}
modified-path {
    path /ios:ip/ssh/client/algorithm/encryption
    info leaf/leaf-list type has changed
}
modified-path {
    path /ios:ip/ssh/client/algorithm/mac
    info leaf/leaf-list type has changed
}
```

```
...

modified-path {
    path /ios:ip/icmp/rate-limit/unreachable/DF
    info sub-tree has been deleted
}
modified-path {
--More-- [32 ]
```


You can abort further output by pressing the **Ctrl+C** key combination.

Step 16

Display the full device configuration with the addition of service metadata, which shows you the number of backpointers to existing services.

Use the command provided in the following output.

```
student@ncs# show running-config devices device CE40 config ip flow-
export | display xml | display service-meta-data
<config xmlns="http://tail-f.com/ns/config/1.0">
  <devices xmlns="http://tail-f.com/ns/ncs">
    <device>
      <name>CE40</name>
      <config>
        <ip xmlns="urn:ios">
          <flow-export>
            <source>
              <GigabitEthernet refcounter="1" >1/0</GigabitEthernet>
            </source>
            <version refcounter="1" >5</version>
            <destination>
              <ip refcounter="1" >10.100.0.1</ip>
            </destination>
          </flow-export>
        </ip>
      </config>
    </device>
  </devices>
</config>
student@ncs#
```

Step 17

Migrate the device to the new NED ID, this time without the **dry-run** parameter. To have the least amount of service downtime as possible, you should also use the **no-networking** parameter, which prevents any southbound communication to the devices. This means that the CDB and the devices will be out of sync for the time being, until the affected services are fixed, redeployed, and the device configuration is synchronized.

Use the command provided in the following output.

As an alternative approach to the CDM device migration, you can prepare and update the service in advance, to avoid going out of sync. This requires an additional device that already uses the newer version of the NED, which allows you to create the configuration template for the updated service.

```
student@ncs# devices migrate device [ CE40 ] old-ned-id cisco-ios-
cli-6.21 new-ned-id cisco-ios-cli-6.85 no-networking
migrate-result {
    device CE40
    result true
}
modified-path {
    path /ios:spd/headroom
    info leaf/leaf-list type has changed
}
modified-path {
    path /ios:transceiver/type/all/monitoring/interval
    info leaf/leaf-list type has changed from uint16 to uint32
}
modified-path {
    path /ios:platform/punt-policer/rate
    info leaf/leaf-list type has changed
}

...

modified-path {
    path /ios:foobar
    info sub-tree has been deleted
}
student@ncs#
```

Step 18

Verify that the CE40 device is using the cisco-ios-cli-6.85 NED.

Use the **show devices list** command.

```
student@ncs# show devices list
NAME  ADDRESS    DESCRIPTION  NED ID              ADMIN STATE
-----------------------------------------------------------------
CE40  127.0.0.1  -            cisco-ios-cli-6.85  unlocked
student@ncs#
```

Activity Verification

You have completed this task when you attain these results:

- The CE40 device is using the cisco-ios-cli-6.85 NED.

Task 2: Update the Service After NED Migration

In this task, you will update the existing service so that it works with both NED versions.

Activity

Complete these steps:

Step 1

Examine the device configuration for service backpointers again.

The configuration elements in which the change occurred are no longer linked back to the service. The only remaining backpointer is the one on the "source" element. The version node was also removed because it has a different structure now, which is not compatible with the previous data model.

```
student@ncs# config
Entering configuration mode terminal
student@ncs(config)# show full-configuration devices device CE40 config
ip flow-export | display xml | display service-meta-data
<config xmlns="http://tail-f.com/ns/config/1.0">
  <devices xmlns="http://tail-f.com/ns/ncs">
    <device>
      <name>CE40</name>
      <config>
        <ip xmlns="urn:ios">
          <flow-export>
            <source>
              <GigabitEthernet refcounter="1">1/0</GigabitEthernet>
            </source>
          </flow-export>
        </ip>
      </config>
    </device>
  </devices>
</config>
student@ncs(config)#
```

Step 2

Configure the missing configuration for NetFlow data exporting on the CE40 device, which now uses a new NED.

The destination now requires a version in a new format, and a destination port. Use the default 2055 port. Display the changes by using the **dry-run commit** parameter.

```
student@ncs(config)# devices device CE40 config ip flow-export
destination 10.100.0.1 2055
student @ncs(config-config)# ip flow-export version 5
student @ncs(config-config)# commit dry-run outformat xml
result-xml {
    local-node {
        data <devices xmlns="http://tail-f.com/ns/ncs">
               <device>
                 <name>CE40</name>
                 <config>
```

```
                    <ip xmlns="urn:ios">
                      <flow-export>
                        <version>
                          <version>5</version>
                        </version>
                        <destination>
                          <ip>10.100.0.1</ip>
                          <port>2055</port>
                        </destination>
                      </flow-export>
                    </ip>
                  </config>
                </device>
              </devices>
    }
}
student@ncs(config-config)#
```

Step 3

Do not commit the changes and exit the NSO CLI.

Use the commands provided in the following output.

```
student@ncs(config-config)# abort
student@ncs# exit
student@nso-server:~$
```

Step 4

Open the XML template of the Netflow service. You will now modify the XML template to support both versions of the NED.

Since both versions use the "urn:ios" namespace, you will have to make the distinction as to which version of a NED to use for which part of the configuration.

```
student@nso-server:~$ nano /var/opt/ncs/packages/netflow/templates/
netflow-template.xml
```

Step 5

You can use the **<?if-ned-id?>** template element to process the instructions to set the configuration for a specific NED.

Add an instruction for the old **cisco-ios-cli-6.21** NED for the existing flow-export configuration and add another instruction for the new **cisco-ios-cli-6.85 NED** configuration, a combination of migrated changes and dry-run.

```
<?xml version="1.0"?>
<config-template xmlns="http://tail-f.com/ns/config/1.0"
servicepoint="netflow">
  <devices xmlns="http://tail-f.com/ns/ncs">
```

```
    <device>
      <name>{/device}</name>
      <config>
        <ip xmlns="urn:ios">
          <flow-export>
            <source>
              <GigabitEthernet>1/0</GigabitEthernet>
            </source>
            <?if-ned-id cisco-ios-cli-6.21:cisco-ios-cli-6.21?>
              <version>5</version>
              <destination>
                <ip>{/destination}</ip>
              </destination>
            <?elif-ned-id cisco-ios-cli-6.85:cisco-ios-cli-6.85?>
              <version>
                <version>5</version>
              </version>
              <destination>
                <ip>{/destination}</ip>
                <port>2055</port>
              </destination>
            <?end?>
          </flow-export>
        </ip>
        <interface xmlns="urn:ios">
          <GigabitEthernet>
            <name>1/0</name>
          </GigabitEthernet>
        </interface>
      </config>
    </device>
  </devices>
</config-template>
```

Step 6

Save the file.

Use the **Ctrl+X** keyboard combination to exit and confirm with **Yes** to save the file changes.

Step 7

Enter NSO CLI and reload the packages.

No error should now be present for the netflow package.

```
student@nso-server:~$ ncs_cli -C

User student last logged in 2024-02-05T11:33:05.926512+00:00, to nso-
server, from 100.64.0.11 using cli-ssh
student connected from 100.64.0.11 using ssh on nso-server

student@ncs# packages reload
reload-result {
    package cisco-ios-cli-6.21
    result true
```

```
}
reload-result {
    package cisco-ios-cli-6.85
    result true
}
reload-result {
    package netflow
    result true
}
student@ncs#
System message at 2024-02-05 11:51:07...
    Subsystem stopped: ncs-dp-2-cisco-ios-cli-6.21:IOSDp
student@ncs#
System message at 2024-02-05 11:51:07...
    Subsystem stopped: ncs-dp-3-cisco-ios-cli-6.85:IOSDp
student@ncs#
System message at 2024-02-05 11:51:07...
    Subsystem started: ncs-dp-4-cisco-ios-cli-6.21:IOSDp
student@ncs#
System message at 2024-02-05 11:51:07...
    Subsystem started: ncs-dp-5-cisco-ios-cli-6.85:IOSDp
student@ncs#
```

Step 8

Synchronize the CDB configuration to the CE40 device and re-deploy the netflow service.

Use the **sync-to** and **re-deploy** actions.

```
student@ncs# devices device CE40 sync-to
result true
student@ncs# services netflow CE40 re-deploy
student@ncs#
System message at 2024-02-05 11:52:05...
Commit performed by student via ssh using cli.
student@ncs#
```


Re-deploy action will evaluate if any of the configuration elements of the service are missing on the CE40 device and add them to the device configuration again.

Step 9

Verify the configuration of the re-deployed netflow service.

The output should resemble the following output.

```
student@ncs# show running-config devices device CE40 config ip flow-
export | display xml
<config xmlns="http://tail-f.com/ns/config/1.0">
  <devices xmlns="http://tail-f.com/ns/ncs">
    <device>
```

```
      <name>CE40</name>
      <config>
        <ip xmlns="urn:ios">
          <flow-export>
            <source>
              <GigabitEthernet>1/0</GigabitEthernet>
            </source>
            <version>
              <version>5</version>
            </version>
            <destination>
              <ip>10.100.0.1</ip>
              <port>2055</port>
            </destination>
          </flow-export>
        </ip>
      </config>
    </device>
  </devices>
</config>
student@ncs#
```

Activity Verification

You have completed this task when you attain these results:

- The netflow service has been successfully redeployed using the new cisco-ios-cli-6.85 NED.

Which template processing instruction must be used in XML to instruct the NSO to map the configuration just for a specific NED version?

- <?for?>
- <?if?>
- <?if-ned-id?>
- <?set-context-node?>