The World of NSO Web UI

DEVLIT-1259

Speakers:

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1 - Cisco Network Services Orchestrator (NSO) Requirements

In this workbook you will find a step-by-step guide that goes from the NSO installation to its operations basics, always using the WEB-UI.

NSO can be installed on a **MAC**, or **Linux**. With the **NSO 6.1** launch we started offering as well native **docker** support. (guide can be found in nso admin-guide)

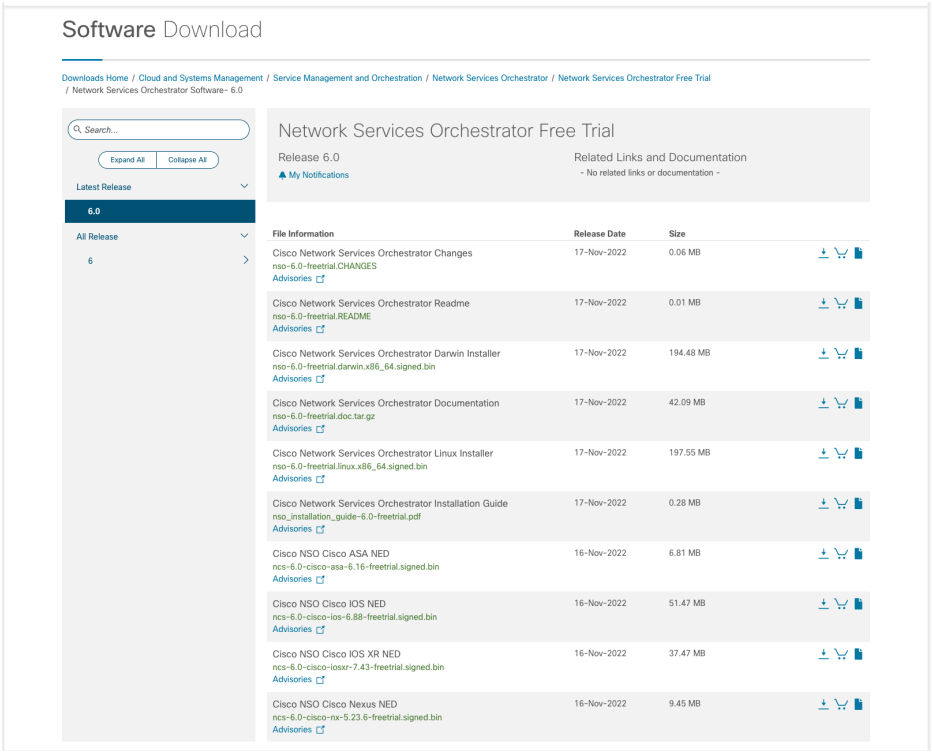
Opening this link, you will find the operating system requirements and how to install them.

https://developer.cisco.com/docs/nso/#!getting-and-installing-nso/requirements

1.1 - Install NSO and Network Element Drivers (NEDs)

Download NSO for your Operating System and the NEDs (for trial purposes, only NSO 6.0 is available)

https://developer.cisco.com/docs/nso/#!getting-and-installing-nso/download-your-nso-free-trial-installer-and-cisco-neds



Unpack NSO

```
user@Pc # % sh nso-6.0-freetrial.darwin.x86_64.signed.bin
Unpacking...
Verifying signature...
Retrieving CA certificate from
http://www.cisco.com/security/pki/certs/crcam2.cer ...
```

```
Successfully retrieved and verified crcam2.cer.
Retrieving SubCA certificate from
http://www.cisco.com/security/pki/certs/innerspace.cer ...
Successfully retrieved and verified innerspace.cer.
Successfully verified root, subca and end-entity certificate chain.
Successfully fetched a public key from tailf.cer.
Successfully verified the signature of nso-6.0.darwin.x86_64.installer.bin
using tailf.cer
```

After unpacking and verifying the signature you will get the installer.bin

Execute the “nso-6.1.darwin.x86_64.installer.bin” with the “—local-install” flag and choose the installation directory.

```
user@Pc # % sh nso-6.0.darwin.x86_64.installer.bin --local-install ~/NSO-DD
INFO  Using temporary directory
/var/folders/48/yvryv4r96jq9n8gt3hpm13w40000gn/T//ncs_installer.11084 to
stage NCS installation bundle
INFO  Unpacked ncs-6.0 in /Users/user/NSO-DD
INFO  Found and unpacked corresponding DOCUMENTATION_PACKAGE
INFO  Found and unpacked corresponding EXAMPLE_PACKAGE
INFO  Found and unpacked corresponding JAVA_PACKAGE
INFO  Generating default SSH hostkey (this may take some time)
INFO  SSH hostkey generated
INFO  Generating self-signed certificates for HTTPS
INFO  Environment set-up generated in /Users/user/NSO-DD/ncsrc
INFO  NSO installation script finished
INFO  Found and unpacked corresponding NETSIM_PACKAGE
INFO  NCS installation complete
```

Go to the installation folder and source NSO

```
user@Pc # % cd ~/NSO-DD
user@Pc NSO-DD % source ncsrc
```

Execute the NSO Setup script

```
user@Pc NSO-DD % ncs-setup --dest nso-instance
```

Change directory to the “nso-instance” folder and execute the command “ncs”

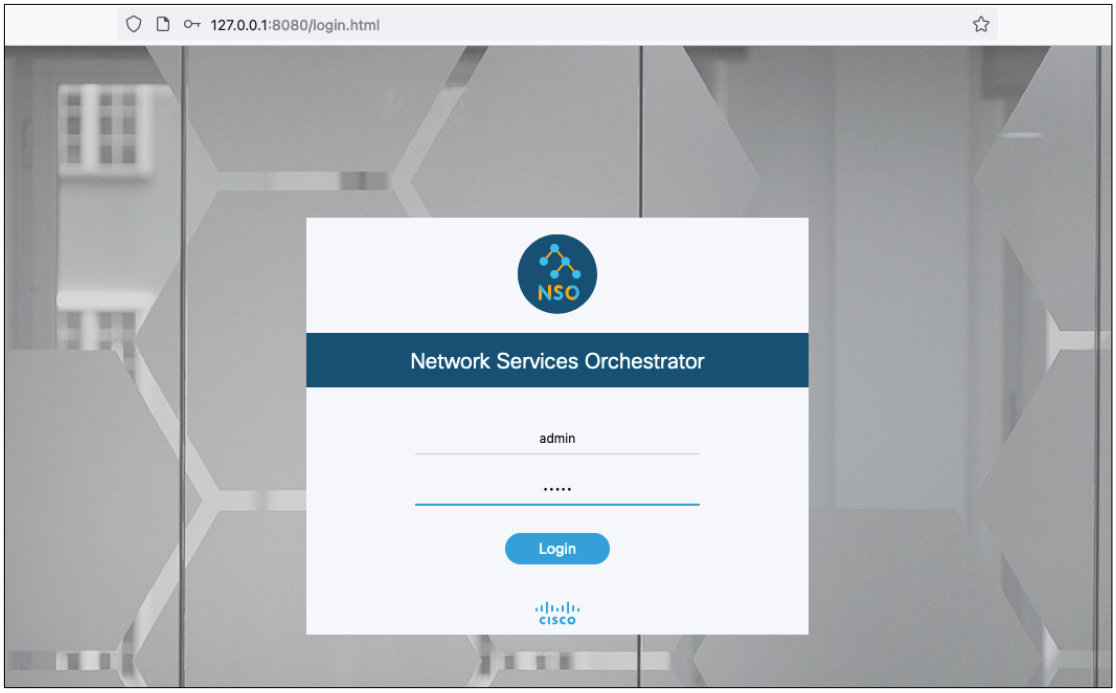
```
user@Pc NSO-DD % cd nso-instance
user@Pc nso-instance % ncs
```

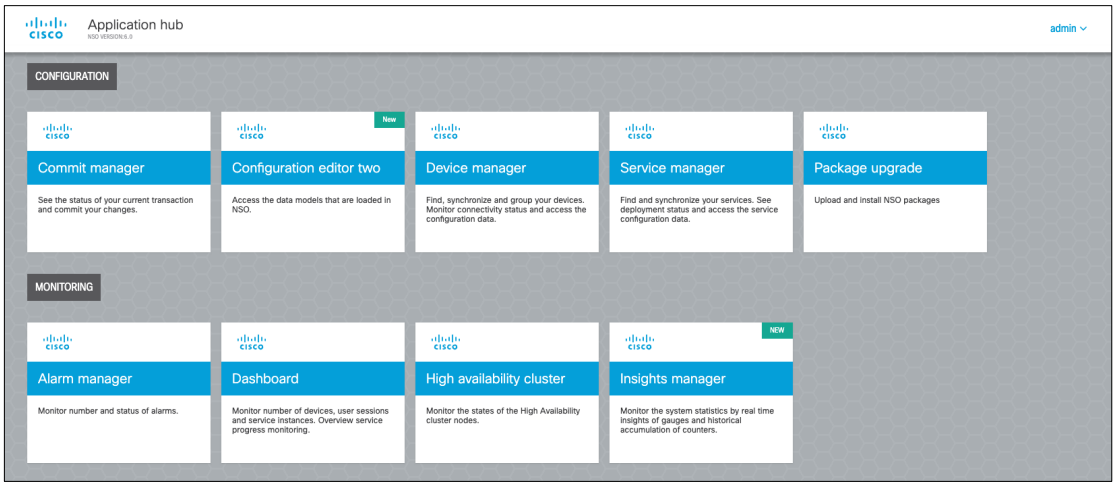
Check if NSO is running

```
user@Pc nso-instance % ncs --status | grep started
status: started
```

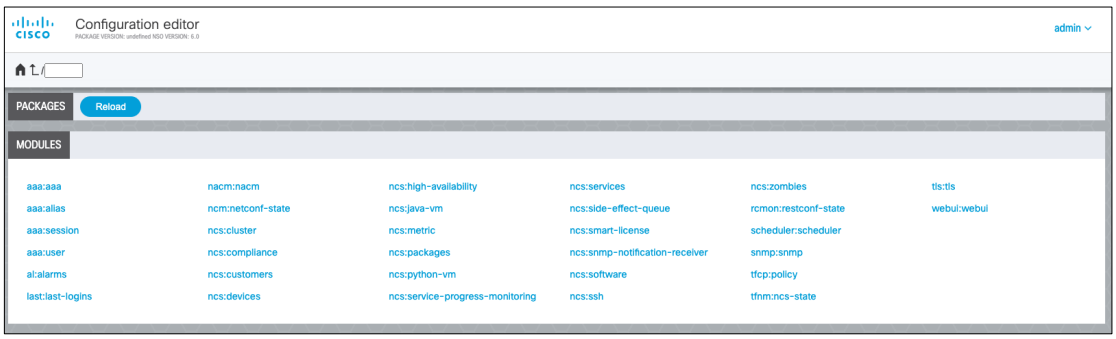
Login into NSO via WEBUI using the default port 8080 (HTTP) http://127.0.0.1:8080/login.html

Use the default username and password (admin : admin)





Go to the “Configuration Editor two” (The older version is deprecated but utilization is still available via webui)



Since it’s a fresh installation we’ve no packages, let’s add the NED we’ve downloaded.

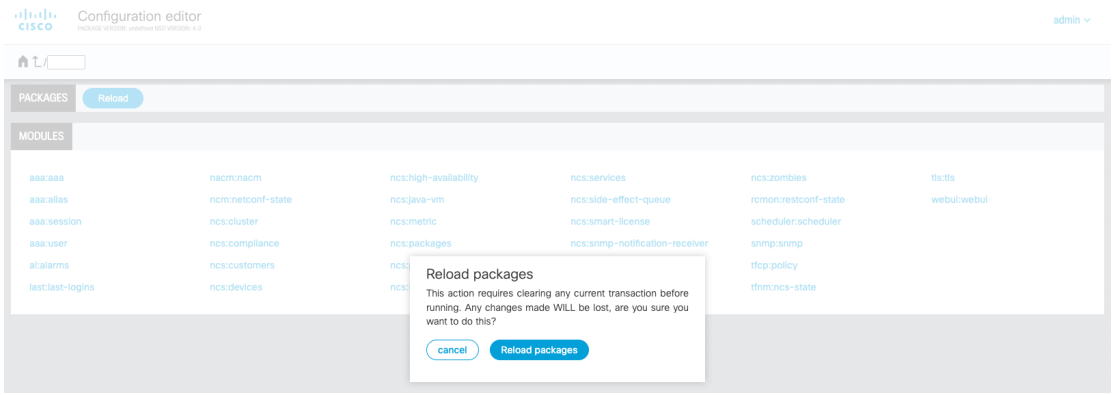
Go back to the folder where you downloaded the NED and repeat the same process we did for the NSO installation. Execute the “ncs-6.0-cisco-iosxr-7.43-freetrial.signed”.

```
user@Pc # % sh ncs-6.0-cisco-iosxr-7.43-freetrial.signed.bin
```

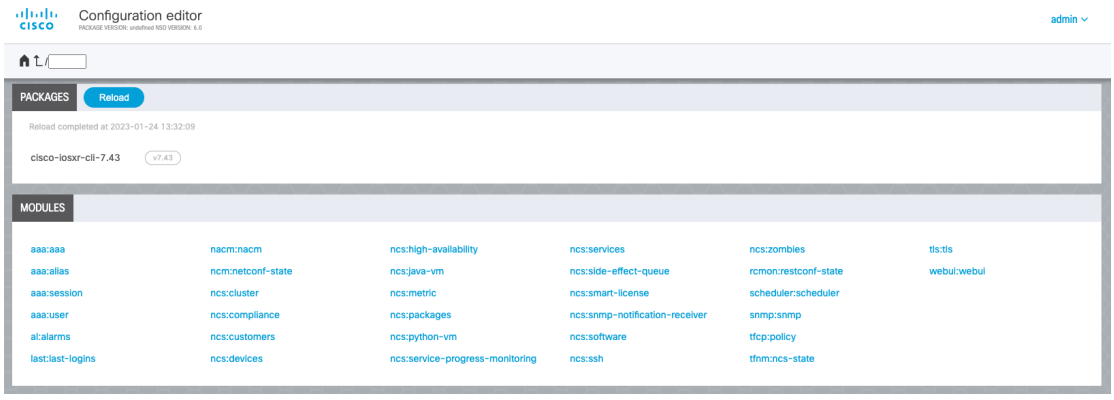
```
Unpacking...
Verifying signature...
Retrieving CA certificate from
http://www.cisco.com/security/pki/certs/crcam2.cer ...
Successfully retrieved and verified crcam2.cer.
Retrieving SubCA certificate from
http://www.cisco.com/security/pki/certs/innerspace.cer ...
Successfully retrieved and verified innerspace.cer.
Successfully verified root, subca and end-entity certificate chain.
Successfully fetched a public key from tailf.cer.
Successfully verified the signature of ncs-6.0-cisco-iosxr-7.43.tar.gz
using tailf.cer
```

Copy the ".tar.gz" file to the /nso-instance/packages folder

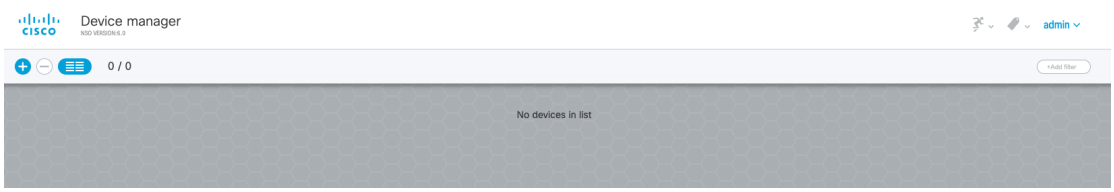
Go back to NSO WEB UI and Click on "Reload" packages button



As the result of the "packages reload" you should now be able to see your "cisco-iosxr" package.



Now that we've added our NED let's go to the "Device Manager".



There are still no devices on the list, we can add them manually by clicking on + button, or, use scripts / APIs to add them.

1.2 - Using Network Simulators (NETSIMs)

What we will do now is use the NETSIM (Network Simulator) capability to simulate devices and add them to NSO. This is a very useful tool that NSO brings for us to test device configurations.

Going back to the CLI (where we did the “source ncsrc” command) and use the command “ncs-netsim” to create simulated devices.

```
user@Pc nso-instance % ncs-netsim create-network packages/cisco-
iosxr-cli-7.43.tar.gz 4 ios-xr-
DEVICE ios-xr-0 CREATED
DEVICE ios-xr-1 CREATED
DEVICE ios-xr-2 CREATED
DEVICE ios-xr-3 CREATED
```

Using the command “ncs-netsim list” we’re able to see all the communication ports that we can use to connect to these simulated devices.

```
user@Pc nso-instance % ncs-netsim list
ncs-netsim list for  /Users/user/NSO-DD/nso-instance/netsim

name=ios-xr-0 netconf=12022 snmp=11022 ipc=5010 cli=10022
dir=/Users/user/NSO-DD/nso-instance/netsim/ios-xr-/ios-xr-0
name=ios-xr-1 netconf=12023 snmp=11023 ipc=5011 cli=10023
dir=/Users/user/NSO-DD/nso-instance/netsim/ios-xr-/ios-xr-1
name=ios-xr-2 netconf=12024 snmp=11024 ipc=5012 cli=10024
dir=/Users/user/NSO-DD/nso-instance/netsim/ios-xr-/ios-xr-2
name=ios-xr-3 netconf=12025 snmp=11025 ipc=5013 cli=10025
dir=/Users/user/NSO-DD/nso-instance/netsim/ios-xr-/ios-xr-3
```

Start the devices.

```
user@Pc nso-instance % ncs-netsim start
DEVICE ios-xr-0 OK STARTED
DEVICE ios-xr-1 OK STARTED
DEVICE ios-xr-2 OK STARTED
DEVICE ios-xr-3 OK STARTED
```

To test the connectivity to one device you can use the command “ncs-netsim cli-c ios-xr-0”. Let’s now, make a quick Loopback 0 configuration.

```
user@Pc nso-instance % ncs-netsim cli-c ios-xr-0

admin connected from 127.0.0.1 using console on Pc.local
ios-xr-0# conf
Entering configuration mode terminal
ios-xr-0(config)# interface Loopback 0
ios-xr-0(config-if)# ipv4 address 1.1.1.1 255.255.255.255
ios-xr-0(config-if)# commit
```

```
Commit complete.
ios-xr-0(config-if)# end
```

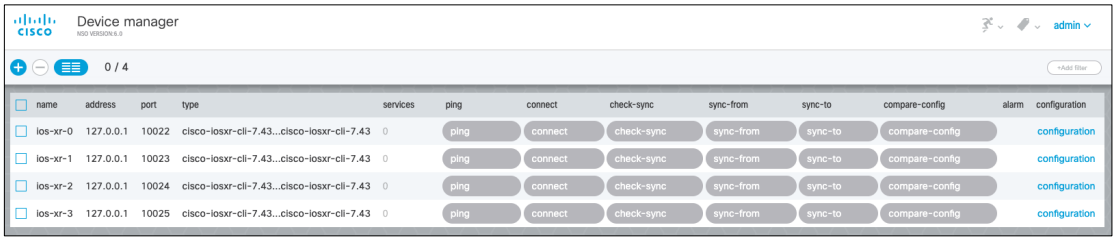
Netsims have limited capabilities on show commands. You can try the show-running-config.

```
ios-xr-0# show running-config
admin
 exit-admin-config
!
interface Loopback 0
 no shutdown
 ipv4 address 1.1.1.1 255.255.255.255
exit
ios-xr-0# exit
```

To add the 4 devices to NSO we need to export them to an XML file and use the “ncs_load” command to load them. -l (load) -m (merge)

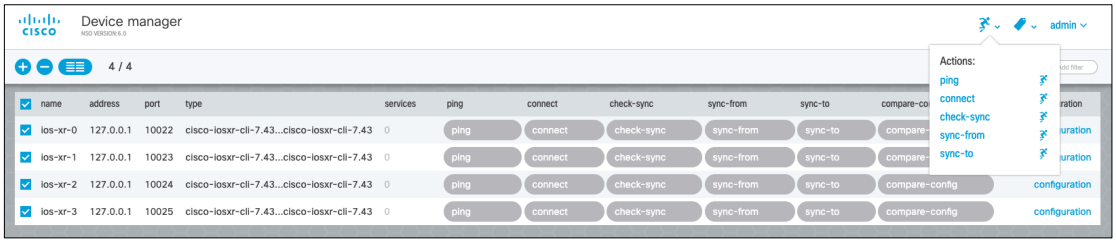
```
user@Pc nso-instance % ncs-netsim ncs-xml-init > devices.xml
user@Pc nso-instance % ncs_load -l -m devices.xml
```

Go back to NSO and click on Device Manager. Your recently created devices should be there.

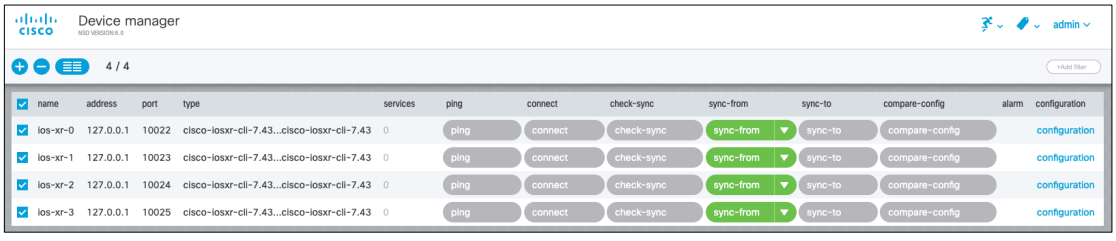


The first thing that you need to do after adding a device to NSO is to execute the “sync-from” so you update NSO CDB with the device configuration.

Instead of doing the sync-from device by device we can select all devices (click on the box on the left of the header “name”) and click on sync-from.

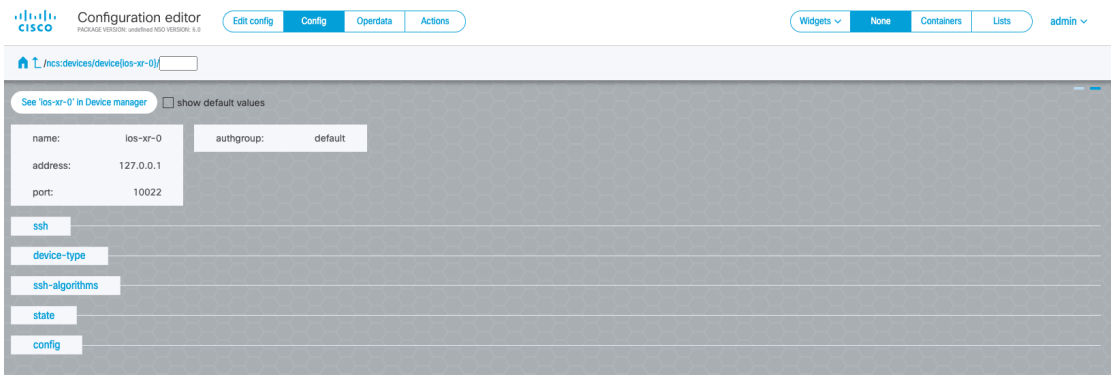


If the result is green, means that now NSO CDB is successfully updated with the device configurations.

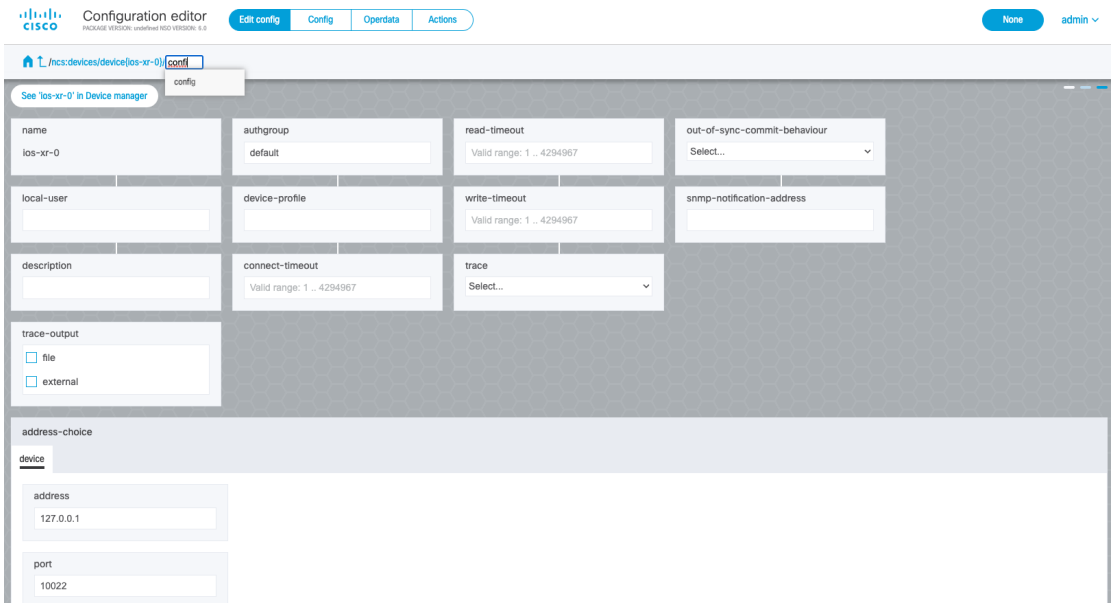


1.3 – Configure Devices using NSO

To configure a device using NSO Web UI we just need to click on the device name. For example, let's enter in ios-xr-0 and verify if the loopback 0 interface that we've configured is already there.



To navigate in the configurations you can use the Top bar (where I typed "confi") or scroll down and look for what you want to configure



You can follow the path and verify the Loopback 0 configuration

Full Path: /ncs:devices/device{ios-xr-0}/config/cisco-ios-xr:interface/Loopback{0}/ipv4/address/

config

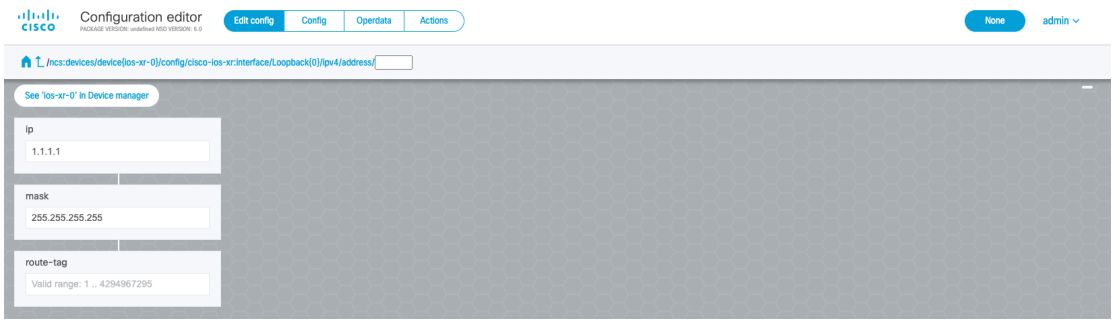
cisco-ios-xr-interface

Loopback -> 0

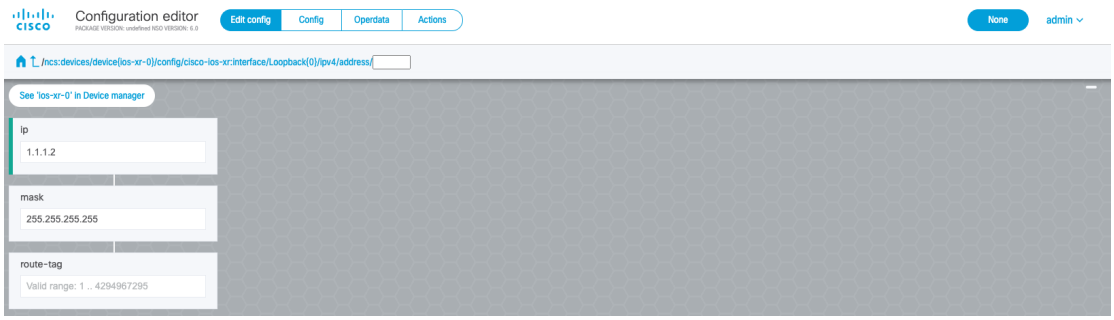
ipv4

address-choice -> address

We can verify that the IP address we configured previously in the device is shown here.



How do we change configuration values? We just need to edit the field that we want, let's change the IP address.

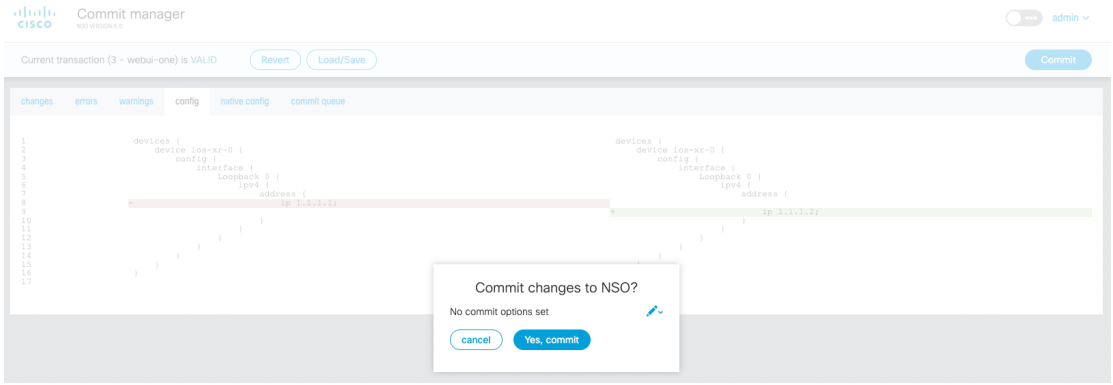


You can notice there is a green bar on the left of the tile that you edited. This means there is a candidate configuration on-going, and this configuration will only be pushed to the device after you commit.

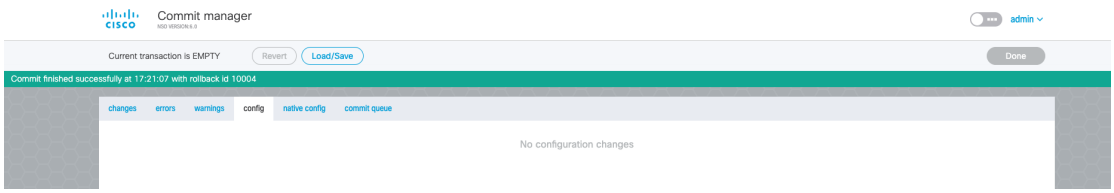
Let's go the Commit Manager.

On the Top we've many options, from "changes" to "commit queue", click on "config" so you can see the changes that will be performed in a diff view like on GitHub.

If we agree with the changes, we click on commit.



After our commit is done, we can see a rollback is created. This is because, every time we make a commit in NSO we create a rollback file that allow us to revert what we did.

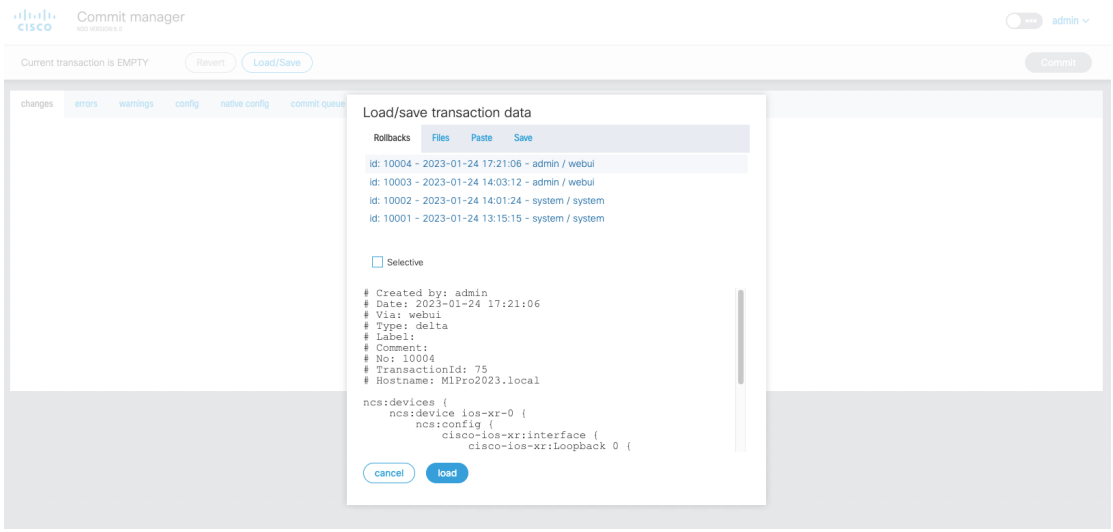


If we go back to CLI of the netsim and execute the “show run”, we can see that our device now have the new IP on the Loopback Interface

```
ios-xr-0# show run
admin
 exit-admin-config
!
interface Loopback 0
 no shutdown
 ipv4 address 1.1.1.2 255.255.255.255
exit
```

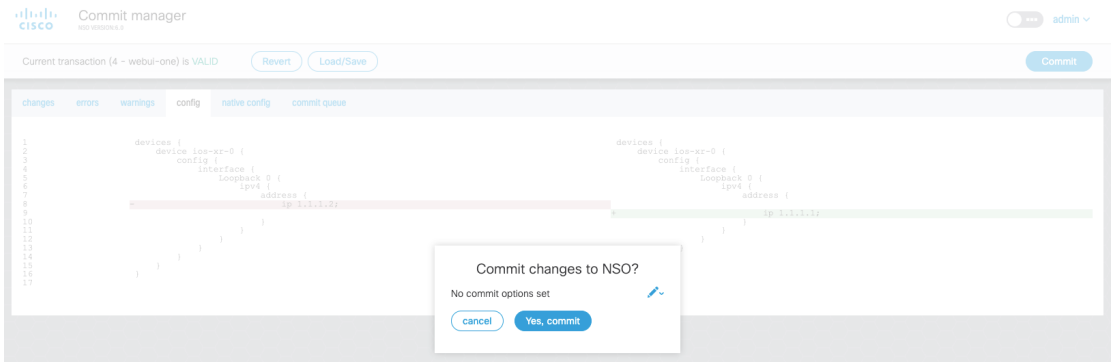
1.4 – Using Rollback’s

To Rollback this we just need to go back to Commit Manager, click on “Load/Save” Button and choose the rollback file that we want.



We can see the user that made the commit and what northbound interface was used. In this case was the user admin via Web UI. We click on load, then config, and we can see that the change that we've made to the Loopback 0 address will be reverted.

If we're ok with the change we hit the commit button and confirm.



After the commit we can check on the device that the change was reverted.

```
ios-xr-0# show run
admin
 exit-admin-config
!
interface Loopback 0
 no shutdown
 ipv4 address 1.1.1.1 255.255.255.255
exit
```

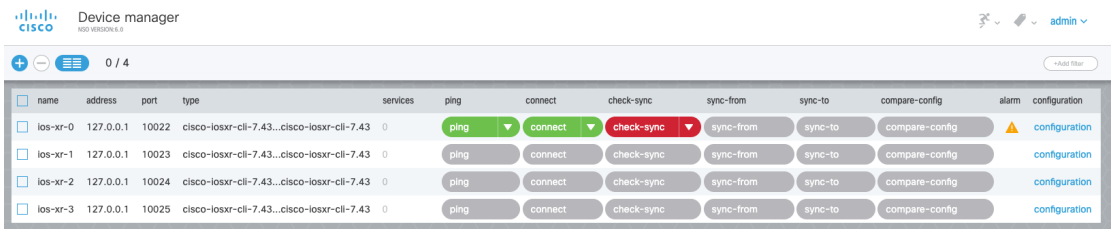
1.5 – Using NSO capabilities to detect Out-of-Band device configurations

So, now let's see one of the main NSO capabilities (check-sync, sync-from, sync-to).

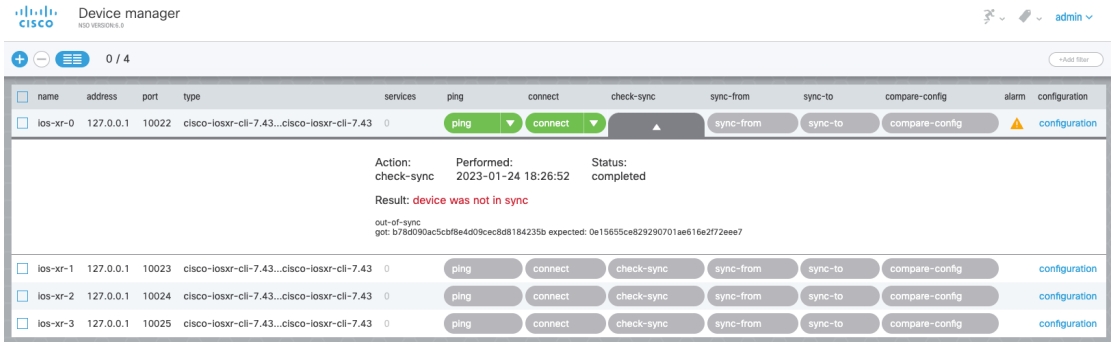
Login into ios-xr-0 device using SSH or "ncs-netsim clic- ios-xr-0" and configure the VTP mode off.

```
user@Pc nso-instance % ncs-netsim cli-c ios-xr-0
ios-xr-0# config
Entering configuration mode terminal
ios-xr-0(config)# vtp mode
  client         Set the device to client mode.
  off            Set the device to off mode.
  server         Set the device to server mode.
  transparent    Set the device to transparent mode.
ios-xr-0(config)# vtp mode off
ios-xr-0(config)# commit
Commit complete.
```

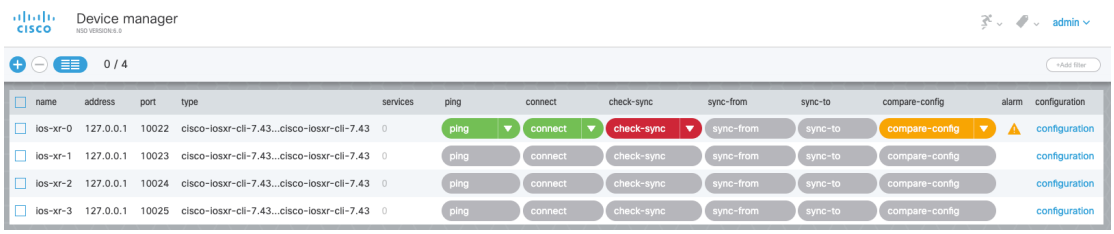
Since this change was done out of NSO we can go to NSO WEB UI / CLI and see if the device is in sync.

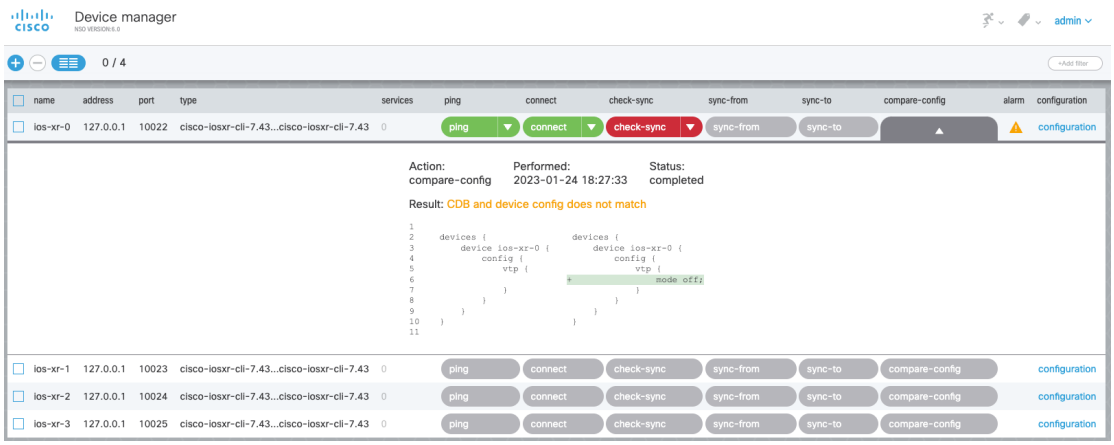


We got a red alert because this change was done outside of NSO. And we can see that the hash of the configuration present on NSO is not the same that we got from the device.



If we click on "compare-config" button we can see exactly what was done outside of NSO





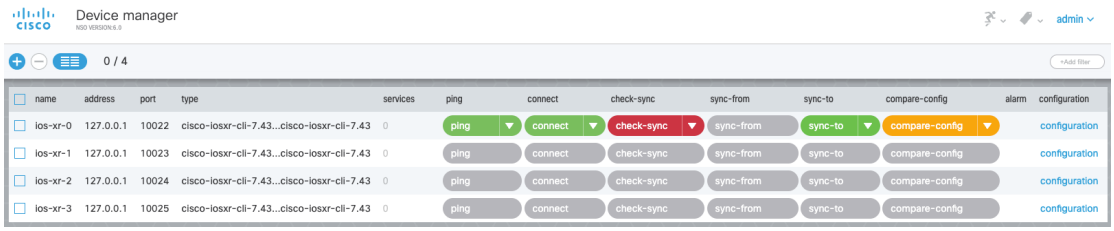
And now we've 2 options

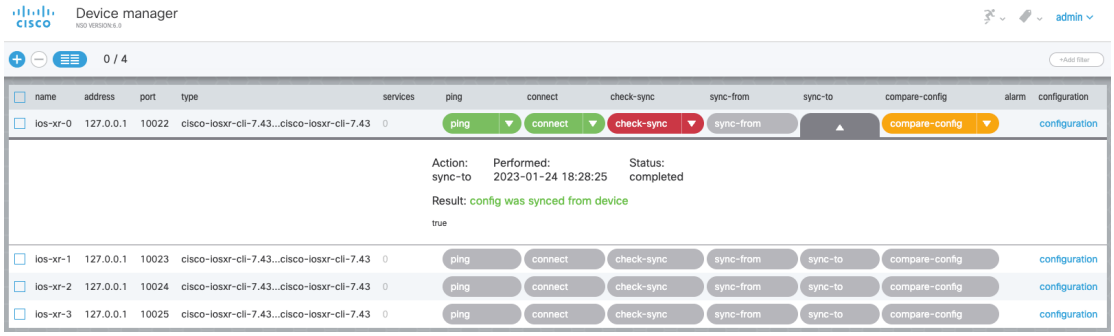
Option 1 : We "SYNC-FROM" the device

Option 2 : We "SYNC-TO" device

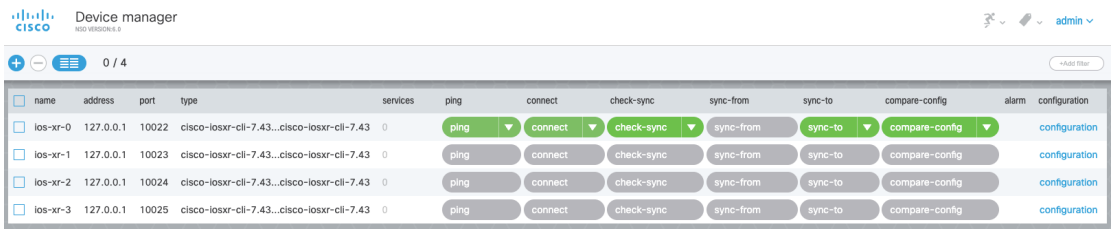
If we go with Option 1 we will grab the configuration that was done in the device without using NSO and push to NSO. If we use the Option 2 we will push to the device the configuration that NSO had previously about the device (it will act like a rollback)

In this case we want to delete the configuration that was done outside of NSO so we will click on the "sync-to" button





We can now click on Check-Sync and confirm that both device and NSO device configuration are the same.



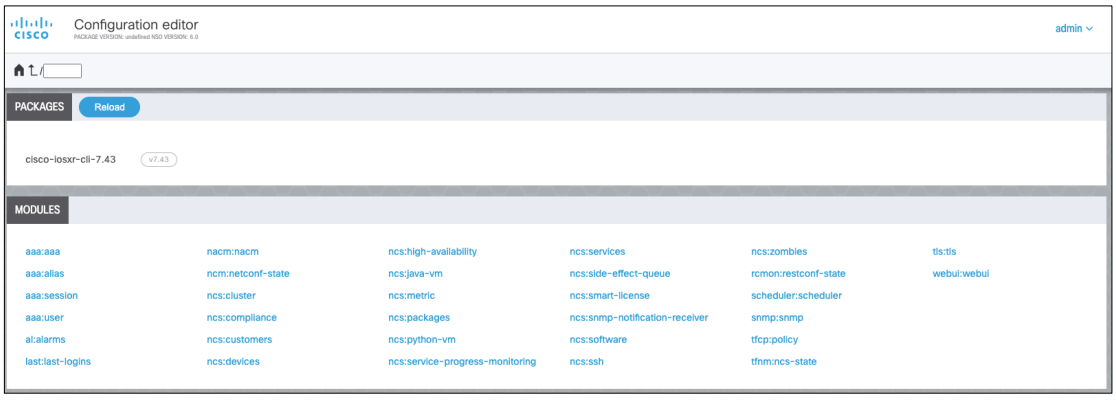
If we login to the device, we will confirm that the VTP configuration is not there anymore.

```
ios-xr-0(config)# end
ios-xr-0# show run
admin
 exit-admin-config
!
interface Loopback 0
 no shutdown
 ipv4 address 1.1.1.1 255.255.255.255
exit
```

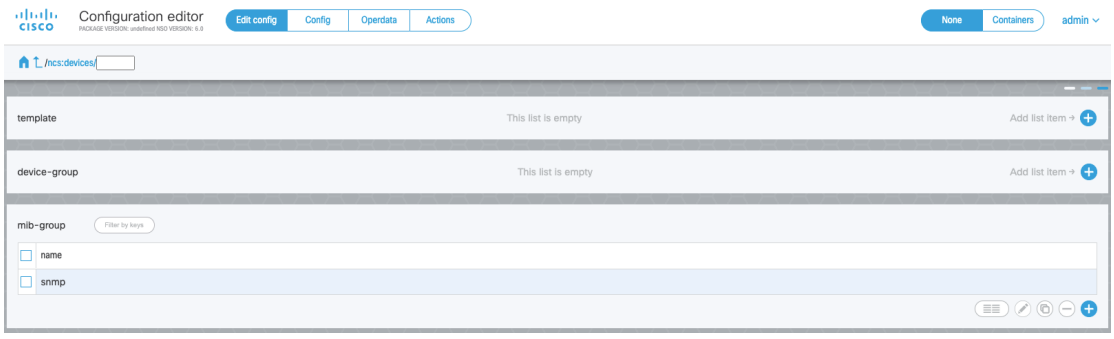
1.6 - Create Device Groups and Device Templates

Ok, so what if we want to apply configurations to several devices at the same time? To achieve this we need to create a device Group.

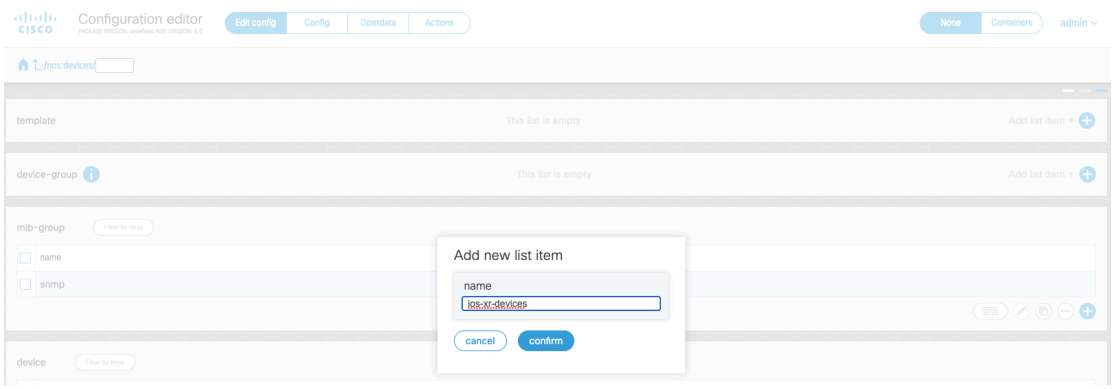
Go into configuration Editor and select the “ncs:devices” module.



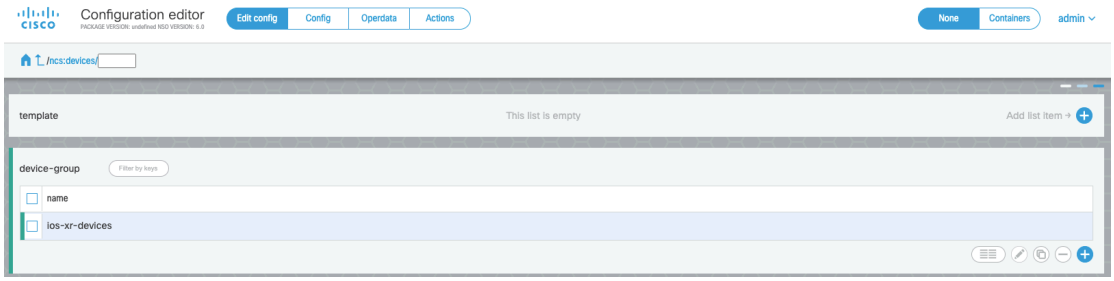
In the Device-Group click on the Plus button



Create the group “ios-xr-devices”

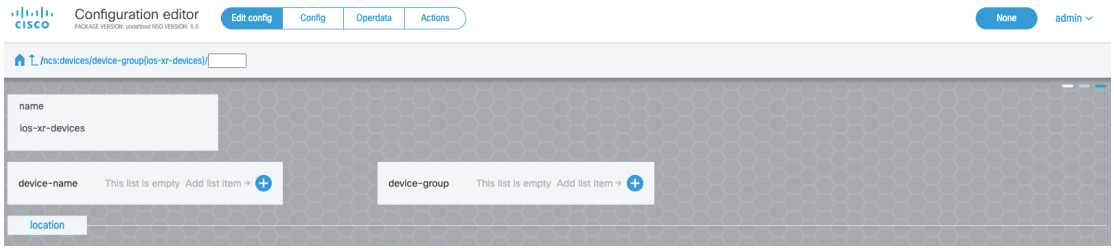


Click on “confirm”

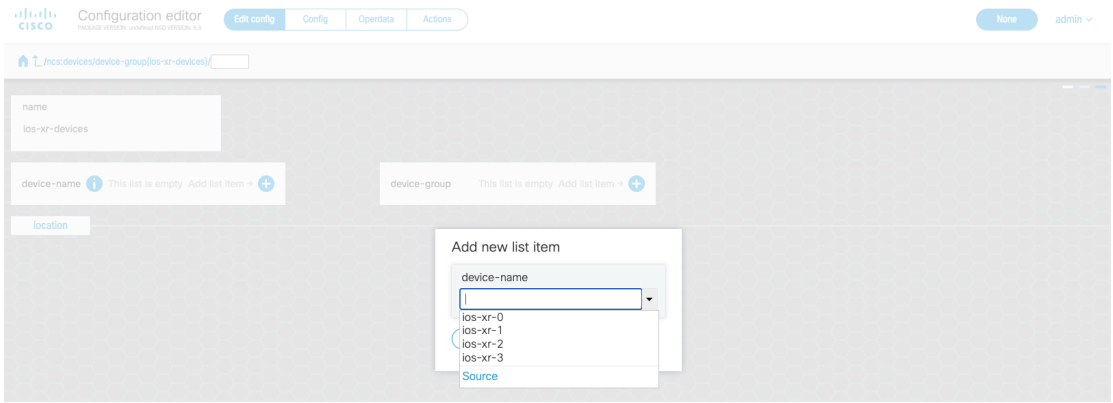


Now let’s click on the device-group that you’ve created.

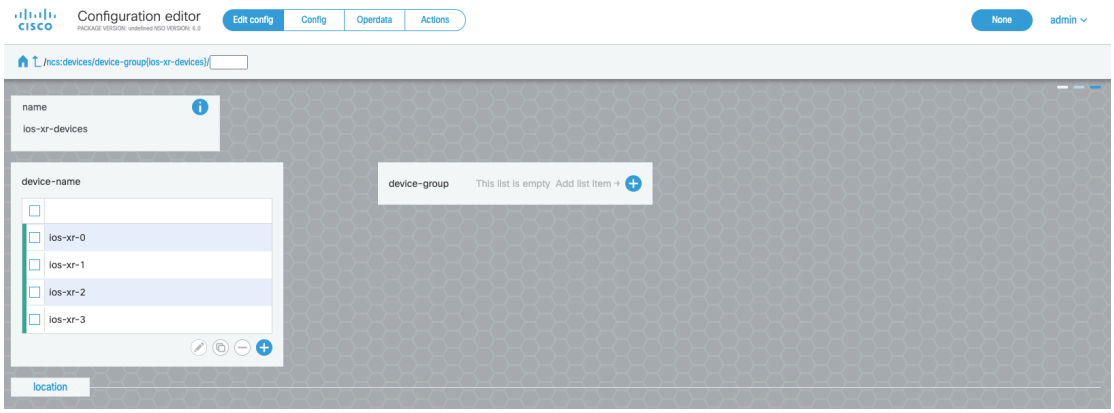
To Add devices to the device Group we click on the + button next to device-name tile.



It will show up all the devices we’ve available



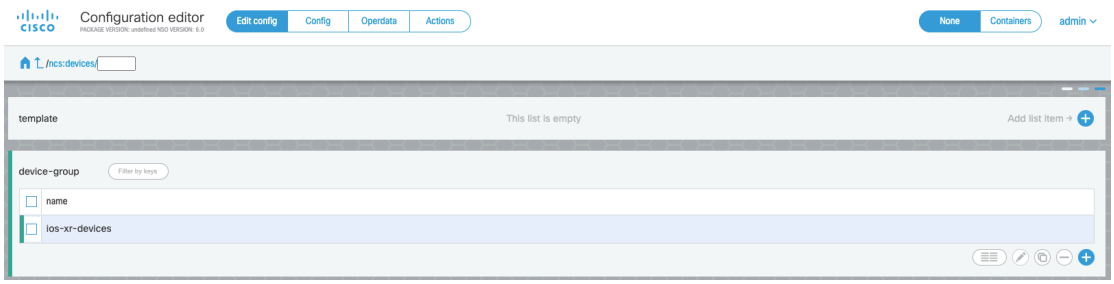
If we select all the devices this should be the result.



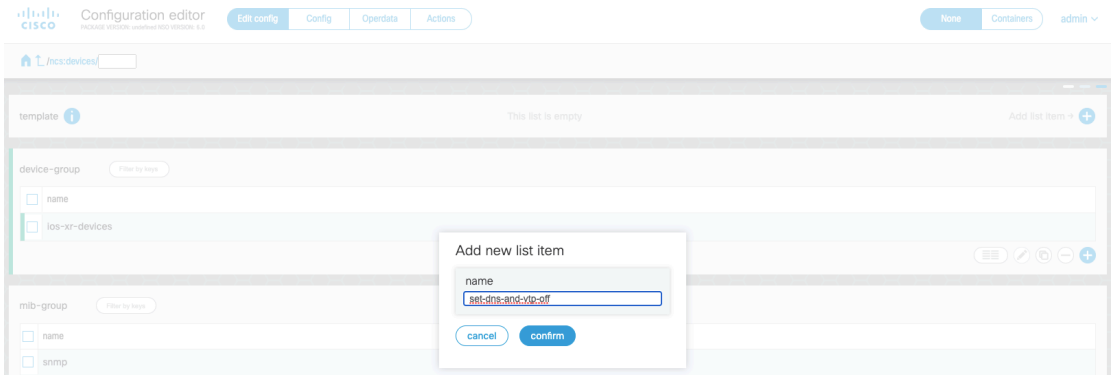
After creating a Device group, let's create a Device Template so we can create a config that we will spread across all the devices in the group with just few clicks.

Go to the "Configuration Editor" and choose the "ncs:devices" module

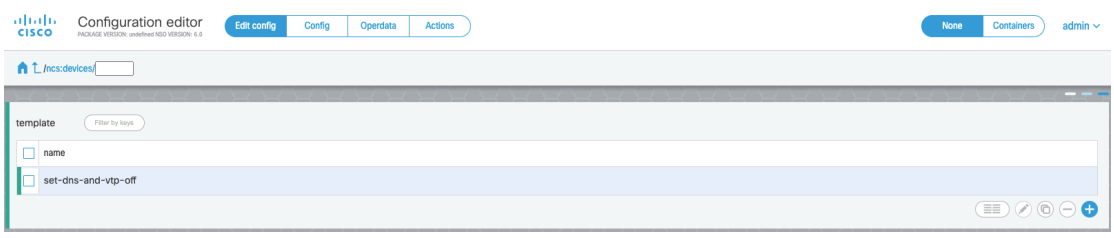
In the template tile, click on the + button.



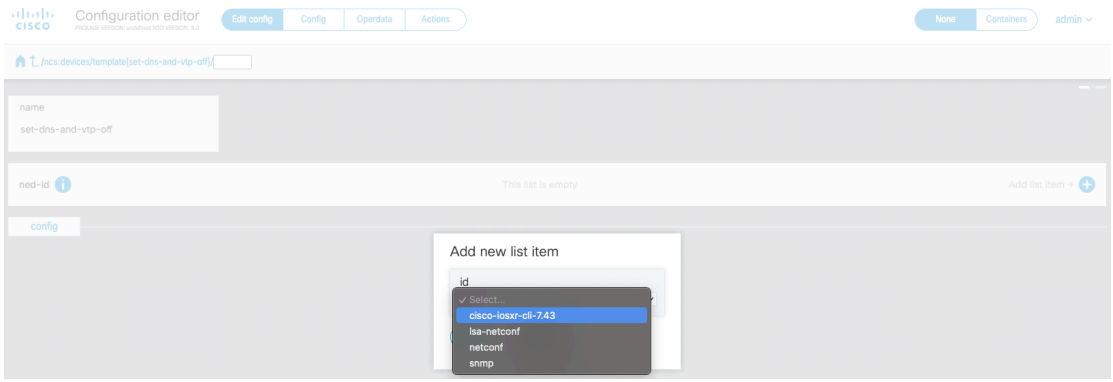
Create the template "set-dns-and-vtp-off".



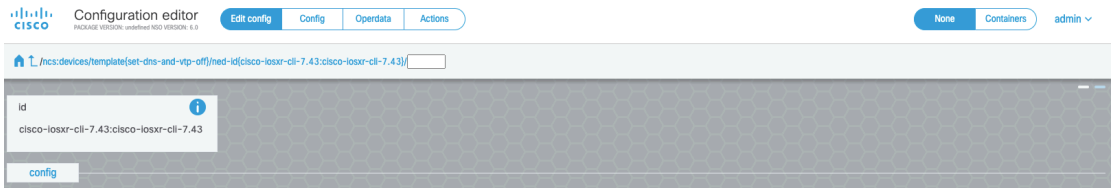
Click on the "confirm" button



Enter in the template and select the NED that we're using (ios-xr) and click Confirm.



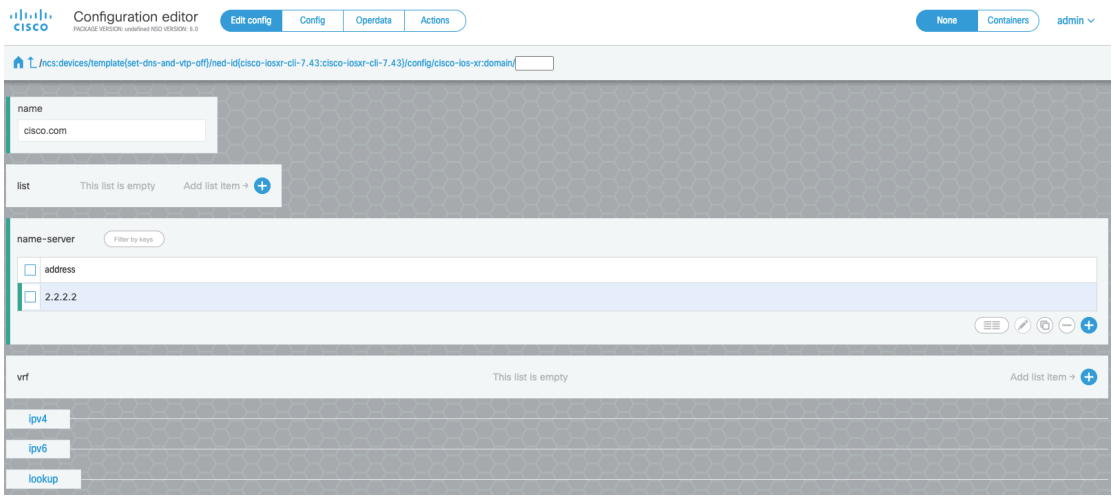
Now click on the config (inside the NED)



And now you just need to setup the configurations that you want to apply. Let's create a DNS configuration and set the VTP to off.

Start with VTP, choose the mode "off".

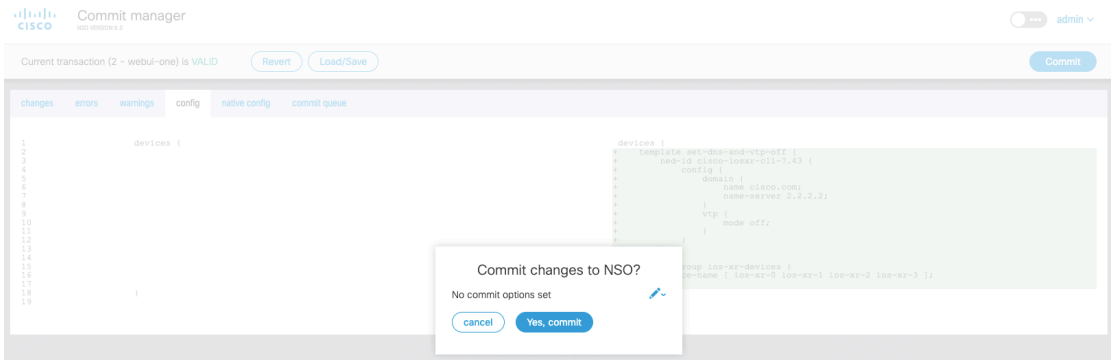
Now, go back to the config and look for Domain. Add the Domain name and name-server.



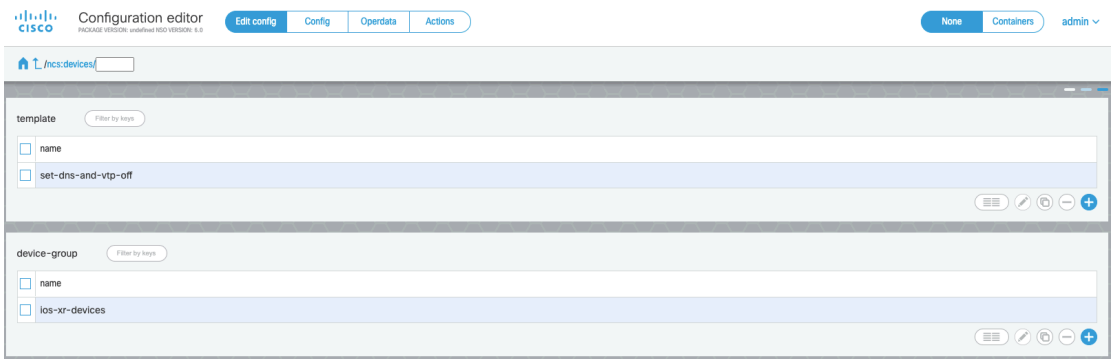
Now, we go to the commit manager and let's see the differences.

From the config diff we can see the device-group and the configuration template that we've created.

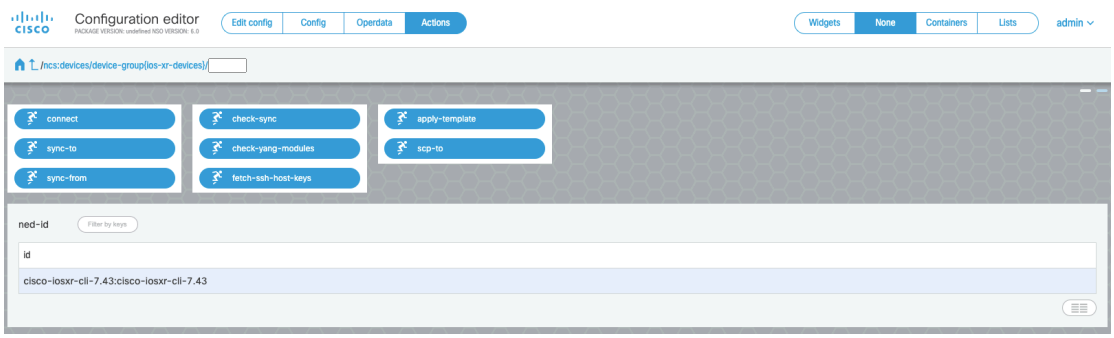
After commit, we can now go to the Device Group and Apply the Template.



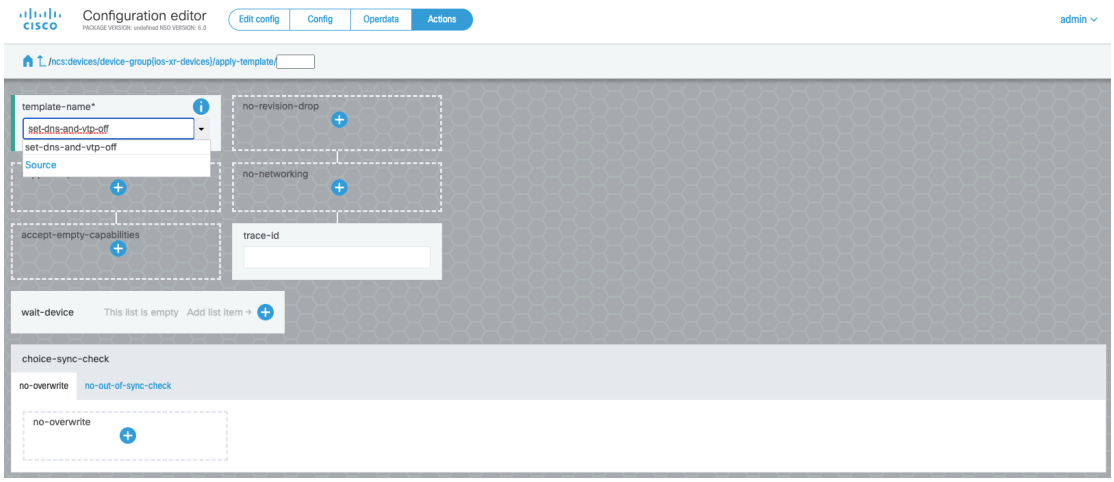
To manage the Device Group we go to the Configuration Editor, “ncs:devices” module and click on the recently created device-group “ios-xr-devices”.



We click on “Actions” and then on the blue button “Apply-Template”

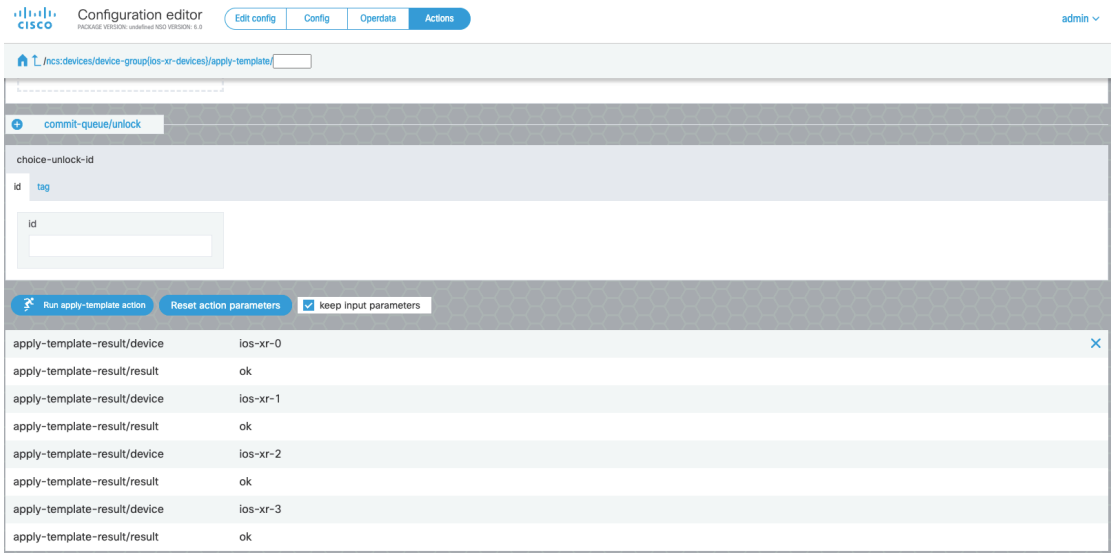


And now, select the “template-name” that we’ve created.



Scroll down and click on “Run apply-template action”.

We can see the apply-template result “ok” for each device present in the device group.



If we go back to the “Commit Manager” we can see that with the application of the template, we will push the same configuration to all the devices at the same time.

We click on the “commit” button and if we go inside the Device CLI we can see that the configurations were applied.

```
ios-xr-0# show run
admin
 exit-admin-config
!
domain name cisco.com
domain name-server 2.2.2.2
vtp mode off
interface Loopback 0
 no shutdown
 ipv4 address 1.1.1.1 255.255.255.255
exit
```

1.7 – Create a simple NSO Service

Templates are very flexible and easy to create. But they lack on configuration consistency after being applied. If someone goes thought NSO and change one configuration that you've done via template, you don't have an easy way to see it and rollback. For that purposes and much more, we have the NSO Services.

An NSO service will allow you to see if the configuration that you applied is still present on the devices. And if someone changed, we could compare-configs and re-deploy if necessary.

The first step is to create a service.

NSO already brings a script that creates a service skeleton.

Use the command "ncs-make-package -h"

```
user@Pc nso-instance % ncs-make-package -h
Usage: ncs-make-package [options] package-name

  ncs-make-package --netconf-ned DIR package-name
  ncs-make-package --lsa-netconf-ned DIR package-name
  ncs-make-package --generic-ned-skeleton package-name
  ncs-make-package --snmp-ned DIR package-name
  ncs-make-package --service-skeleton TYPE package-name
  ncs-make-package --data-provider-skeleton package-name
  ncs-make-package --erlang-skeleton package-name

      where TYPE is one of:
          java                  Java based service
          java-and-template     Java service with template
          python                Python based service
          python-and-template   Python service with template
          template              Template service (no code)

  ADDITIONAL OPTIONS
  --dest DIR
  --build
  --verbose
  --no-test
  --no-fail-on-warnings
  -h | --help

  SERVICE specific options:
    --augment PATH
    --root-container NAME

  JAVA specific options:
    --java-package NAME

  NED specific options:
    --no-java
    --no-netsim
    --no-python
    --no-template
    --vendor STRING
```

```
    --package-version STRING

  NETCONF NED specific options:
    --ncs-depend-package DIR
    --pyang-sanitize
    --confd-netsim-db-mode candidate | startup | running-only

  LSA NETCONF NED specific options:
    --lsa-lower-nso PKG | DIR
      where PKG can be one of: cisco-nso-nc-4.7 cisco-nso-nc-5.6
cisco-nso-nc-5.7 cisco-nso-nc-5.8 cisco-nso-nc-6.0

  PYTHON specific options:
    --component-class NAME (default main.Main)
    --action-example
    --subscriber-example

  ERLANG specific options:
    --erlang-application-name NAME (uses package name as default)

See manpage for ncs-make-package(1) for more info.
```

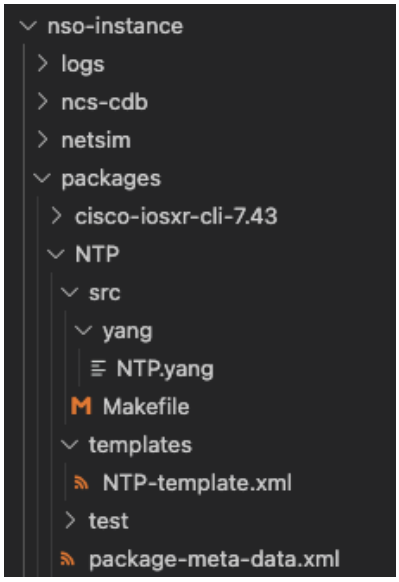
You can see that we've many options here.

Python and Java options are when we want to apply templates/services, based on logic. Imagine you want to apply QOS data to a device interface but only based on the interface high utilization. You can check the interface utilization via external APIs and only send the device configs according to what you receive.

Let's choose the Template option. (create the service inside the packages folder, otherwise you will have to copy the service folder to the packages folder after you're done)

```
user@Pc packages % ncs-make-package --service-skeleton template NTP
```

After you run the script, you will find this structure.



package-meta-data.xml is where you will find the service version and other useful information.

package-meta-data.xml

nso-instance > packages > NTP > package-meta-data.xml > ncs-package

```
<ncs-package xmlns="http://tail-f.com/ns/ncs-packages">
  <name>NTP</name>
  <package-version>1.0</package-version>
  <description>Template-based NTP resource facing service</description>
  <ncs-min-version>6.0</ncs-min-version>

  <!-- It's possible to add more components to the -->
  <!-- same package, multiple services, data providers etc -->

</ncs-package>

```

Then you have the XML file and the YANG file.

This is what we will find in the XML file.

NTP-template.xml

nso-instance > packages > NTP > templates > NTP-template.xml > config-template

```
<config-template xmlns="http://tail-f.com/ns/config/1.0"
                 servicepoint="NTP">
  <devices xmlns="http://tail-f.com/ns/ncs">
    <device>
      <!--
          Select the devices from some data structure in the service
          model. In this skeleton the devices are specified in a leaf-list.
          Select all devices in that leaf-list:
      -->
      <name>{/device}</name>
      <config>
        <!--
            Add device-specific parameters here.
            In this skeleton the service has a leaf "dummy"; use that
            to set something on the device e.g.:
            <ip-address-on-device>{/dummy}</ip-address-on-device>
        -->
      </config>
    </device>
  </devices>
</config-template>
```

And this is what we will find on the YANG file:

Our next step will be:

Go to NSO and make the configurations that we want to automate via the service.

After all the configs are done instead of doing the commit, we will ask for the output of the configurations to be shown in XML.

In this case we want to automate the NTP server and peer configuration.

```
user@Pc packages % ncs_cli -Cu admin
admin@ncs# config
Entering configuration mode terminal
admin@ncs(config)# devices device ios-xr-1
admin@ncs(config-device-ios-xr-1)# config
admin@ncs(config-config)# ntp
```

```
admin@ncs(config-ntp)# server 172.16.22.44 minpoll 8 maxpoll 12
admin@ncs(config-ntp)# peer 192.168.22.33
admin@ncs(config-ntp)# commit dry-run outformat xml
result-xml {
    local-node {
        data <devices xmlns="http://tail-f.com/ns/ncs">
               <device>
                 <name>ios-xr-1</name>
                 <config>
                   <ntp xmlns="http://tail-f.com/ned/cisco-ios-xr">
                     <peer>
                       <address>192.168.22.33</address>
                     </peer>
                     <server>
                       <server-list>
                         <name>172.16.22.44</name>
                         <minpoll>8</minpoll>
                         <maxpoll>12</maxpoll>
                       </server-list>
                     </server>
                   </ntp>
                 </config>
               </device>
             </devices>
    }
}
```

Now, we grab the XML that we got from the NSO cli config and we paste into the skeleton XML file that was generated.

We only grab what is inside the <config></config> flags.

```
<ntp xmlns="http://tail-f.com/ned/cisco-ios-xr">
                     <peer>
                       <address>192.168.22.33</address>
                     </peer>
                     <server>
                       <server-list>
                         <name>172.16.22.44</name>
                         <minpoll>8</minpoll>
                         <maxpoll>12</maxpoll>
                       </server-list>
                     </server>
                   </ntp>
```

This should be the result of the final XML file.

NTP-template.xml

nso-instance > packages > NTP > templates > NTP-template.xml > ...

```
<config-template xmlns="http://tail-f.com/ns/config/1.0"
                 servicepoint="NTP">
  <devices xmlns="http://tail-f.com/ns/ncs">
    <device>
      <!--
        Select the devices from some data structure in the service
        model. In this skeleton the devices are specified in a leaf-list.
        Select all devices in that leaf-list:
      -->
      <name>{/device}</name>
      <config>
        <!--
          Add device-specific parameters here.
          In this skeleton the service has a leaf "dummy"; use that
          to set something on the device e.g.:
          <ip-address-on-device>{/dummy}</ip-address-on-device>
        -->
        <ntp xmlns="http://tail-f.com/ned/cisco-ios-xr">
          <peer>
            <address>192.168.22.33</address>
          </peer>
          <server>
            <server-list>
              <name>172.16.22.44</name>
              <minpoll>8</minpoll>
              <maxpoll>12</maxpoll>
            </server-list>
          </server>
        </ntp>
      </config>
    </device>
  </devices>
</config-template>
```

If we want to apply this static config. We just need to compile the service and we're good to go.

But let's see how we define input variables because if server or peer addresses change we just need to go to our service and change the values to apply the change to all the devices.

Let's create 4 inputs variables:

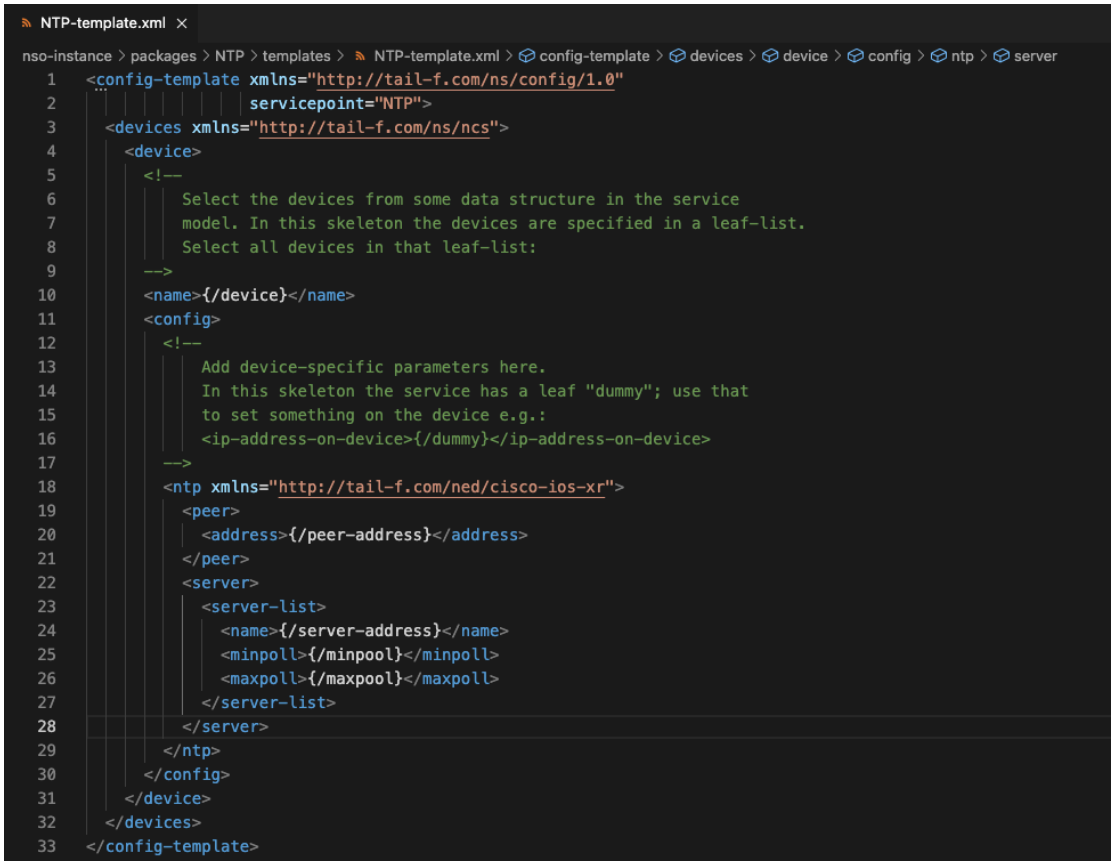
Peer IP-address

Server IP-address

Minpool

Maxpool

After defining the variables our XML should look like this



Now we need to go to the YANG file and setup the definition for each variable.

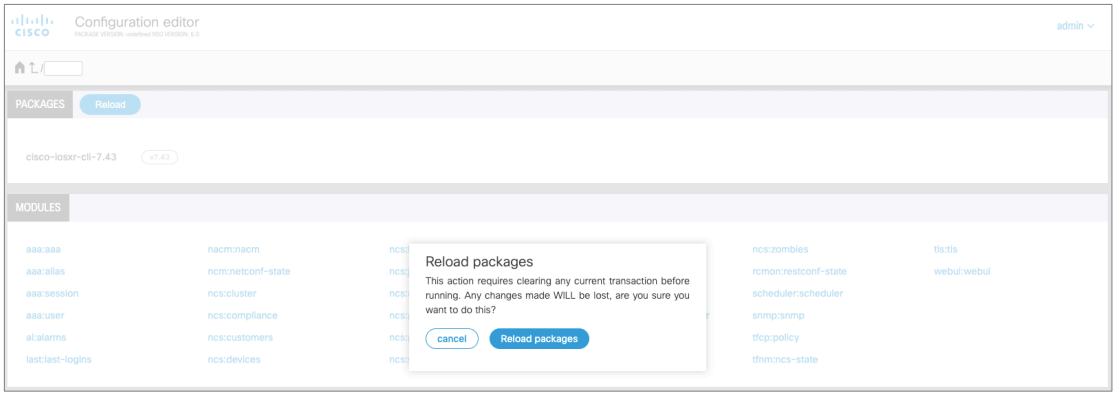
So, we will setup as mandatory inputs the peer-address and server-address (accepting only IP address strings as input) and then the minpoll and maxpoll (they must be the type uint8) will be non-mandatory and with default values.

After all of this is done, we go to the packages folder. Change Directory to NTP/src

And apply the “make” command.

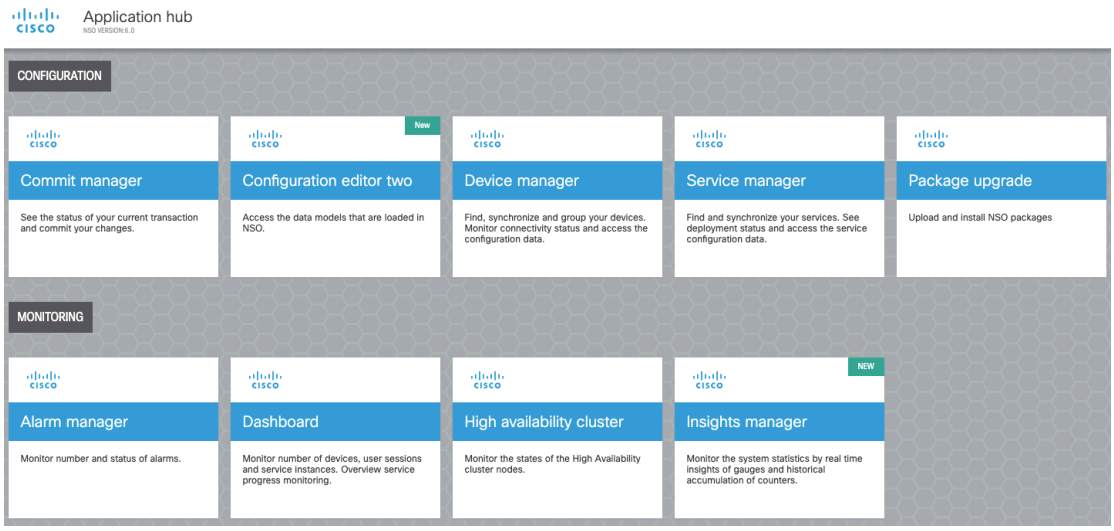
```
user@Pc packages % cd NTP
user@Pc NTP % cd src
user@Pc src % make
mkdir -p ../load-dir
/Users/user/NSO-DD/bin/ncsc `ls NTP-ann.yang  > /dev/null 2>&1 &&
echo "-a NTP-ann.yang"` \
         --fail-on-warnings \
          \
         -c -o ../load-dir/NTP.fxs yang/NTP.yang
```

Then, we should go to NSO, and do a packages reload.



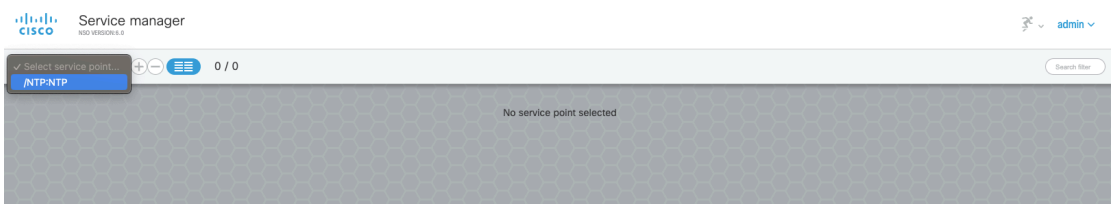
After the reload you will see the NTP service package that we've just created.

Going back to the Homepage we click on the "Service Manager"

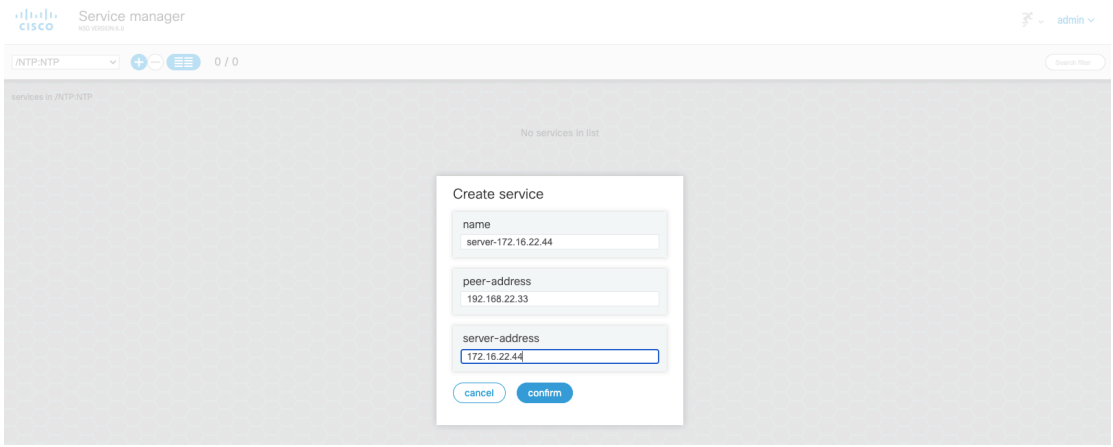


We select the NTP service that we've created

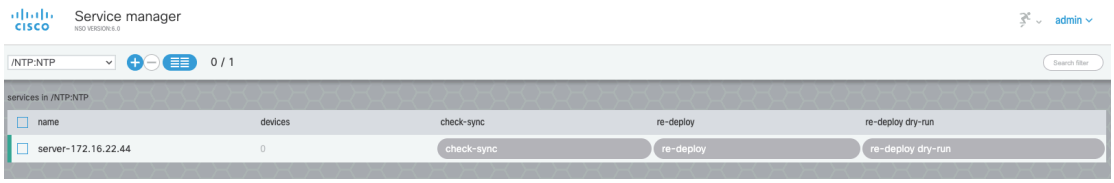
Then, we click on + button



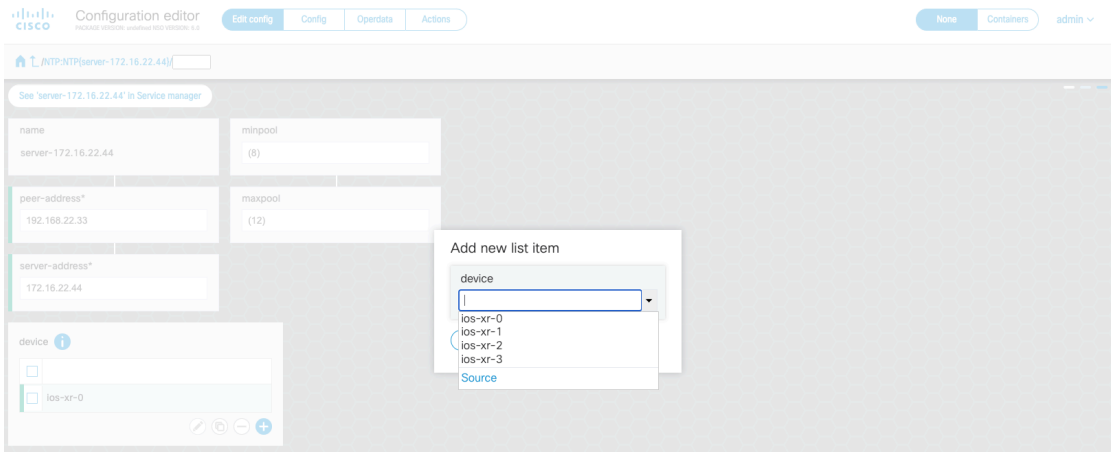
We should give a service name (help us identify the configs applied) and setup the mandatory arguments, in our case, the peer-address and server-address



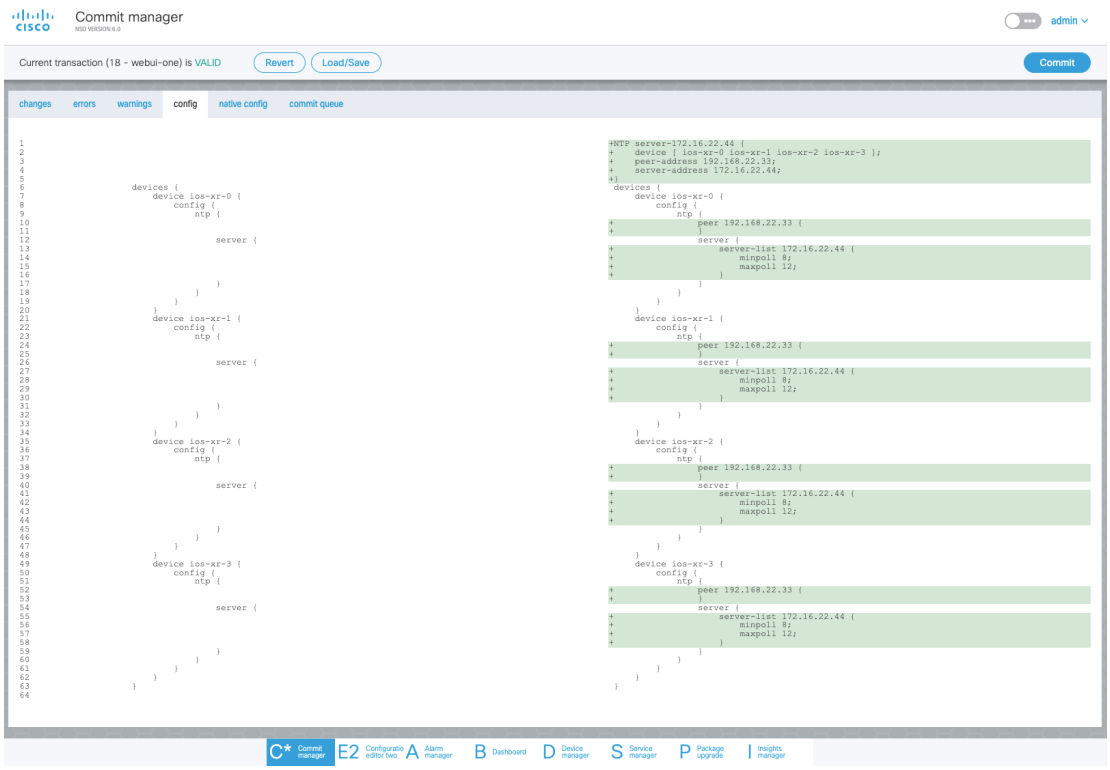
Service Created! Let's add the devices that we want to affect with the service.



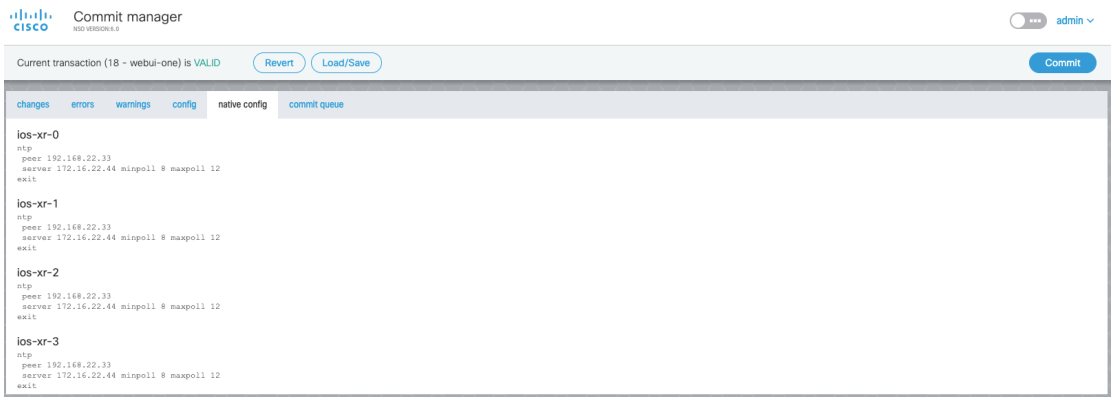
Add the devices you want.



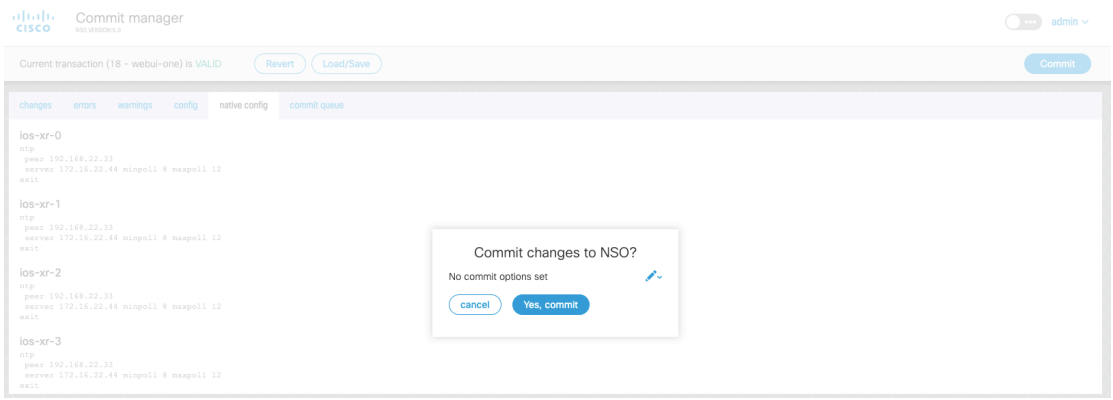
We can keep the minpoll and maxpoll with the default values. And now, if we go to the commit manager we will see the configs applied to all the devices that we've selected.



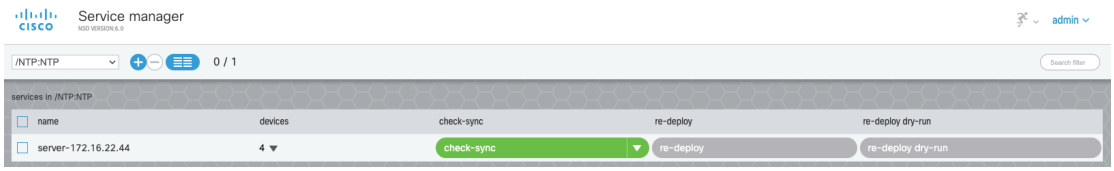
If we click on native config, we can even see the native commands that NSO will send to the devices.



We click on “commit” button and confirm.

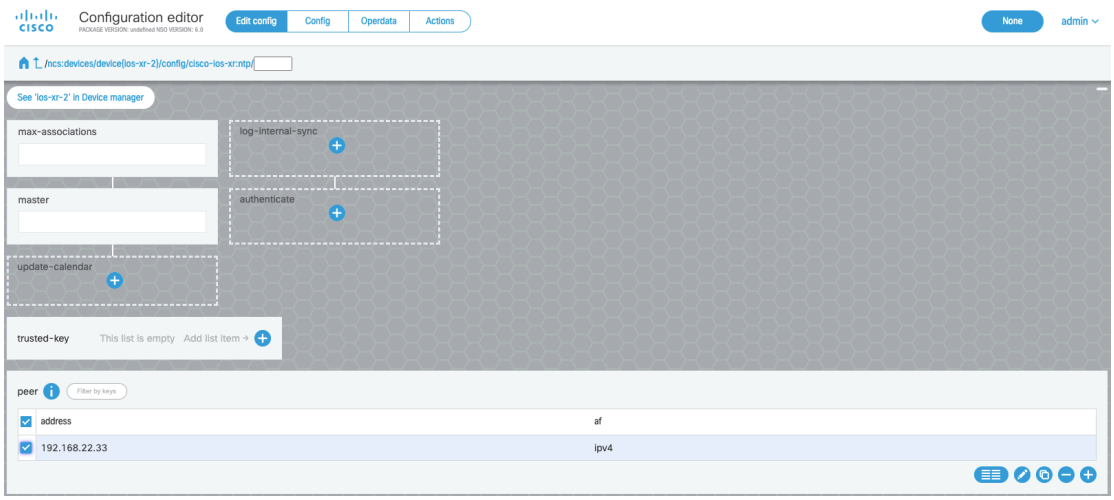


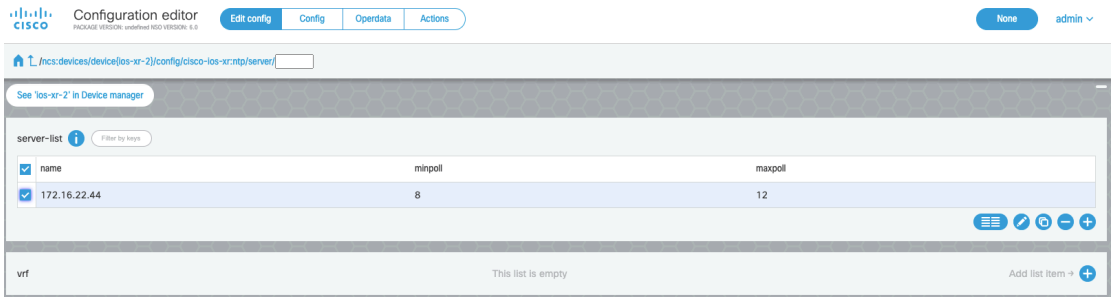
Now we can see if the service is in Sync (meaning that the configs that we applied are still there)



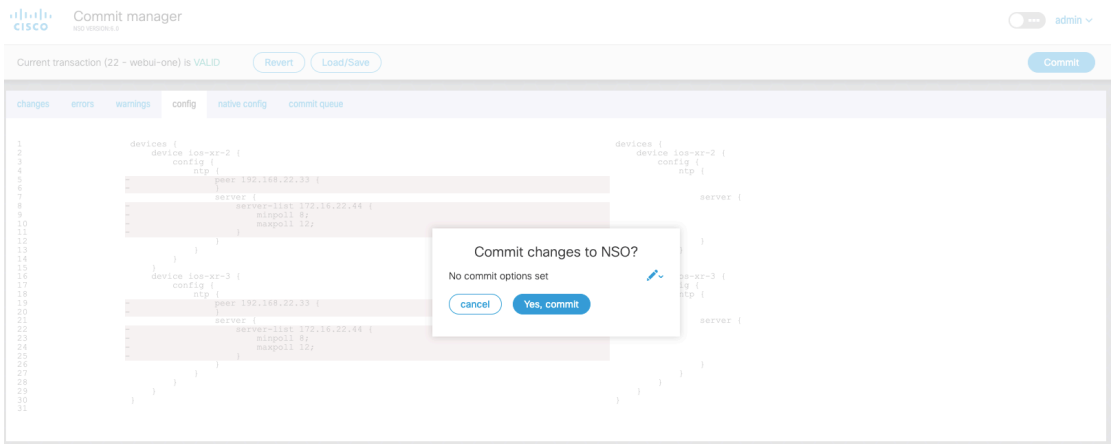
Now, to see the how powerful the services are let's go inside 2 devices, ios-xr-2 and ios-xr-3 and delete the NTP config.

Go to the Device Manager, click on IOS-XR-2 and delete the peer and server configs by selecting them and clicking on the "-" button.

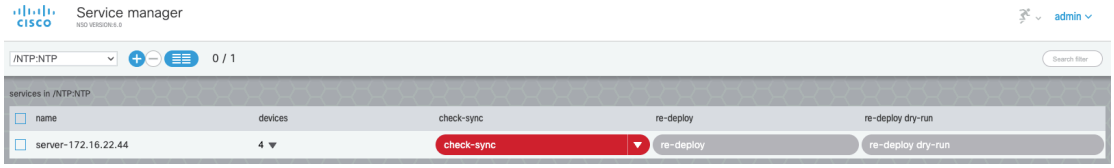


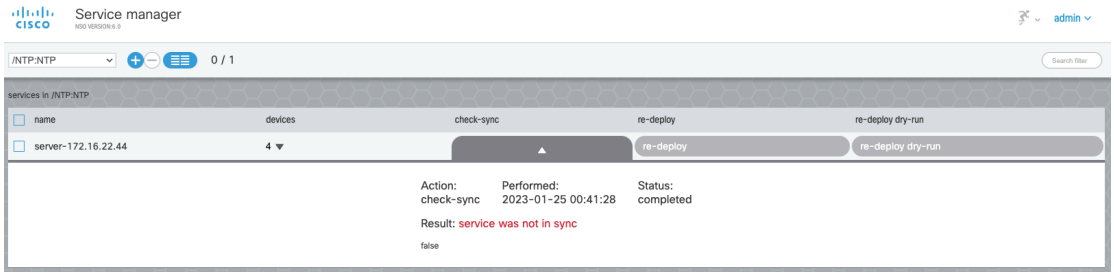


Go to the commit manager and press "Commit"

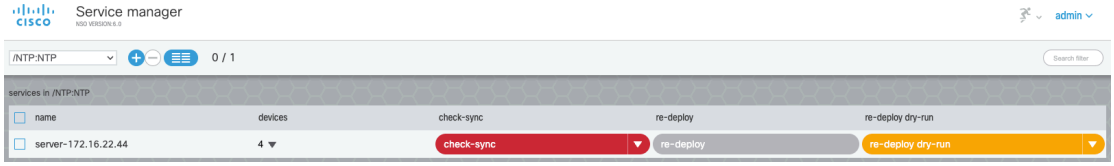


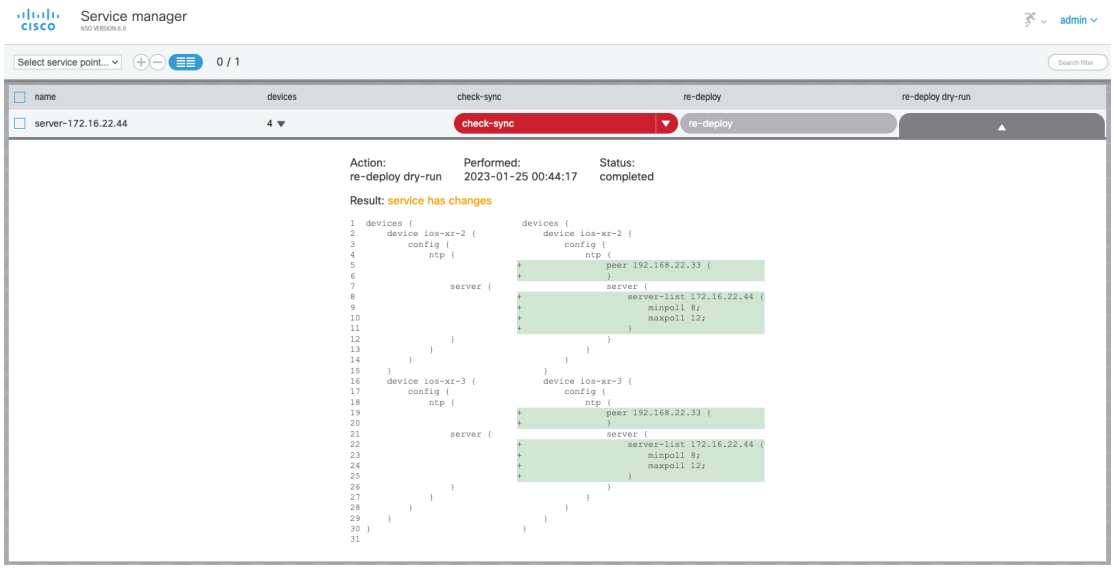
Now, if we go back to the “Service Manager” and we click on “Check-Sync” we will get a RED signal.



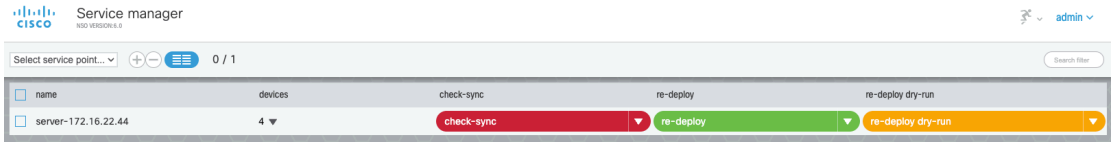


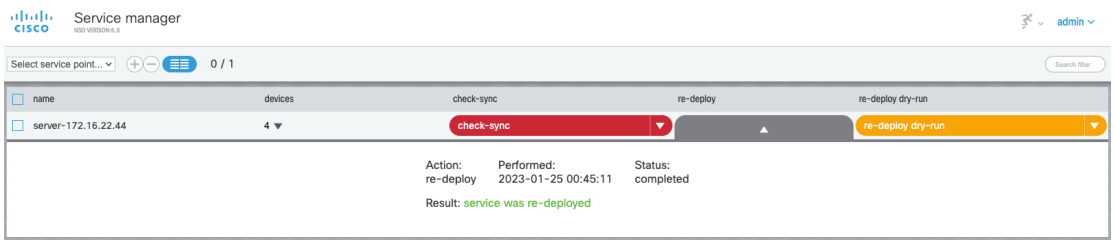
By clicking on Re-deploy Dry-Run

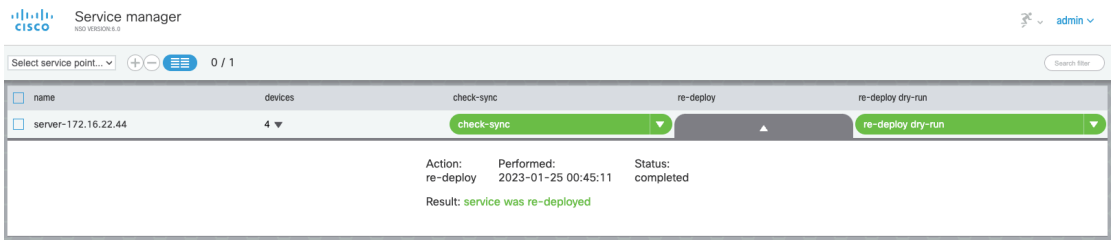




We will see exactly what needs to be added to the devices for them to be compliant with the service. And to configure the devices again we just need to click on re-deploy.







And the service was re-deployed. If we connect to ios-xr-2 and make a “show run” we can see that the configs are there again.

```
ios-xr-2# show run
admin
 exit-admin-config
!
domain name cisco.com
domain name-server 2.2.2.2
ntp
 peer 192.168.22.33
 server 172.16.22.44 minpoll 8 maxpoll 12
```

```
exit
vtp mode off
```

1.8 – NSO APIs

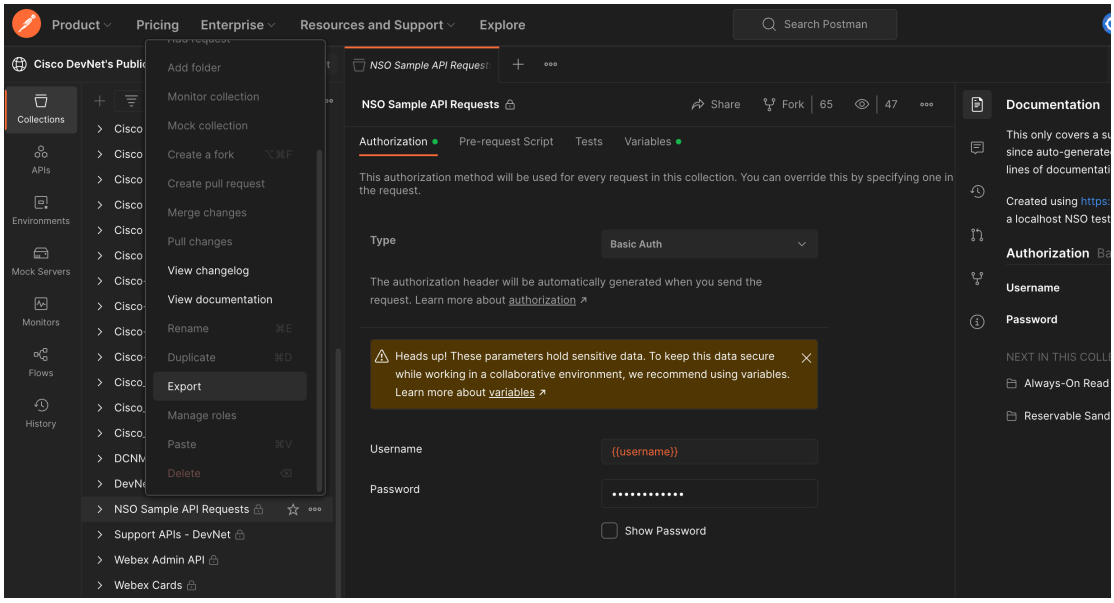
IN NSO you can interact via REST APIs as well.

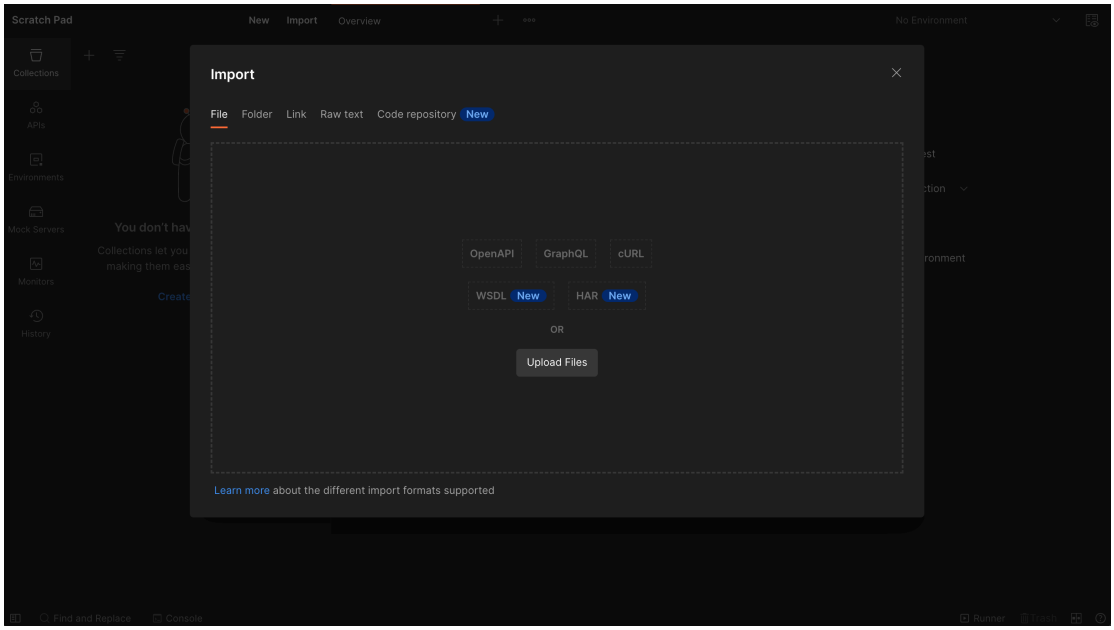
Cisco Provides a Postman collection already with a lot of options for you to interact with NSO.

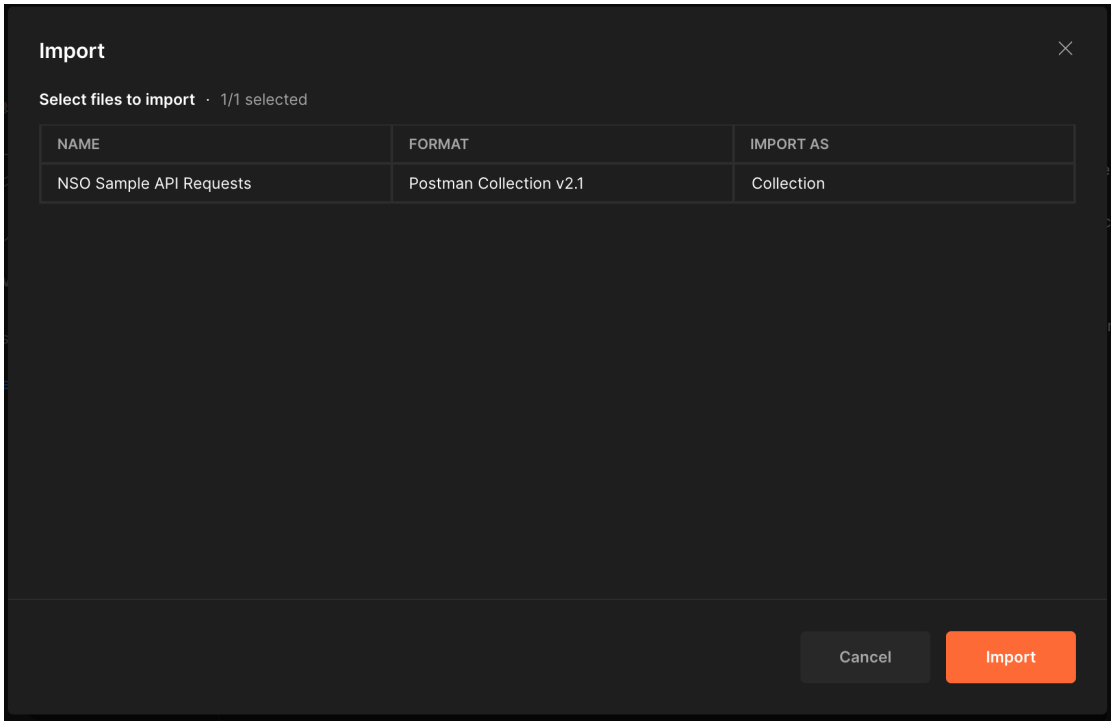
You can download it here.

Download and Import the collection (NSO Sample API Requests).

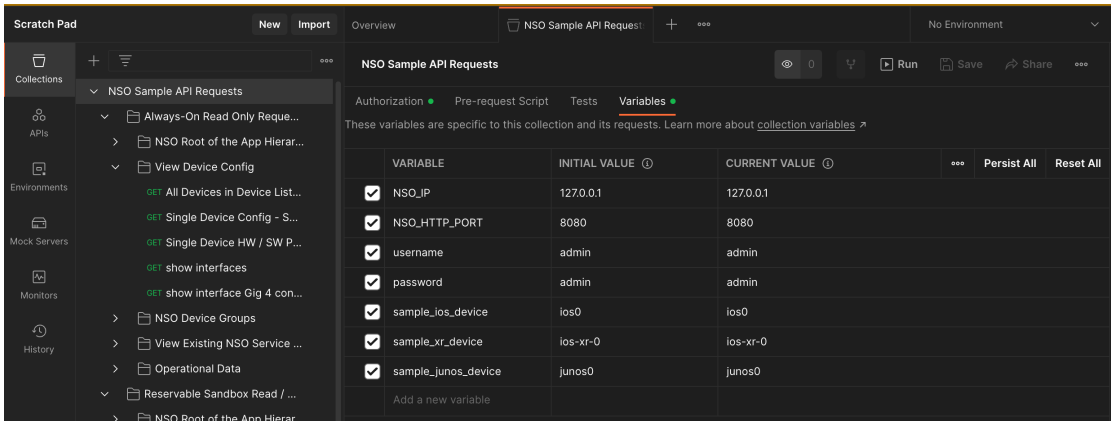
https://developer.cisco.com/docs/nso/#!nso-postman-collections







Change the Collection variables to the ones that fit your environment.

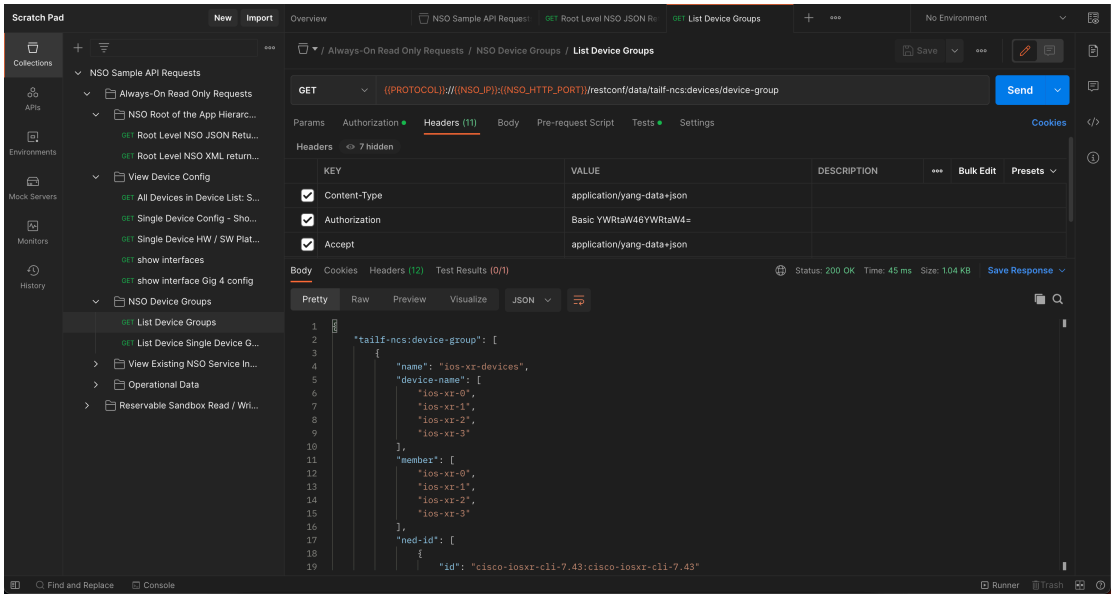


If you're using the default installation, change the NSO_HTTP_PORT from 8009 to 8080

And, if you gave the same name to the devices, you can change the sample_xr_device to "ios-xr-0"

Define the variable PROTOCOL with values http

Here is an example of the Device Group request.



How to get the RESTCONF pahts ? There are many ways to get them, one of them is going thought NSO CLI and use the command "show running-config devices device ios-xr-0 | display restconf"

And it will return the paths available for each device.

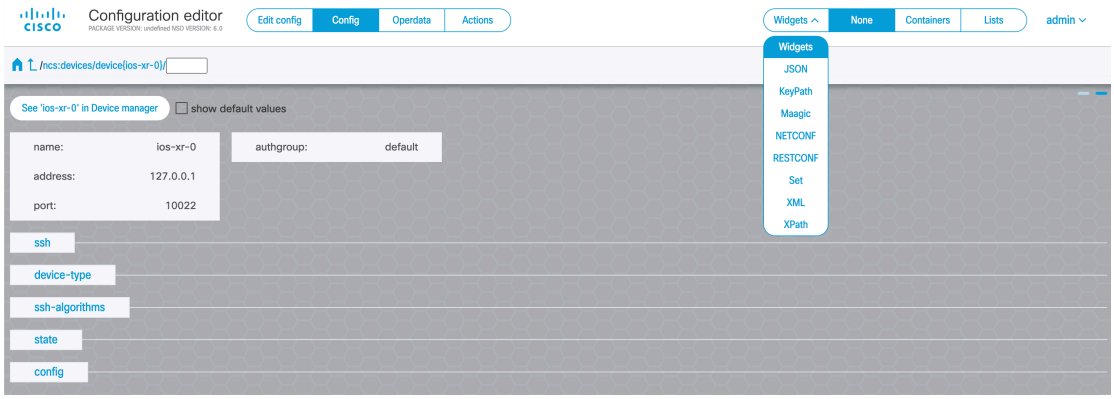
```
admin@ncs# show running-config devices device ios-xr-0 | display
restconf
/restconf/data/tailf-ncs:devices/device=ios-xr-0/address 127.0.0.1
```

```
/restconf/data/tailf-ncs:devices/device=ios-xr-0/port 10022
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh/host-key=ssh-
rsa/key-data
"AAAAB3NzaC1yc2EAAAADAQABAAABgQDAW+oFswFE439ByAMZ++iMLcnhVsI+Lui5mn/
Wfiie\npC3czutSFlfdIBOIC4sCpqYrxoqowXHhU2T9wnx5sAWwzPJuMjbbgUVnUslCV
8MeF/jWOUL4\n2Rr6IbECuV7qvMHfZmcrTR/BqXUdbqBtb5f0TzHdvT2gBP7AgLPptzV
a5/BDkNV70UG6Ocxc\nIsqWNl5471U0Dol7rSyufKz8y1sa4E0Dayn+9+O8uK6iq7GzP
qyf9fkrQjhmLNc5sozuAPQ4\nFMmjIAAMbQOzz5LvjktUw2QFgFm53Dzp83LxG6nVWBN
S4JlgniLEE4rG06xPDh6IAy5MKiBS\ntN4yBYF++0WL2tKszrCo//jZsDbv2ieTFROTp
mP2ldwgt7YUyep8j6JWVqLRPDVIjgXeGI6C\nG8xa81VW5uElmwGDSSjVFZVyXJQVKog
DNw19vREJHtSRAqjGknN648zAMtdR+BI1c9fLzdxS\nb1o2jJtU/P5WLLFmJDbw0+A+d
39iNuNr9H5PRj8="
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh/host-key=ssh-
ed25519/key-data
AAAAC3NzaC1lZDI1NTE5AAAAIGvE1TpobfiHd3r/Z+1Sxr8bARNNyzIGQt0DMgvpNjmj
/restconf/data/tailf-ncs:devices/device=ios-xr-0/authgroup default
/restconf/data/tailf-ncs:devices/device=ios-xr-0/device-
type/cli/ned-id cisco-iosxr-cli-7.43
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh-
algorithms/public-key [ ssh-ed25519 ssh-rsa ]
/restconf/data/tailf-ncs:devices/device=ios-xr-0/state/admin-state
unlocked
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:domain/name cisco.com
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:domain/name-server=2.2.2.2
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:n/restconf/data/tailf-ncs:devices/device=ios-xr-
0/address 127.0.0.1
/restconf/data/tailf-ncs:devices/device=ios-xr-0/port 10022
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh/host-key=ssh-
rsa/key-data
"AAAAB3NzaC1yc2EAAAADAQABAAABgQDAW+oFswFE439ByAMZ++iMLcnhVsI+Lui5mn/
Wfiie\npC3czutSFlfdIBOIC4sCpqYrxoqowXHhU2T9wnx5sAWwzPJuMjbbgUVnUslCV
8MeF/jWOUL4\n2Rr6IbECuV7qvMHfZmcrTR/BqXUdbqBtb5f0TzHdvT2gBP7AgLPptzV
a5/BDkNV70UG6Ocxc\nIsqWNl5471U0Dol7rSyufKz8y1sa4E0Dayn+9+O8uK6iq7GzP
qyf9fkrQjhmLNc5sozuAPQ4\nFMmjIAAMbQOzz5LvjktUw2QFgFm53Dzp83LxG6nVWBN
S4JlgniLEE4rG06xPDh6IAy5MKiBS\ntN4yBYF++0WL2tKszrCo//jZsDbv2ieTFROTp
mP2ldwgt7YUyep8j6JWVqLRPDVIjgXeGI6C\nG8xa81VW5uElmwGDSSjVFZVyXJQVKog
DNw19vREJHtSRAqjGknN648zAMtdR+BI1c9fLzdxS\nb1o2jJtU/P5WLLFmJDbw0+A+d
39iNuNr9H5PRj8="
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh/host-key=ssh-
ed25519/key-data
AAAAC3NzaC1lZDI1NTE5AAAAIGvE1TpobfiHd3r/Z+1Sxr8bARNNyzIGQt0DMgvpNjmj
/restconf/data/tailf-ncs:devices/device=ios-xr-0/authgroup default
/restconf/data/tailf-ncs:devices/device=ios-xr-0/device-
type/cli/ned-id cisco-iosxr-cli-7.43
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh-
algorithms/public-key [ ssh-ed25519 ssh-rsa ]
/restconf/data/tailf-ncs:devices/device=ios-xr-0/state/admin-state
unlocked
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:domain/name cisco.com
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:domain/name-server=2.2.2.2
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:n/restconf/data/tailf-ncs:devices/device=ios-xr-
0/address 127.0.0.1
```

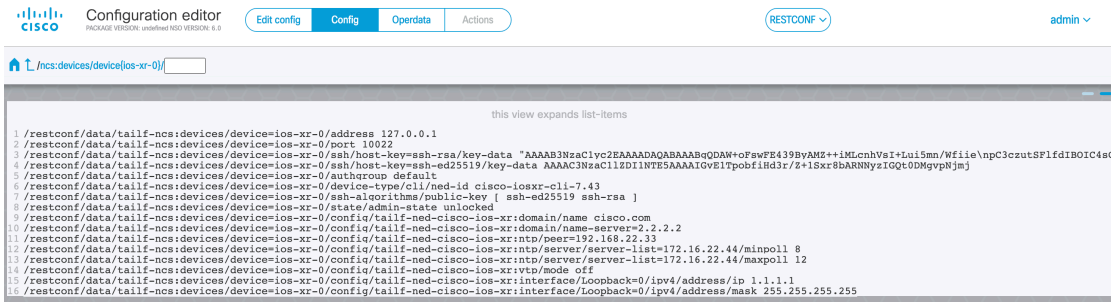
```
/restconf/data/tailf-ncs:devices/device=ios-xr-0/port 10022
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh/host-key=ssh-
rsa/key-data
"AAAAB3NzaC1yc2EAAAADAQABAAABgQDAW+oFswFE439ByAMZ++iMLcnhVsI+Lui5mn/
Wfiie\npC3czutSFlfdIBOIC4sCpqYrxoqowXHhU2T9wnx5sAWwzPJuMjbbgUVnUslCV
8MeF/jWOUL4\n2Rr6IbECuV7qvMHfZmcrTR/BqXUdbqBtb5f0TzHdvT2gBP7AgLPptzV
a5/BDkNV70UG6Ocxc\nIsqWNl5471U0Dol7rSyufKz8y1sa4E0Dayn+9+O8uK6iq7GzP
qyf9fkrQjhmLNc5sozuAPQ4\nFMmjIAAMbQOzz5LvjktUw2QFgFm53Dzp83LxG6nVWBN
S4JlgniLEE4rG06xPDh6IAy5MKiBS\ntN4yBYF++0WL2tKszrCo//jZsDbv2ieTFROTp
mP2ldwgt7YUyep8j6JWVqLRPDVIjgXeGI6C\nG8xa81VW5uElmwGDSSjVFZVyXJQVKog
DNw19vREJHtSRAqjGknN648zAMtdR+BI1c9fLzdxS\nb1o2jJtU/P5WLLFmJDbw0+A+d
39iNuNr9H5PRj8="
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh/host-key=ssh-
ed25519/key-data
AAAAC3NzaC1lZDI1NTE5AAAAIGvE1TpobfiHd3r/Z+1Sxr8bARNNyzIGQt0DMgvpNjmj
/restconf/data/tailf-ncs:devices/device=ios-xr-0/authgroup default
/restconf/data/tailf-ncs:devices/device=ios-xr-0/device-
type/cli/ned-id cisco-iosxr-cli-7.43
/restconf/data/tailf-ncs:devices/device=ios-xr-0/ssh-
algorithms/public-key [ ssh-ed25519 ssh-rsa ]
/restconf/data/tailf-ncs:devices/device=ios-xr-0/state/admin-state
unlocked
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:domain/name cisco.com
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:domain/name-server=2.2.2.2
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:ntp/peer=192.168.22.33
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:ntp/server/server-list=172.16.22.44/minpoll 8
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:ntp/server/server-list=172.16.22.44/maxpoll 12
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:vtp/mode off
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:interface/Loopback=0/ipv4/address/ip 1.1.1.1
/restconf/data/tailf-ncs:devices/device=ios-xr-0/config/tailf-ned-
cisco-ios-xr:interface/Loopback=0/ipv4/address/mask 255.255.255.255
```

The same output can be reached from the WEBUI

If we navigate to the Device Manager and we select the device “ios-xr-0” we will find on the top right a dropdown named “Widgets” and one of the options is “RESTCONF”



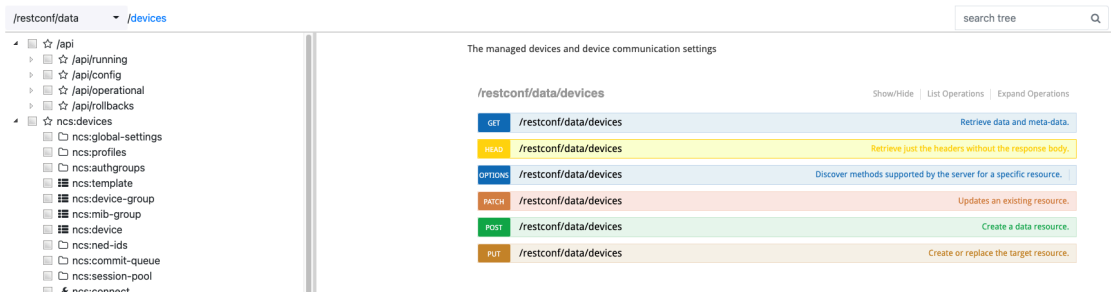
Clicking on RESTCONF option this will be the output. Remember, to use the Widgets function we must be in the Config mode of the device.



Another option to check the paths, is a package that was built for NSO (not made for PROD env), named “rest-api-explorer”

https://gitlab.com/nso-developer/rest-api-explorer

Using this package, you can explore all the available APIs for devices and services inside NSO.

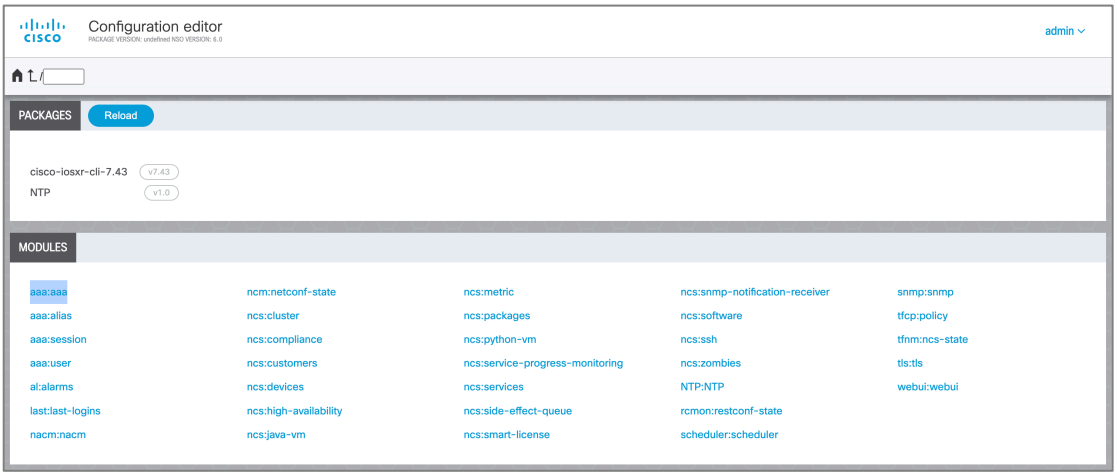


1.9 – Create Role Based and Resource Based Access Control rules

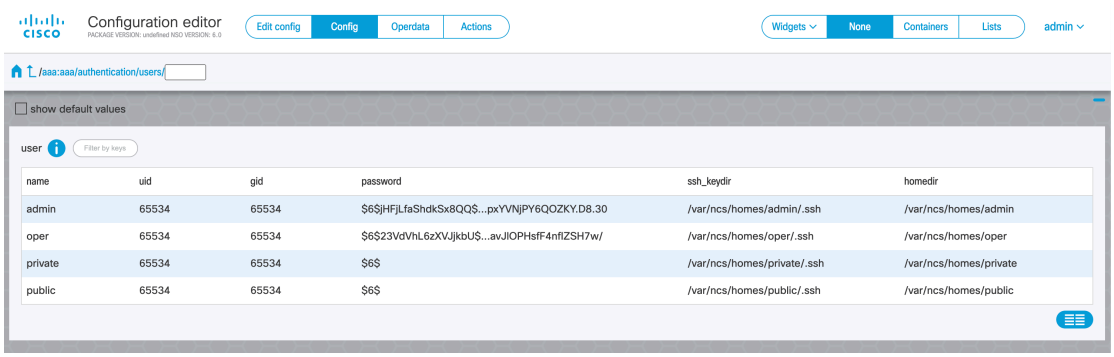
In this section the idea is to show you how we can create Role Based and Resource Based Access Control rules in NSO.

The first step is to add a new user.

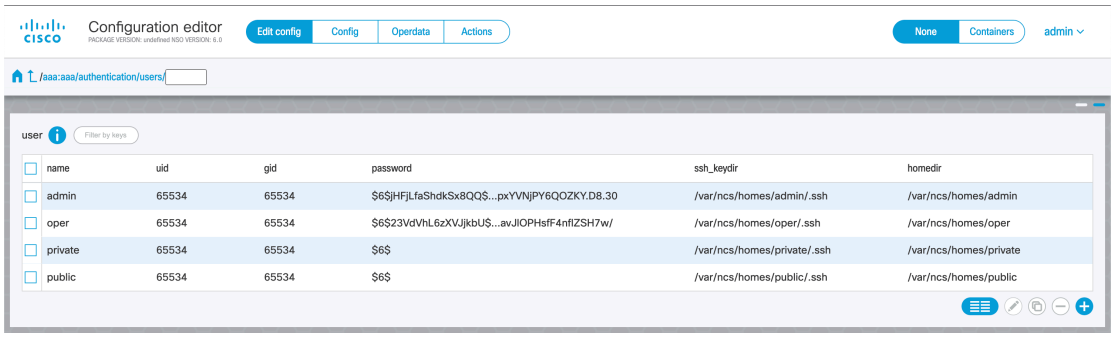
In the Configuration Editor we navigate to the “aaa:aaa” module.



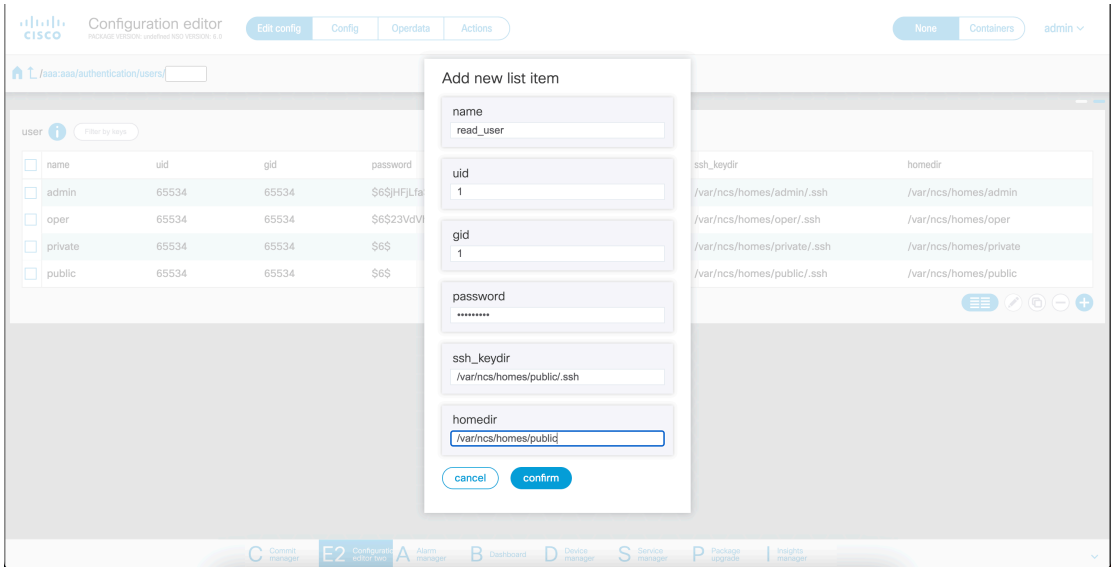
Then we go to the authentication/users



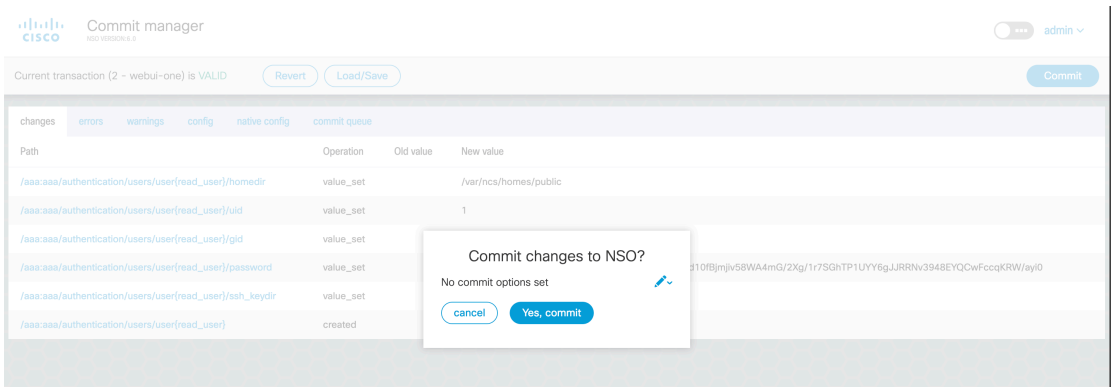
Change from Config to Edit config and we click on “+” button.



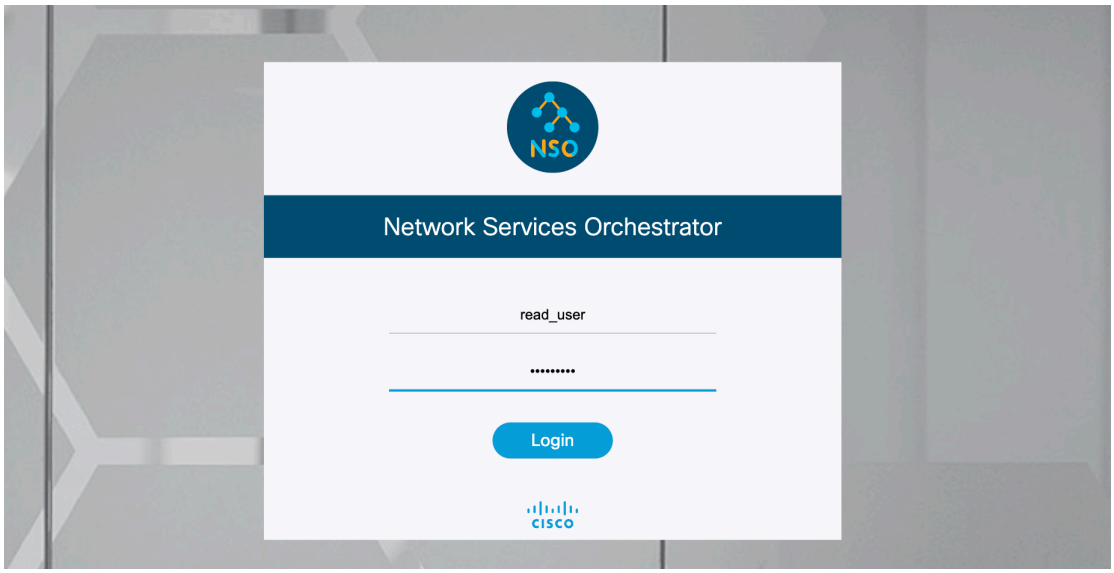
Let’s create the user “read_user”.



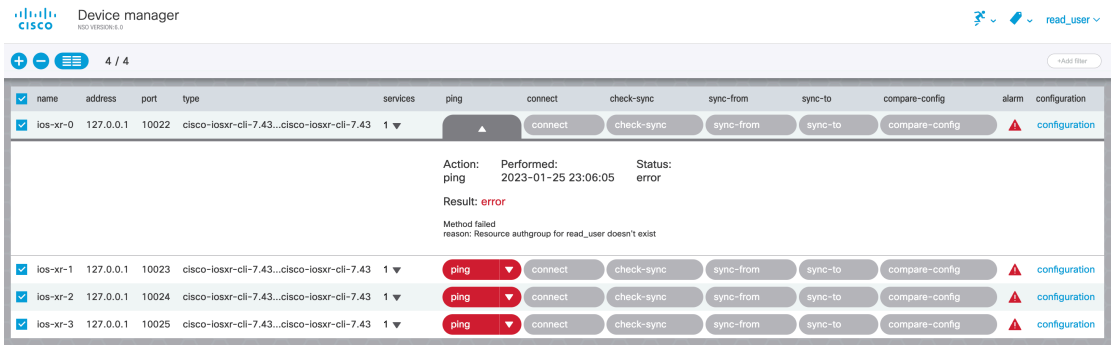
After this we can “Commit”.



And login to the new recently created user



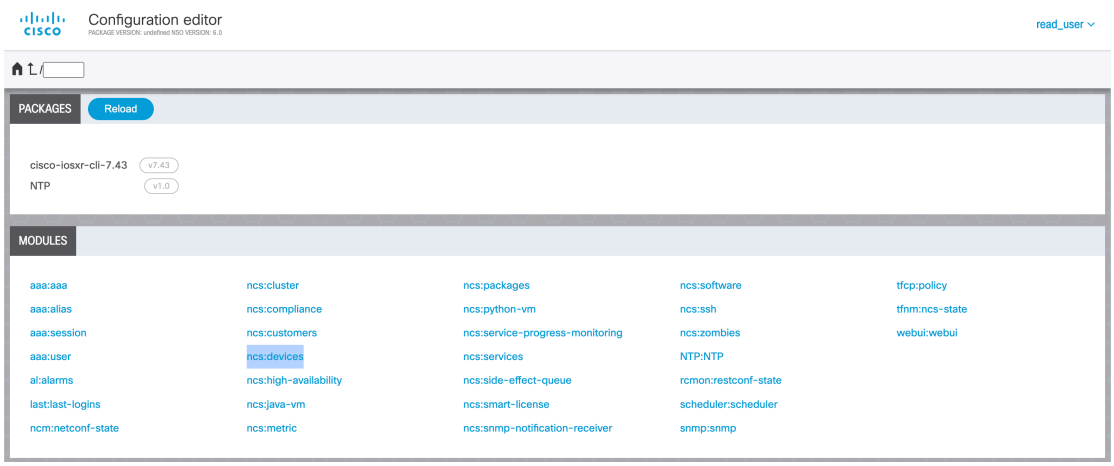
We can now go to the Device Manager and check if this user is able to do all the normal operations.



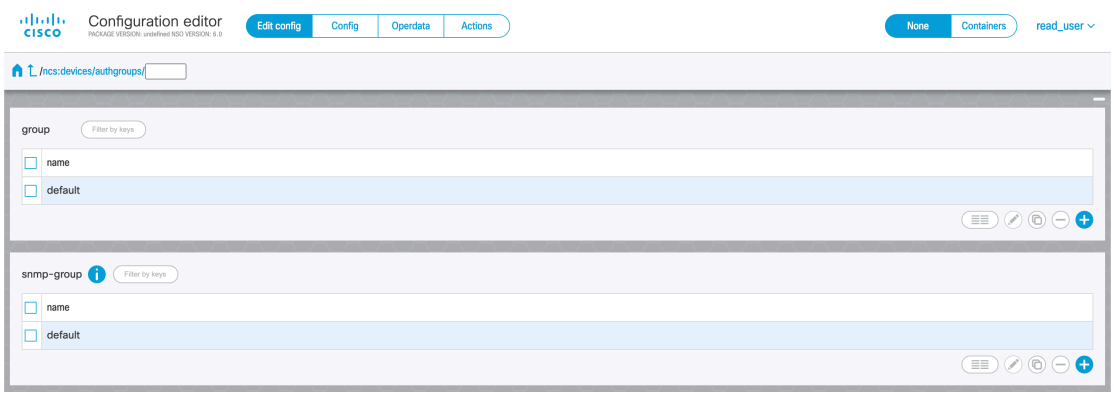
And, as we can see Ping is not possible because the new user does not belong to any authgroup.

The Authgroup is the feature that allows mapping the NSO local user to the device local user. Each Device must belong to an authgroup, and each user much be present in one authgroup as well (or, have a default-mapping per authgroup)

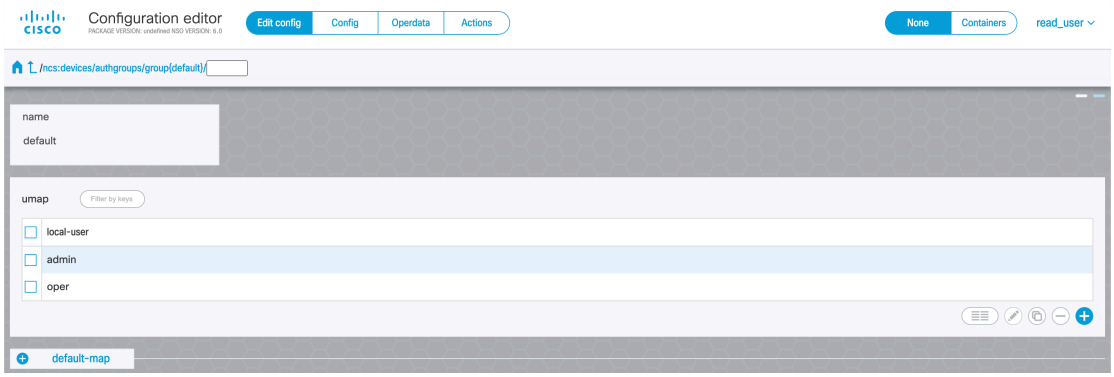
To create a new Authgoup or associate the user with an existing authgroup we go to the Configuration Editor, to the module ncs:devices



Then we select authgroup “default”



At this moment we can make these operations on the “read_user” since we didn’t made any change to user permissions.

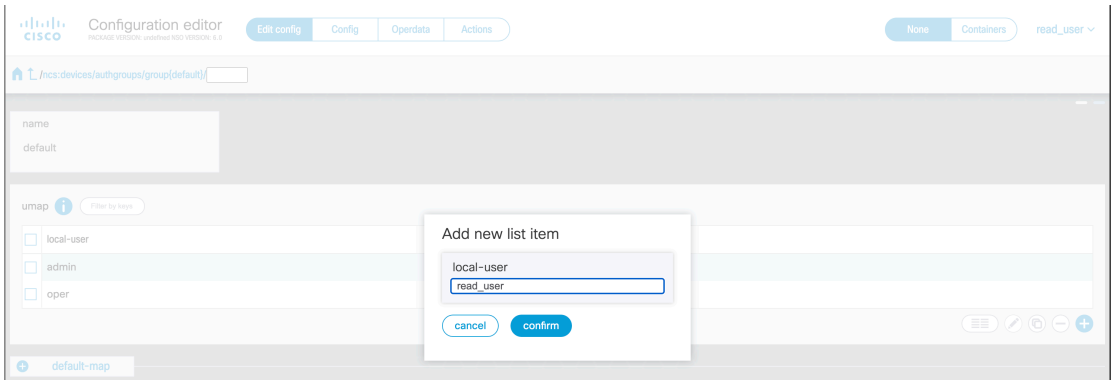


Now, inside the “default” authgroup we’ve the umap and default-map.

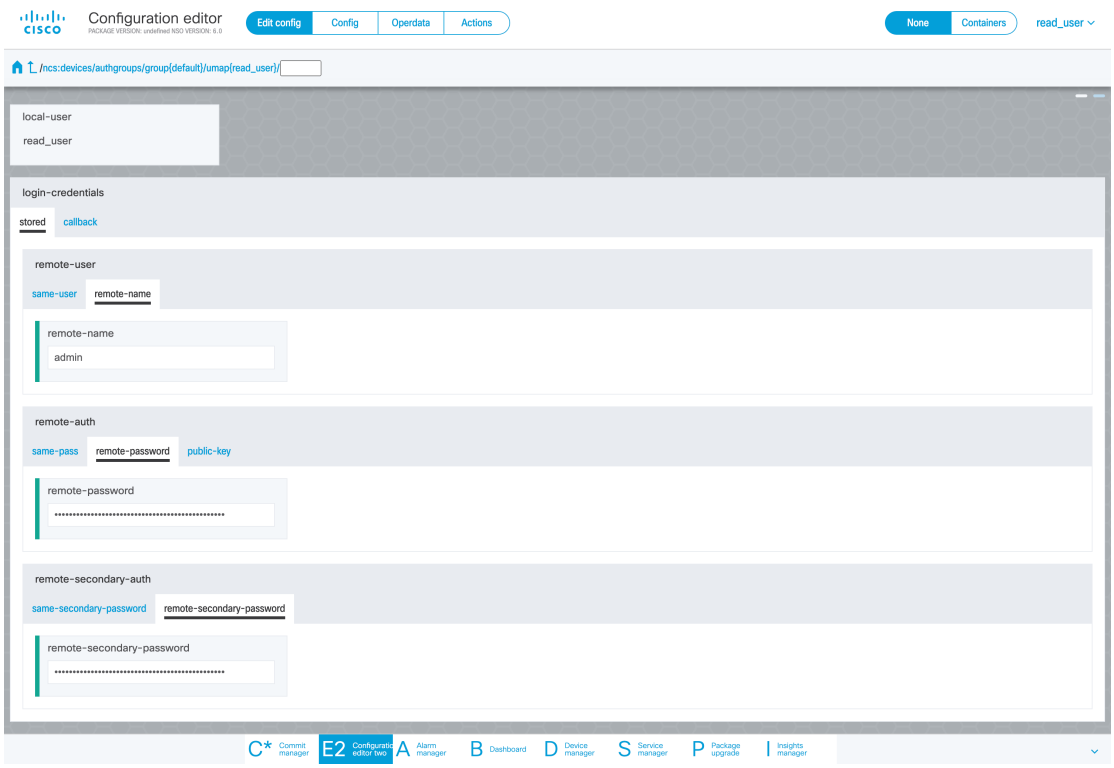
The umap, is a mapping for a local user that belongs to this Authgroup.

And we’ve a default-map, this one is a default mapping for each user that belongs to this group.

Let’s add our read_user to the “default” authgroup.

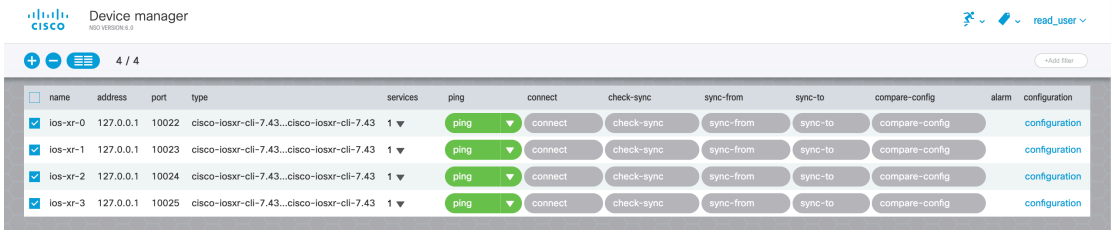


Now, you can choose what will be the credentials that this NSO user will use when connecting to the devices. (we can use admin-admin for the demo proposes).



Go to the commit manager and commit.

Going now back to the “Device Manager” we can now check the Ping again.



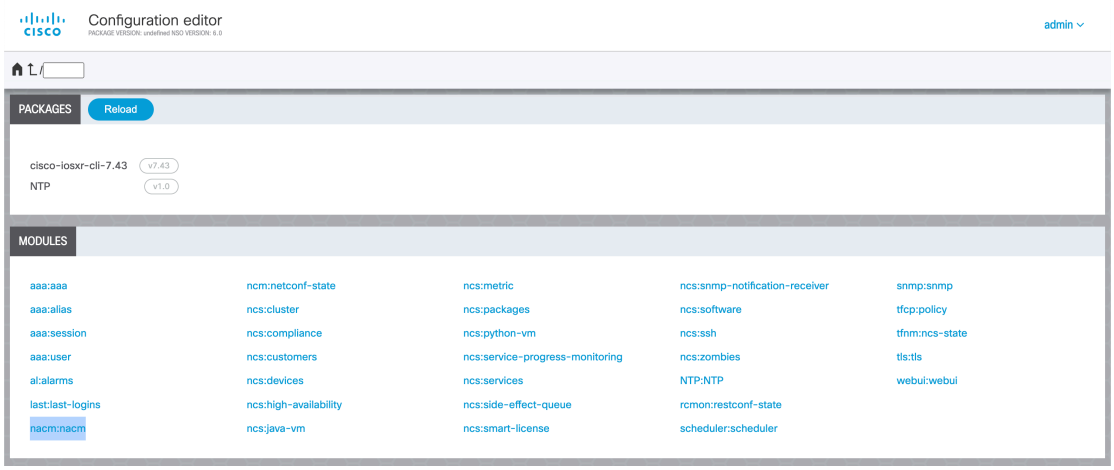
For now, this user can make all the normal operations.

Let’s start making some restrictions.

Go back to the admin user.

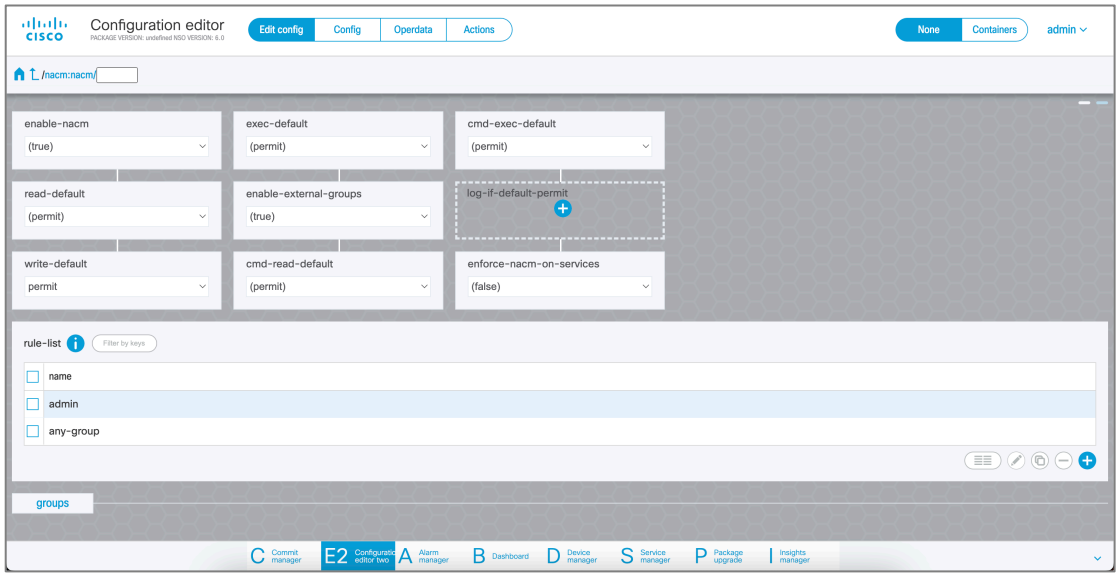
Then, go to the configuration Editor.

And then to the module nacm:nacm

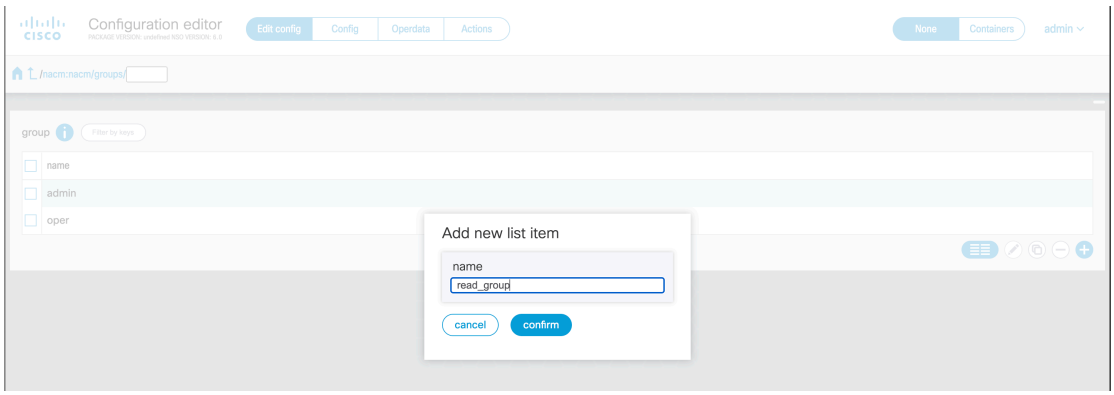


In the NACM module you will see the “rule-list” and the “groups”

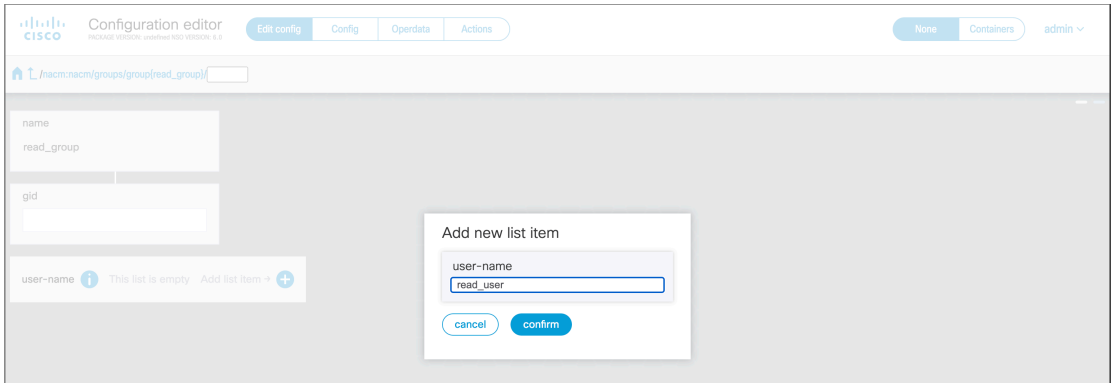
So, to set permissions we need to associate a user to a group, and then associate that group to a rule-list.



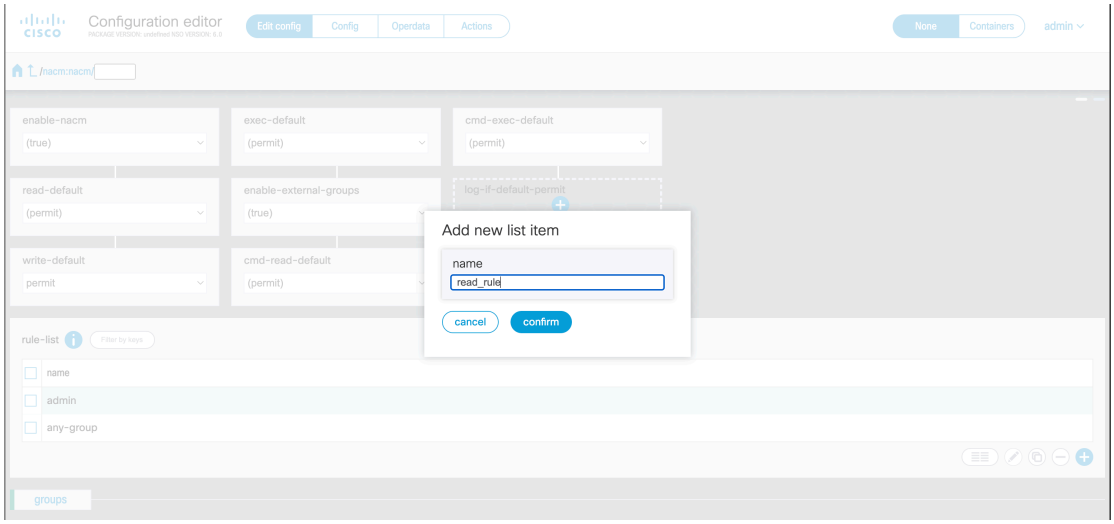
Let’s create the “read_group”



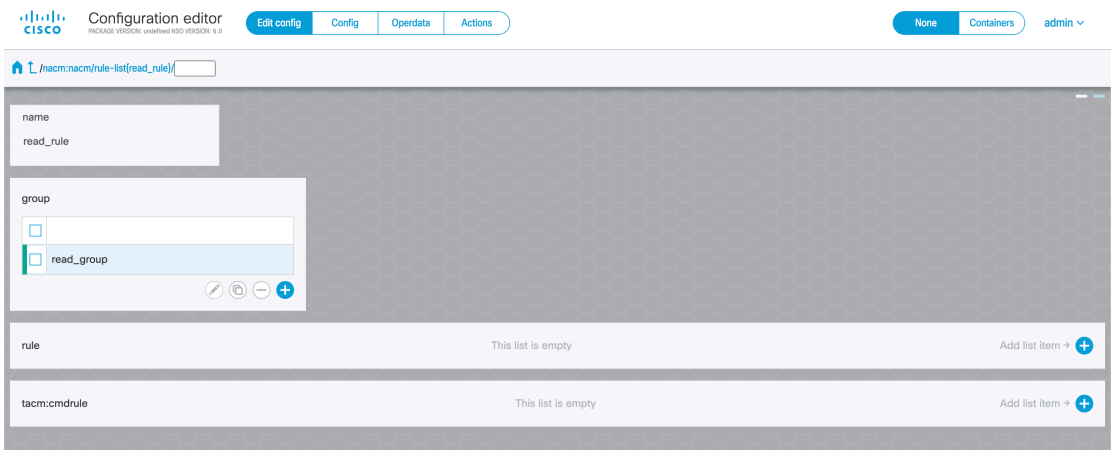
Then we setup one group-id (1 for example) and we add the user “read_user” to that group



After this, we can go back and create the rule-list “read_rule”

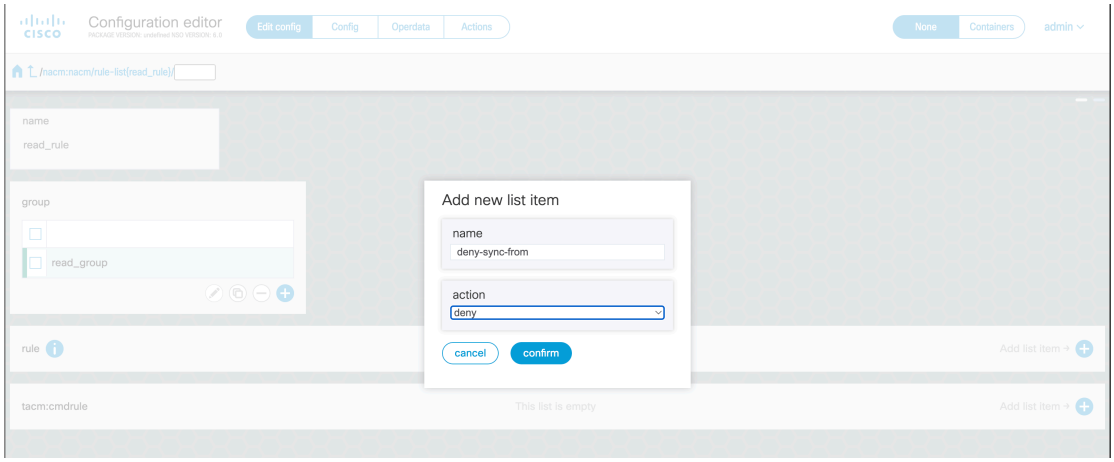


On this rule, we will add the read_group in groups. This means that all the rules that we will setup here will affect only the users that belong to this group.

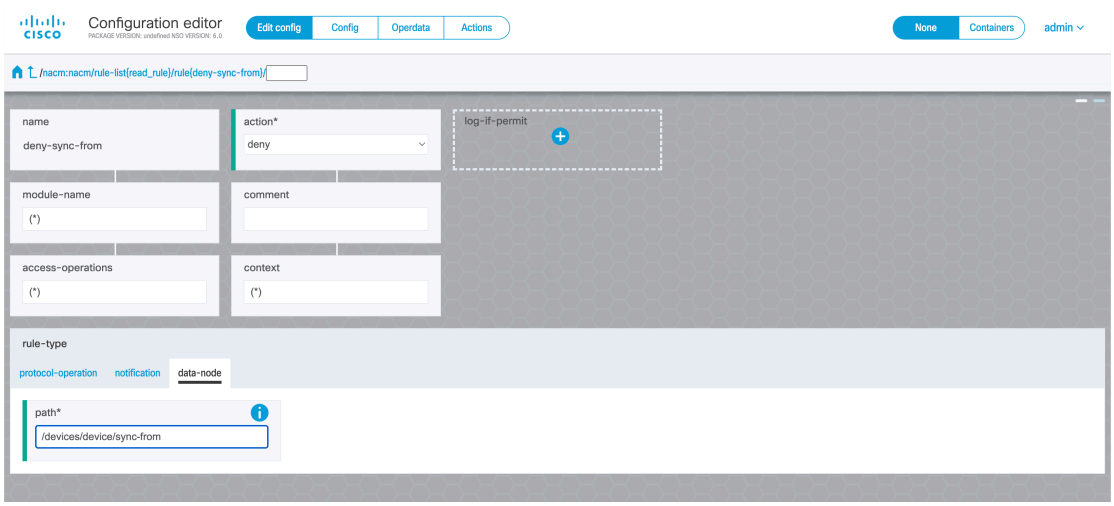


So, now we’ve 2 options, the cmdrule where the entries list are examined for command authorization, and the rule where entries are examined for rpc, notification, and data authorization.

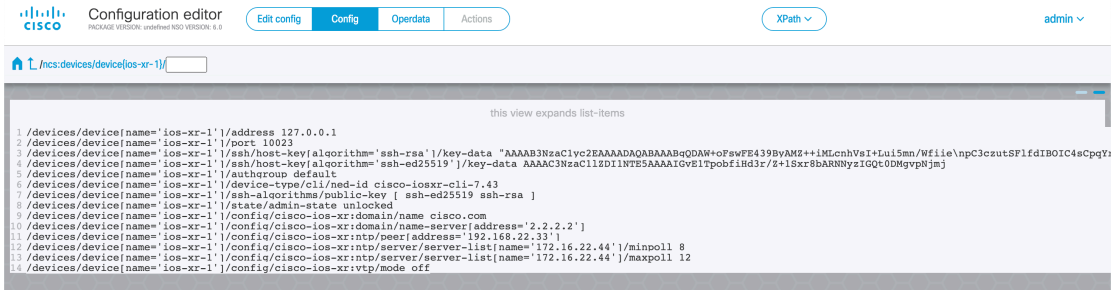
Let’s add a rule to deny the sync-from



In the rule we've to specify a path

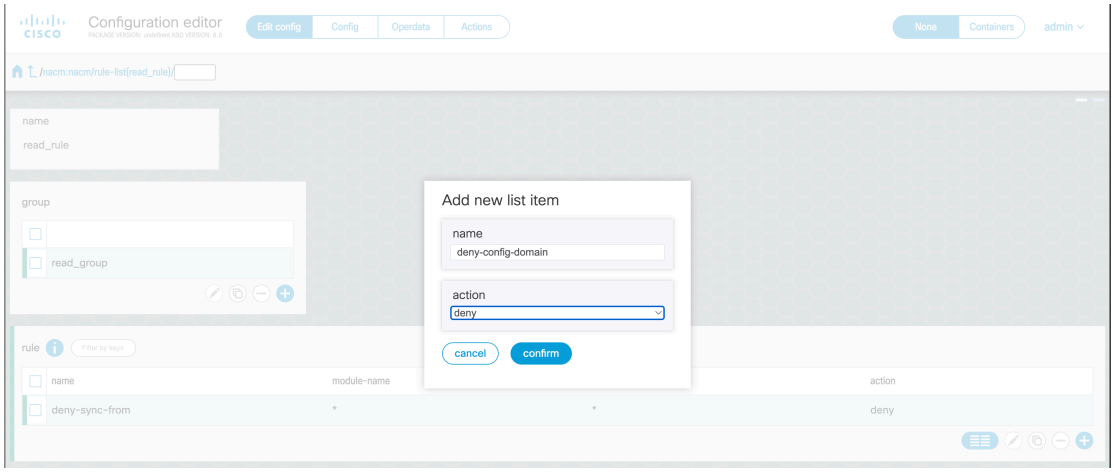


This path is nothing more than an XPATH. Like we saw before XPATHs can be found in many ways. In the next screenshot we can see the paths for the device IOS-XR-1 with the configurations in place.

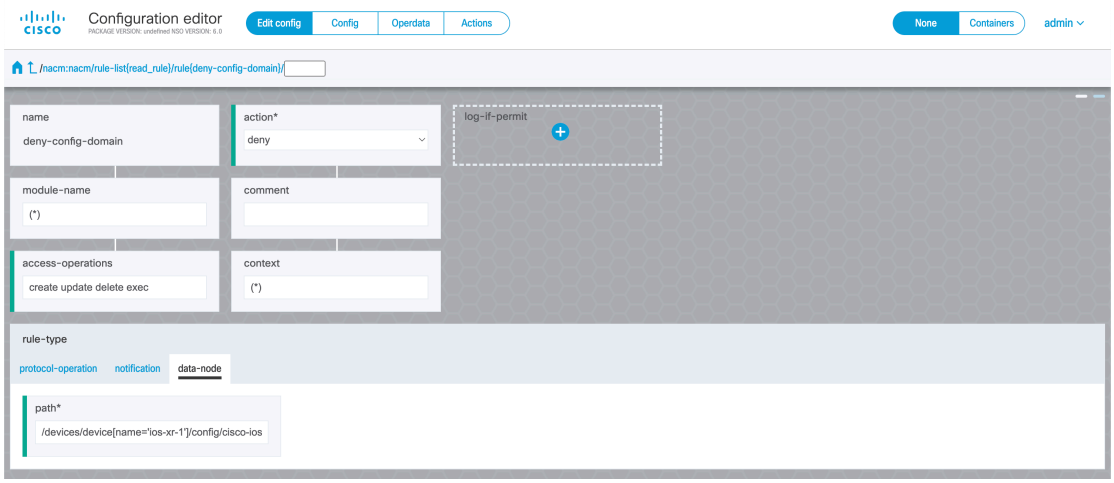


For example, we can grab the path "/devices/device[name='ios-xr-1']/config/cisco-ios-xr:domain" and restrict all the operations with the exception of reading.

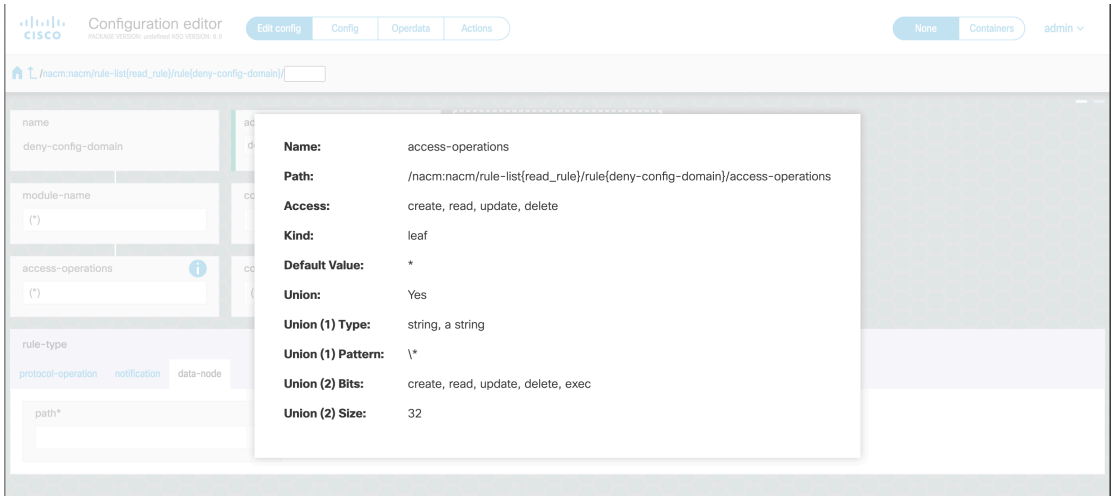
We create the rule "deny-config-domain"



And inside the rule on the data-node we use the path that we just got, we setup the action to deny and access-operations we will deny “create,update,delete,exec”



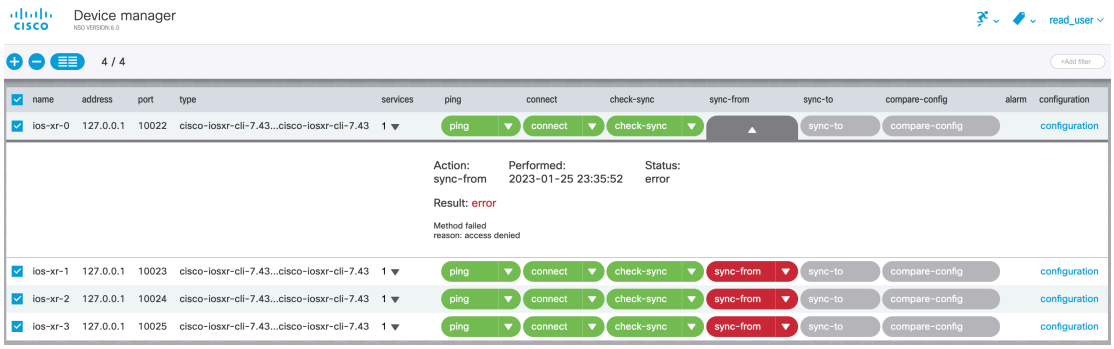
To see all the access-operations you can toggle the button near “view options” on the top right and then the info button will appear in each tile.



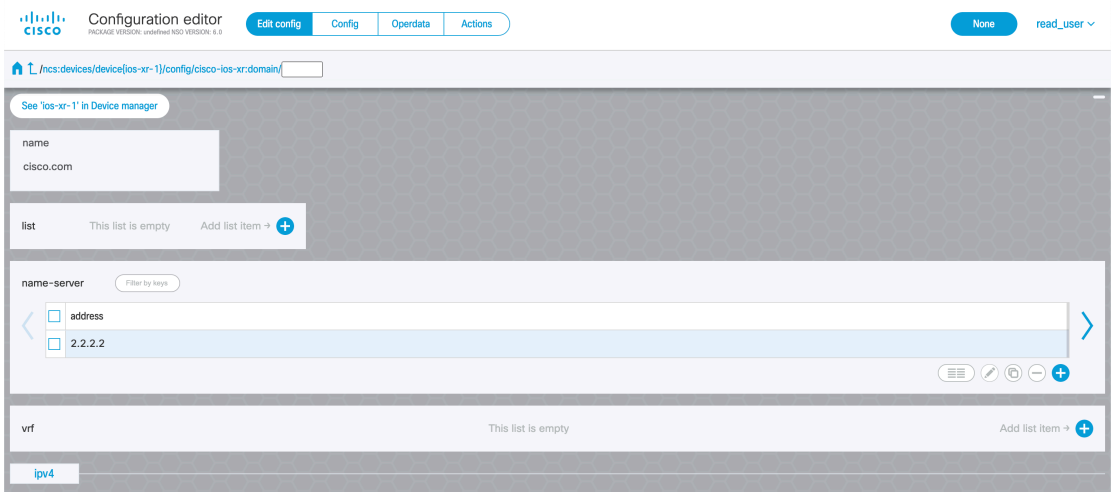
After this, we commit.

We logout from the admin user and we login into the read_user.

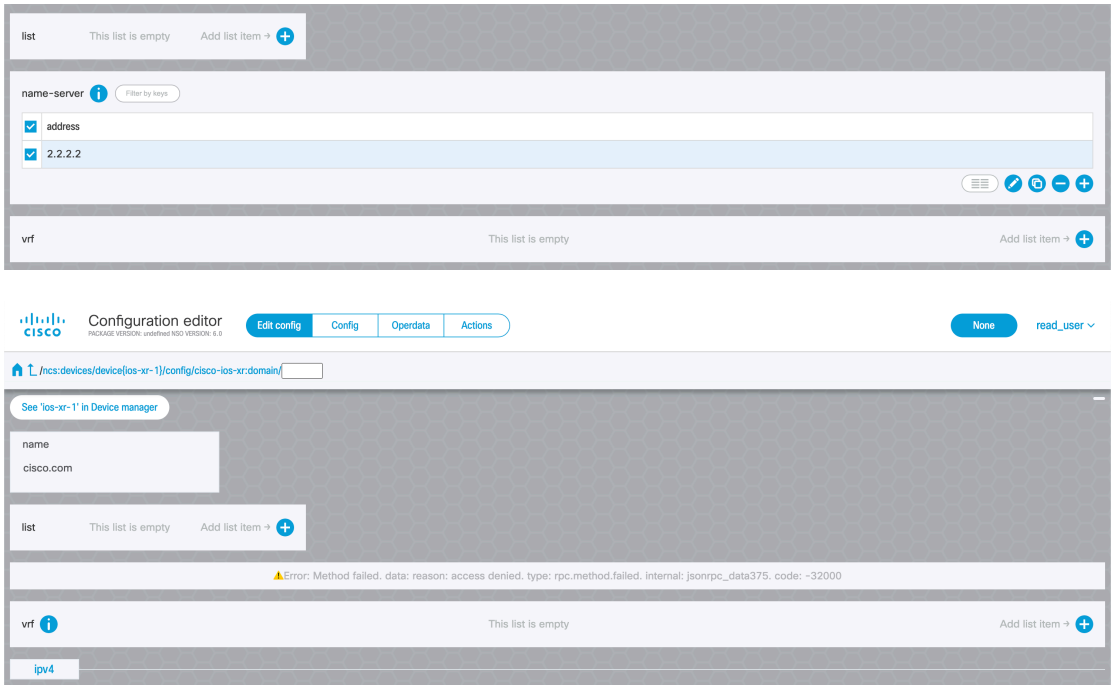
Now we go to the Device Manager and we test our rules. We can check the “ping”, “connect”, “check-sync” and “sync-from” and we will see that the “sync-from” operation got denied.



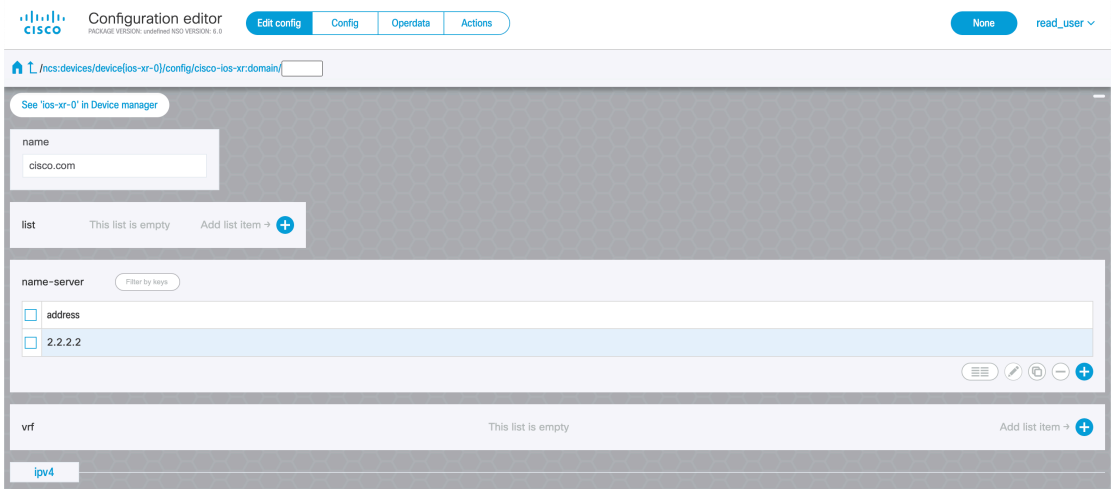
Now, if we go to the device ios-xr-1 and we go into config/domain we will see that we’re only able to read the info



And, if we try to remove anything by clicking on the - button we will get the “access denied” notification.



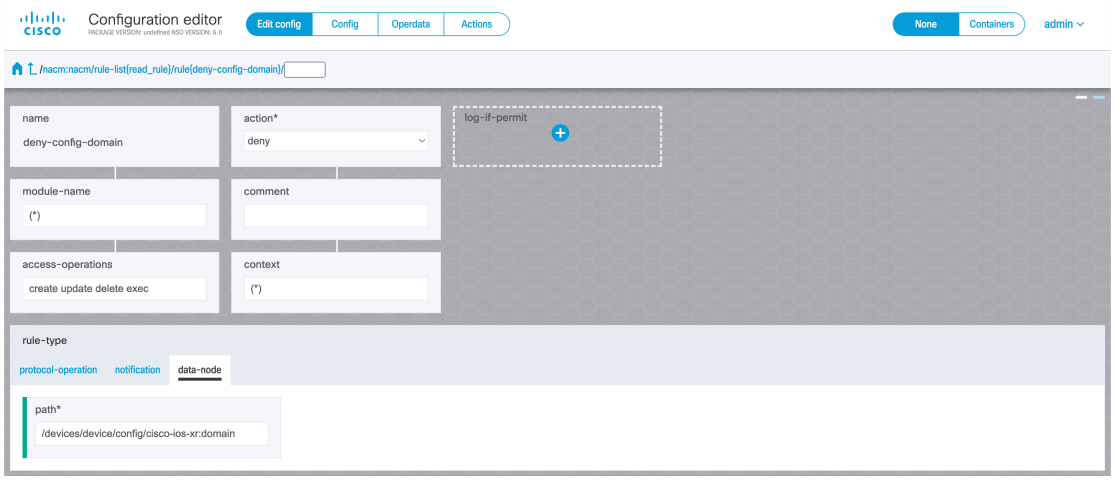
Since we've made the rule just for the ios-xr-1 device, if we go to the other devices, for example ios-xr-0 we see that we can still make changes in the domain configuration.



To apply this to all devices we need to login into the admin user, and change the PATH of this rule.

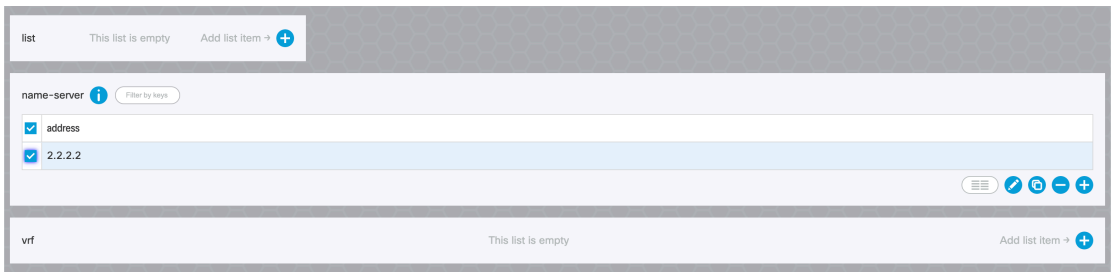
So, instead of "/devices/device[name='ios-xr-1']/config/cisco-ios-xr:domain/"

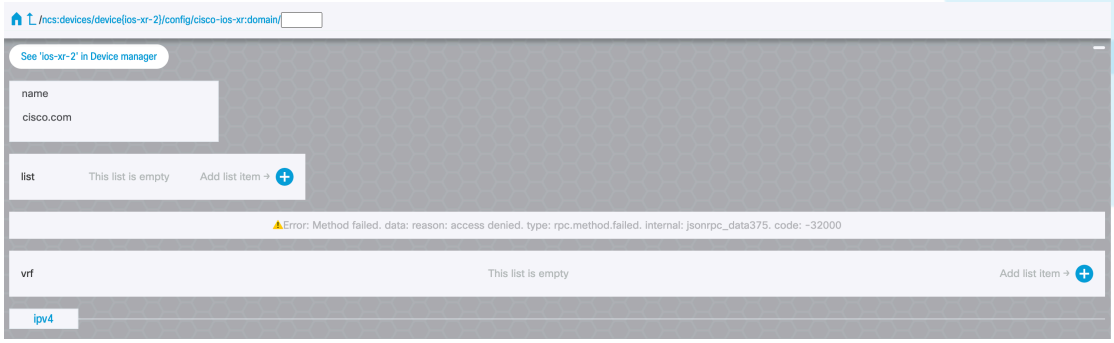
We will change to "/devices/device/config/cisco-ios-xr:domain/"



Commit and go back to the read_user.

We can see that after this change, we're not able to make any change in domain configuration on all managed devices with this user.




/ncs:devices/device{ios-xr-2}/config/cisco-ios-xr:domain/
See 'ios-xr-2' in Device manager
name
cisco.com
list
This list is empty
Add list item
Error: Method failed. data: reason: access denied. type: rpc.method.failed. internal: jsonrpc_data375. code: -32000
vrf
This list is empty
Add list item
ipv4

Thank you !