NCS 1001 Application Hosting

Application hosting

Application Hosting is the infra IOS-XR that allows you to

- run third-party applications on the NCS 1001 devices, and
- use third-party applications to extend device capabilities to complement IOS-XR features.

The Docker daemon is packaged with IOS-XR software on the base Linux OS. This provides native support for running applications inside docker containers on IOS-XR. Docker is the preferred way to run TPAs on IOS-XR.

App Manager

The App Manager is the infra on IOS-XR tasked with the responsibility of managing the life cycle of all container apps (third part and Cisco internal) and process scripts. App Manager runs natively on the host as an IOS-XR process. App Manager leverages the functionalities of docker, systemd and RPM for managing the lifecycle of third-party applications.

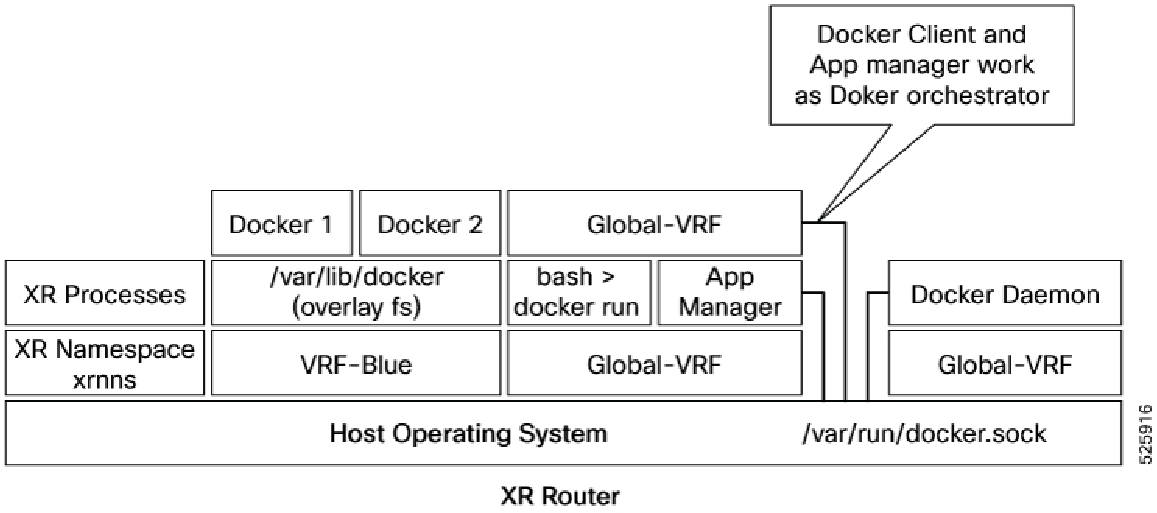
Restriction in docker container application hosting

MPLS packets are not supported on Linux interfaces.

Docker Container Application Hosting Architecture

This section describes the docker container application hosting architecture.

Figure 1: Docker on IOS XR



The App manager internally uses docker client, which interacts with TPAs (docker 1 and docker 2) by using the docker commands. The docker client sends the docker commands to **docker daemon**, which, then, executes the commands. The docker daemon uses the **docker.sock** Unix socket to communicate with the dockers.

When the **docker run** command is executed, a docker container is created and started from the docker image. Docker containers can be either in **global-vrf** namespace.

The docker utilizes overlayfs under the **/var/lib/docker** folder for managing the directories.

To host an application in docker containers, see Hosting an Application in Docker Containers.

Guidelines and Limitations

- For docker run options --mount and --volume, use the host paths.
  - "/var/run/netns"
  - "/var/lib/docker"
  - "/misc/disk1"
  - "/disk0"
  - "/misc/config/grpc"
  - "/etc"
  - "/dev/net/tun"
  - "/var/xr/config/grpc"
  - "/opt/owner"
- The maximum allowed size for shm-size option is 64 Mb.

TP Application Resource Configuration

IOS XR is equipped with inherent safeguards to prevent third party applications from interfering with its role as a Network OS.

- Although IOS XR doesn't impose a limit on the number of TPAs that can run concurrently, it does impose constraints on the resources allocated to the Docker daemon, based on the following parameters:
  - CPU: By default, ¼ of the CPU per core available in the platform.

    You can hard limit the default CPU usage in the range between 25-75% of the total system CPU using the appmgr resources containers limit cpu value command. This configuration restricts the TPAs from using more CPU than the set hard limit value irrespective of the CPU usage by other XR processes.

    This example provides the CPU hard limit configuration.

    ```
    RP/0/RSP0/CPU0:ios(config)#appmgr resources containers limit cpu ?
      <25-75>  In Percentage
    RP/0/RSP0/CPU0:ios(config)#appmgr resources containers limit cpu 25
    ```

  - RAM: By default, 1 GB of memory is available.

    You can hard limit the default memory usage in the range between 1-25% of the overall system memory using the appmgr resources containers limit memory value command. This configuration restricts the TPAs from using more memory than the set hard limit value.

    This example provides the memory hard limit configuration.

    ```
    RP/0/RSP0/CPU0:ios(config)#appmgr resources containers limit memory ?
      <1-25>  In Percentage
    RP/0/RSP0/CPU0:ios(config)#appmgr resources containers limit memory 20
    ```

  - Disk space is restricted by the partition size, which varies by platform and can be checked by executing "run df -h" and examining the size of the `/misc/app_host` or `/var/lib/docker` mounts.

- All traffic to and from the application is monitored by the XR control protection, LPTS.
- Signed Applications are supported on IOS XR. Users have the option to sign their own applications by onboarding an Owner Certificate (OC) through Ownership Voucher-based workflows as described in RFC 8366. Once an Owner Certificate is onboarded, users can sign applications with GPG keys based on the Owner Certificate, which can then be authenticated during the application installation process on the router.

The table below shows the various functions performed by appmgr.

Package Manager	Lifecyle Manager	Monitoring and Debugging
• Handles installation of docker images packaged as RPMs. • Syncs the required state to standby to restart apps in cases of switchover, etc	• Handles application start/stop/kill operations. • Handles automatic application reload on: • Router reboot • Container crash • Switchover	• Logging, stats, application health check. • Forwards docker deamon logs to XR syslog. • Allows to execute into docker shell of running application.

TP App Bring-up

This section provides the information, how to bring-up the TP container app. This can be done by following below mentioned four ways.

- App Config
- UM Model
- Native Yang Model
- gNOI Containerz

Bring up TPAs using application configuration

Follow these steps to configure the docker run time options.

Procedure

Step 1 Configure the docker run time option.

Use **--pids-limit** to limit the number of process IDs using appmgr.

Example:

This example shows the configuration of the docker run time option **--pids-limit** to limit the number of process IDs using appmgr.

```
RP/0/RP0/CPU0:ios#appmgr application alpine_app activate type docker source alpine docker-run-opts
"-it –pids-limit 90" docker-run-cmd "sh"
```

The number of process IDs is limited to 90.

Step 2 Verify the docker run time option configuration.

Use the **show running-config appmgr** command to verify the run time option.

Example:

This example shows how to verify the docker run time option configuration.

```
RP/0/RP0/CPU0:ios#show running-config appmgr
Thu Mar 23 08:22:47.014 UTC
appmgr
 application alpine_app
  activate type docker source alpine docker-run-opts "-it –pids-limit 90" docker-run-cmd "sh"
 !
!
```

Bring up TPAs using UM model

Follow these steps to configure the docker run time options.

Procedure

Configure the docker run time option.

Use **--pids-limit** to limit the number of process IDs using Netconf.

Example:

This example shows the configuration of the docker run time option **--pids-limit** to limit the number of process IDs using Netconf.

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <edit-config>
    <target>
      <candidate/>
    </target>
    <config>
      <appmgr xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-appmgr-cfg>
        <applications>
          <application>
            <application-name>alpine_app</application-name>
            <activate>
              <type>docker</type>
                  <source-name>alpine</source-name>
                  <docker-run-cmd>/bin/sh</docker-run-cmd>
                  <docker-run-opts>-it --pids-limit=90</docker-run-opts>
            </activate>
          </application>
        </applications>
      </appmgr>
    </config>
  </edit-config>
```

The number of process IDs is limited to 90.

Bring up TPAs using Native model

This example shows the configuration of the docker run time option **--pids-limit** to limit the number of process IDs using Native YANG model.

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <edit-config>
    <target>
      <candidate/>
    </target>
    <config>
      <appmgr xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-appmgr-cfg>
        <applications>
          <application>
            <application-name>alpine_app</application-name>
            <activate>
              <type>docker</type>
               <source-name>alpine</source-name>
               <docker-run-cmd>/bin/sh</docker-run-cmd>
               <docker-run-opts>-it --pids-limit=90</docker-run-opts>
            </activate>
          </application>
        </applications>
      </appmgr>
    </config>
  </edit-config>
```

Bringup TPAs using gNOI Containerz

The Containerz - gNOI Container Service on NCS 1001 device is a workflow to onboard and manage third-party applications using gNOI RPCs.

For more information, see gNOI Containerz.

Docker Run Options Using Application Manager

With this feature, runtime options for docker containerized applications on IOS-XR can be configured during launch using the **appmgr activate** " command. AppMgr, which oversees docker containerized applications, ensures that these runtime options can effectively override default configurations, covering aspects like CPU, security, and health checks during the container launch.

This feature introduces multiple runtime options that allow users to customize different parameters of docker containers. The configuration of these runtime options is flexible, as users can use either command or Netconf for the configuration process. Regardless of the chosen method, runtime options must be added to **docker-run-opts** as needed.

Table 1:

Docker Run Option	Description
--cpus	Number of CPUs
--cpuset-cpus	CPUs in which to allow execution (0-3, 0,1)
--cap-drop	Drop Linux capabilities
--user, -u	Sets the username or UID
--group-add	Add additional groups to run
--health-cmd	Run to check health
--health-interval	Time between running the check
--health-retries	Consecutive failures needed to report unhealthy
--health-start-period	Start period for the container to initialize before starting health-retries countdown
--health-timeout	Maximum time to allow one check to run
--no-healthcheck	Disable any container-specified HEALTHCHECK
--add-host	Add a custom host-to-IP mapping (host:ip)
--dns	Set custom DNS servers
--dns-opt	Set DNS options
--dns-search	Set custom DNS search domains

Docker Run Option	Description
--domainname	Container NIS domain name
--oom-score-adj	Tune host's OOM preferences (-1000 to 1000)
--shm-size	Option to set the size of /dev/shm
--init	Run an init inside the container that forwards signals and reaps processes
--label, -l	Set meta data on a container
--label-file	Read in a line delimited file of labels
--pids-limit	Tune container pids limit (set -1 for unlimited)
--work-dir	Working directory inside the container
--ulimit	Ulimit options
--read-only	Mount the container's root filesystem as read only
--volumes-from	Mount volumes from the specified container(s)
--stop-signal	Signal to stop the container
--stop-timeout	Timeout (in seconds) to stop a container
--cap-addNET_RAW	Enable NET_RAW capabilities
--publish	Publish a container's port(s) to the host
--entrypoint	Overwrite the default ENTRYPOINT of the image
--expose	Expose a port or a range of ports
--link	Add link to another container
--env	Set environment variables
--env-file	Read in a file of environment variables
--network	Connect a container to a network
--hostname	Container host name
--interactive	Keep STDIN open even if not attached
--tty	Allocate a pseudo-TTY
--publish-all	Publish all exposed ports to random ports
--volume	Bind mount a volume
--mount	Attach a filesystem mount to the container
--restart	Restart policy to apply when a container exits

Docker Run Option	Description
--cap-add	Add Linux capabilities
--log-driver	Logging driver for the container
--log-opt	Log driver options
--detach	Run container in background and print container ID
--memory	Memory limit
--memory-reservation	Memory soft limit
--cpu-shares	CPU shares (relative weight)
--sysctl	Sysctl options

Third party RPMs installation using App Manager install UI

This section describes how to install third party RPMs using App Manager install UI at runtime while the router is running.

Limitation and guidelines for third party RPMs

These are the limitations and guidelines for the TP RPMs.

- RPM must not have “scriptlets”. Scriptlets allow packages to run code on installation and removal.
- RPM must not be already installed via XR Install UI.
- RPM must not be already installed via App manager UI.
- TP RPMs must install files only to the `/var/lib/docker/appmgr/` filesystem location.
- RPM Signature verification is not enforced by App Manager Install UI. It supports unsigned TP RPMs.

Install third party RPMs using App Manager install UI

Use this task to install third party RPMs using App Manager install UI.

Procedure

Step 1 Create an RPM containing the application (in the form of a docker container image).

Step 2 Use App manager RPM build tool to generate TP RPMs. See https://github.com/ios-xr/xr-appmgr-build/blob/main/README.md.

Step 3 Install the TP RPM using the App Manager Install UI command.

Example:

```
RP/0/RP0/CPU0:ios# appmgr package install rpm /harddisk\:/alpine-0.1.0-XR_7.3.1.x86_64.rpm
```

Uninstall third party RPMs using App Manager install UI

Use this task to uninstall third party RPMs using App Manager install UI.

Uninstallation of TP RPM can be performed using two ways.

Attention App manager uninstall CLI uninstalls the TP RPM at runtime while NCS 1001 is running.

Procedure

Step 1 Uninstall using source name.

Example:

```
RP/0/RP0/CPU0:ios# appmgr package uninstall source alpine
```

Step 2 Uninstall using package name.

Example:

```
RP/0/RP0/CPU0:ios# appmgr package uninstall package alpine-0.1.0-XR_7.3.1.x86_64
```

Supported commands on application manager

This section describes the operations and the IOS XR commands that are supported on the application manager:

Action commands

App Manager action commands are used to start, stop, kill and exec shell commands inside running container.

Table 2: Action commands

Command name	Commands	Purpose
Application start	**appmgr application start name** <*name*>	Starts a stopped container or application.
Application stop	**appmgr application stop name** <*name*>	Stops a stopped running container or application.
Application kill	**appmgr application kill name** <*name*>	Kills a running container or application.
Application copy	**appmgr application copy** <*storage-path*>	Copy data between host and container.

Command name	Commands	Purpose
Appliction exec	**appmgr application exec** *<name>* **docker-exec-cmd** *<cmd>*	Executes command inside TP container application (docker only).

Examples

Here are examples for the app manager action commands. For more information on the commands, see *Command Reference Guide for NCS 1001*.

Action CLI (Start): This starts a stopped container

```
RP/0/RP0/CPU0:ios# appmgr application start name alpine_app
```

Action CLI (Stop): This stops a running container

```
RP/0/RP0/CPU0:ios# appmgr application stop name alpine_app
```

Action CLI (Kill): This forcefully kills a running container

```
RP/0/RP0/CPU0:ios# appmgr application kill name alpine_app
```

Action CLI (Copy): Copy data between host and container

```
RP/0/RP0/CPU0:ios# appmgr application copy harddisk:/data.txt alpine_app:/
```

Action CLI (Exec): Execute command inside TP container app

```
RP/0/RP0/CPU0:ios# appmgr application exec name txt alpine_app docker-exec-cmd “ls -ltr”
```

Show commands

App Manager show commands shows the application or container info.

Table 3: show commands

Command name	Commands	Purpose
Source table modification	**show appmgr source-table**	Lists all third-party applications onboarded via (XR Infra / Appmgr CLI / Containerz).
Application table modification	**show appmgr application-table**	Lists all third-party applications managed via (Config / Containerz) workflow in a tabular view.
Application source name	**show appmgr source name** *<name>*	Shows the source name.
Application package install	**show appmgr packages installed**	Lists all the application manager RPM packages installed.
Appliction exec	**show appmgr application name** *<name>* **info** [**detail** | **summary**]	Shows application information at desired verbosity.
Application logs	**show appmgr application name** *<name>* **logs**	Shows application logs.

Command name	Commands	Purpose
Application stats	**show appmgr application name** *name* **stats**	Shows application statistics.
Application process script table	**show appmgr process-script-table**	Shows summary status of all registered process-scripts.

Examples

This section shows the example outputs for the show appmgr commands. For more information on the show appmgr commands, see the *Command Reference guide for the NCS 1001*.

The example output shows the onboarded TP applications.

```
RP/0/RP0/CPU0:ios# show appmgr source-table
Sno Name                   File                                Installed By

--- ----------------- -------------------- -----------------------------------
1   alpine                 alpine.tar.gz                containerz
2   hello-world        hello-world.tar.gz       app_manager
3   bonnet               bonnet.tar.gz              xr_install
```

The example output shows the Workflow column that specifies how to manage the TP applications.

```
RP/0/RP0/CPU0:ios#show appmgr application-table
Name          Type    Config State  Status                 Workflow
------------- ------ ------------ ------------- ---------------------------------
alp-cz-app    Docker  Activated    Up 2 minutes     containerz
bnt-cfg-app  Docker  Activated    Up 1 minutes     config
```

The example output shows the details of the *swan* application. The `Status` value under `Vrf Relay: <name>` indicates the running status of the relay agent. If it reports an `Exited` state or a `Restarting` state, use the relay agent logs for troubleshooting.

```
RP/0/RP0/CPU0:ios#show appmgr application name swan info detail
Mon Nov 23 21:22:47.240 UTC
Application: swan
  Type: Docker
  Source: swanagent
  Config State: Activated
  Docker Information:
    Container ID: cd27988cd5b066d6272085e5e3ff675c94a64cb4ad06f90c2d89453a8ec4af34
    Container name: swan
    Labels:
    Image: swanagent:latest
    Command: "./agentxr"
    Created at: 2020-11-23 21:22:39 +0000 UTC
    Running for: 8 seconds ago
    Status: Up Less than a second
    Size: 0B (virtual 82.9MB)
    Ports:
    Mounts: /var/opt/cisco/iosxr/appmgr/config/docker/swanagent,/var/run/netns
    Networks: host
    LocalVolumes: 0
    Vrf Relays:
      Vrf Relay: vrf_relay.swan.70ec1f59336271ab
        Source VRF: vrf-mgmt
        Source Port: 8000
        Destination VRF: vrf-default
        Destination Port: 10000
        IP Address Range: 172.16.0.0/12
        Status: Up 10 seconds
      Vrf Relay: vrf_relay.swan.5c7373d41d0ec84f
        Source VRF: vrf-mgmt
        Source Port: 8001
        Destination VRF: vrf-default
        Destination Port: 10001
        IP Address Range: 172.16.0.0/12
        Status: Up 11 seconds
```

Top Use Cases for Application Hosting

Some of the top use cases for application hosting are:

- **Measure Network Performance**: An application can be hosted to measure the bandwidth, throughput and latency of the network and monitor the performance. An example of such an application is the iPerf tool.
- **Automate Server Management**: An application can be hosted to automate the server functions like upgrading software, allocation of resources, creating user accounts, and so on. Examples of such an application are the Chef and Puppet configuration management tools.

Manually deploy and activate third party script

NCS 1001 provides CLI commands to perform configurations and operations on the optical devices. If you want to automate the NCS 1001 node operations, you can run third party scripts through App manager. See Automatically deploy and activate third party script, on page 18.

Follow these steps to deploy and activate third party script manually.

Procedure

Step 1 Use the **show script status** command to check the list of the OPS scripts that are in-built in XR.

Example:

This command lists the status of *xr_script_scheduler* script. *Ready* status in the output means that the script checksum is verified and is ready to run.

```
RP/0/RP0/CPU0:ios#show script status
Tue Oct 24 18:03:09.220 UTC
===================================================================================================

 Name                            | Type   | Status            | Last Action | Action Time

---------------------------------------------------------------------------------------------------

 show_interfaces_counters_ecn.py | exec   | Ready             | NEW         | Tue Oct 24 07:10:36
2025
 xr_data_collector.py            | exec   | Ready             | NEW         | Tue Oct 24 07:10:36
2025
 xr_script_scheduler.py          | process| Ready             | NEW         | Tue Oct 24 07:10:36
2025
===================================================================================================
RP/0/RP0/CPU0:ios#
```

Step 2 Use the appmgr to run the XR scheduler script.

XR scheduler script contains the necessary

Example:

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#appmgr
RP/0/RP0/CPU0:ios(config-appmgr)#process-script xr_script_scheduler
RP/0/RP0/CPU0:ios(config-process-script)#executable xr_script_scheduler.py
RP/0/RP0/CPU0:ios(config-process-script)#commit
```

Step 3 Check for available process scripts in app manager.

Example:

This output highlights the *xr_script_scheduler.py* process script that is not activated.

```
RP/0/RP0/CPU0:ios#show appmgr process-script-table
Wed Oct 22 09:45:02.795 UTC
Name                 Executable           Activated  Status    Restart Policy    Config Pending
-------------------- -------------------- ----------- --------- ---------------- ----------------
xr_script_scheduler  xr_script_scheduler.py     No     Not Started   Always                 No
```

Step 4 Activate the available process script.

You can start executing a process script only after it is activated.

Example:

```
RP/0/RP0/CPU0:ios#appmgr process-script activate name xr_script_scheduler
Wed Oct 22 09:45:41.035 UTC
```

(Optional) Verify the status of the process script. This example shows the process script *xr_script_scheduler* is *Activated*.

```
RP/0/RP0/CPU0:ios#show appmgr process-script-table
Wed Oct 22 09:45:47.275 UTC
Name                 Executable           Activated  Status    Restart Policy    Config Pending
-------------------- -------------------- ----------- --------- ---------------- ----------------
xr_script_scheduler  xr_script_scheduler.py     Yes     Not Started   Always                 No
```

Step 5 Use the **appmgr process-script start** command to start the available process script.

Example:

xr_script_scheduler is the only available process script.

This command starts the process script *xr_script_scheduler*.

```
RP/0/RP0/CPU0:ios#appmgr process-script start name xr_script_scheduler
Wed Oct 22 09:46:08.273 UTC
```

(Optional) Verify the status of the process script after activation. This example shows the process script *xr_script_scheduler* is *Activated* and *Started.*

```
RP/0/RP0/CPU0:ios#show appmgr process-script-table
Wed Oct 22 09:46:24.679 UTC
Name                 Executable           Activated  Status    Restart Policy    Config Pending
-------------------- -------------------- ----------- --------- ---------------- ----------------
xr_script_scheduler  xr_script_scheduler.py       Yes     Started   Always                 No
```

Step 6 Verify the scheduler script is running.

a) Run the **show script execution** command to verify the functioning of the debug and monitoring scripts.

Example:

This command displays a list of OPS scripts currently running.

```
RP/0/RP0/CPU0:ios# show script execution
Tue Oct 24 19:41:15.882 UTC
================================================================================================

 Req. ID   | Name (type)                            | Start                      | Duration
 | Return | Status
------------------------------------------------------------------------------------------------

 1698176223| xr_script_scheduler.py (process)       | Tue Oct 24 19:37:02 2025 | 253.32s
 | None   | Started
================================================================================================
RP/0/RP0/CPU0:ios#
```

b) Use the **show script execution details** command to verify if the scheduler script is running.

Example:

This command displays a list of OPS scripts currently running. If the scheduler script is correctly configured and activated, the scheduler script execution detail appears in the output.

```
RP/0/RP0/CPU0:ios#show script execution details
Tue Oct 25 18:01:56.590 UTC
================================================================================================

 Req. ID   | Name (type)                            | Start                      | Duration
 | Return | Status
------------------------------------------------------------------------------------------------

 1698170509| xr_script_scheduler.py (process)       | Tue Oct 25 18:01:49 2023 | 7.68s
 | None   | Started
------------------------------------------------------------------------------------------------

 Execution Details:
 ------------------
 Script Name  : xr_script_scheduler.py
 Version      : 25.3.1.14Iv1.0.0
 Log location :
/harddisk:/mirror/script-mgmt/logs/xr_script_scheduler.py_process_xr_script_scheduler
 Arguments    :
 Run Options  : Logging level - INFO, Max. Runtime - 0s, Mode - Background
 Events:
 -------
 1.   Event        : New
      Time         : Tue Oct 25 18:01:49 2025
      Time Elapsed : 0.00s Seconds
      Description  : Started by Appmgr
 2.   Event        : Started
      Time         : Tue Oct 25 18:01:49 2025
      Time Elapsed : 0.11s Seconds
      Description  : Script execution started. PID (15985)
================================================================================================
RP/0/RP0/CPU0:ios#
```

Step 7 Copy the third party RPM files to the NCS 1001 node.

a) Use any of the file transfer mechanisms to copy third-party RPM.

Example:

This example shows copying the RPM to the harddisk of the NCS 1001 node using **scp**.

```
RP/0/RP0/CPU0:ios#scp
user@171.xx.xxx.xxx:/users/user/rpm-factory/RPMS/x86_64/nms-1.1-25.3.1.x86_64.rpm /harddisk:
Tue Oct 24 18:02:42.400 UTC
<snip>
```

```
Password:
nms-1.1-24.1.1.x86_64.rpm                                           100% 9664   881.5KB/s
00:00
RP/0/RP0/CPU0:ios#
```

b) (Optional) Verify the RPM files using **dir <filepath>**.

Example:

```
RP/0/RP0/CPU0:ios#dir harddisk:/nms-1.1-24.1.1.x86_64.rpm
Wed Oct  24 19:53:54.041 UTC
```

Step 8 Install the third party RPM files to use the required debug and monitoring python scripts.

The third party RPM files have the customized scripts to be executed. The third-party RPM contains two types of files:

- One or more python scripts—For more information on developing python scripts, see IOS XR Programmability with Python and xr-python-scripts.
- Run parameter JSON file—*xr_script_scheduler.json* has instruction for the scheduler script.

Example:

This is an example *xr_script_scheduler.json* file. Customize this file as per your requirements.

```
[
    {
        "name": "__template_entry__.py",
        "description": ["**This is a template entry for documentation purpose. This entry will be
ignored**",
                        "name : Name of the python script to be executed",
                        "       [string][mandatory]",
                        "description:  Description of the script",
                       "              [string or list of strings][optional: default empty string]",

                        "cmd_line_parameters: Script command line parameters" ,
                        "                     [list of strings][optional: default Null][Example:
",
                        "env_variables: Enviromental variables to be set in script run shell",
                        "               [list of key value pairs][optional: default Null][Example:
 [['INT_NAME': 'hu0/1/0/1']]",
                        "run_policy: Script restart policy when script exits",
                       "           [string: one of always/once/stop][optional: default 'always']",

                        "            always: restart the script every time it exits",
                        "            once:  do not restart the script if it exits",
                        "            stop:  stop an existing script run "
                        ],
        "cmd_line_parameters": [],
        "env_variables": [],
        "run_policy": "always"
    },
    {
        "name": "monitor_int_rx_cntr.py",
        "description": "Monitoring mgmt interface for Rx threshold of 100 ",
        "cmd_line_parameters": ["MgmtEth0/RP0/CPU0/0", "200", "-log", "debug"],
        "env_variables": [["INT_NAME", "FourHundredGigE0/9/0/0"], ["INT_NAME2",
"FourHundredGigE0/10/0/0"]],
        "run_policy": "always"
    },
    {
        "name": "monitor_int_rx_cntr.py",
        "description": "Monitoring Fo0/0/0/0 interface for Rx threshold of 1000000 ",
        "cmd_line_parameters": ["FourHundredGigE0/0/0/0", "1000000"],
        "run_policy": "once"
    },
    {
        "name": "monitor_int_rx_cntr2.py",
        "description": "Monitoring Fo0/0/0/1 interface for Rx threshold of 5000000 ",
        "cmd_line_parameters": ["FourHundredGigE0/0/0/1", "5000000"],
        "run_policy": "always"
    },
    {
        "name": "monitor_int_rx_cntr2.py",
        "description": "Monitoring Fo0/0/0/2 interface for Rx threshold of 5000000 ",
        "cmd_line_parameters": ["FourHundredGigE0/0/0/2", "8000000"],
        "run_policy": "stop"
    }
]
```

Example:

Use the **appmgr package install rpm <full RPM file path>** command to install the third-party RPMs.

```
RP/0/RP0/CPU0:ios#appmgr package install rpm /harddisk:/nms-1.1-25.3.1.x86_64.rpm
Tue Oct 24 18:03:26.685 UTC
RP/0/RP0/CPU0:ios#
RP/0/RP0/CPU0:ios#show appmgr packages installed
Tue Oct 24 19:42:07.967 UTC
Sno Package
--- ------------------------------------------------------------
1   nms-1.1-25.3.1.x86_64
RP/0/RP0/CPU0:ios#
```

After the scripts and the run parameters file become ready, build the RPM and configure the RPM to install files at `<default exr appmgr rpm install path>/ops-script-repo/exec/<rpm name>/`. RPM build tool for TPA is available at RPM Build Tool.

Note

Install the scripts in directories named after the RPM for smoother execution.

Step 9 Use the **show script status** command to verify that the scripts and the run parameter files contained in the RPM are all installed successfully and added to the script management repository.

Example:

This output shows the status that two scripts (monitor_int_xr_cntr.py and monitor_int_rx_cntr2.py) and a run parameter file (xr_script_scheduler.json) file were installed in the third-party RPM named “nms”.

```
RP/0/RP0/CPU0:ios#show script status

Tue Oct 24 19:41:10.696 UTC
===================================================================================================

 Name                            | Type    | Status            | Last Action | Action Time

---------------------------------------------------------------------------------------------------

 nms/monitor_int_rx_cntr.py      | exec    | Ready             | NEW         | Tue Oct 24 19:38:41
2023
 nms/monitor_int_rx_cntr2.py     | exec    | Ready             | NEW         | Tue Oct 24 19:38:41
2023
 nms/xr_script_scheduler.json    | exec    | Ready             | NEW         | Tue Oct 24 19:38:41
2023
 show_interfaces_counters_ecn.py | exec    | Ready             | NEW         | Tue Oct 24 19:33:52
2023
 xr_data_collector.py            | exec    | Ready             | NEW         | Tue Oct 24 19:33:52
```

```
2023
 xr_script_scheduler.py          | process| Ready            | NEW         | Tue Oct 24 19:33:52
2023
=================================================================================================
RP/0/RP0/CPU0:ios#
```

After the scripts are installed, the scheduler script starts reading the run parameter JSON file and executes the required debug and monitoring scripts.

The logs generated by the scripts are available in the directory `/harddisk\:/mirror/script-mgmt/logs/`.

Step 10 Verify that the debug and monitoring scripts are running.

Example:

Use the **show script execution** command to verify that the scripts are running.

```
RP/0/RP0/CPU0:ios#show script execution
Tue Oct 24 19:41:15.882 UTC
=================================================================================================

 Req. ID   | Name (type)                               | Start                     | Duration   |
Return | Status
-------------------------------------------------------------------------------------------------

 1698176223| xr_script_scheduler.py (process)          | Tue Oct 24 19:37:02 2023 | 253.32s    |
None   | Started
 1698176224| nms/monitor_int_rx_cntr.py (exec)         | Tue Oct 24 19:38:43 2023 | 152.46s    |
None   | Started
 1698176225| nms/monitor_int_rx_cntr.py (exec)         | Tue Oct 24 19:38:44 2023 | 152.03s    |
None   | Started
 1698176226| nms/monitor_int_rx_cntr2.py (exec)        | Tue Oct 24 19:38:44 2023 | 151.63s    |
None   | Started
=================================================================================================
RP/0/RP0/CPU0:ios#
```

(Optional) Use the **show script execution** [**name** *script-name* **detail [output][error]**]

Step 11 Verify all the active packages are installed.

Example:

```
RP/0/RP0/CPU0:ios#show install active summary
Fri Nov 14 12:52:39.322 IST
Label : 25.3.1.31I-iso

    Active Packages: 2
        ncs1001-xr-25.4.1.31I version=25.4.1.31I [Boot image]
        ncs1001-cosm-1.0.0.0-r253131I
```

Step 12 (Optional) Use the **appmgr process-script stop** command to stop the process script.

Example:

This command stops the execution of the process script *xr_script_scheduler*.

```
RP/0/RP0/CPU0:ios#appmgr process-script stop name xr_script_scheduler
Wed Oct 22 09:46:35.110 UTC
```

(Optional) Verify the status of the process script after stopping it. This example shows the process script *xr_script_scheduler* is *Activated* and *Stopped*.

```
RP/0/RP0/CPU0:ios#show appmgr process-script-table
Wed Oct 22 09:46:41.245 UT
Name                 Executable            Activated  Status    Restart Policy    Config Pending
```

```
-------------------- -------------------- ----------- --------- ---------------- ----------------
xr_script_scheduler  xr_script_scheduler.py       Yes     Stopped   Always                 No
```

Automated Deployment of Third Party Python Scripts

Efficient network automation is pivotal in handling extensive cloud-computing networks. The Cisco IOS XR infrastructure plays a crucial role by enabling automation through the initiation of API calls and execution of scripts. Traditionally, an external controller is used for this purpose, utilizing interfaces like NETCONF, SNMP, and SSH to communicate with NCS 1001.

This feature streamlines the operational structure by executing automation scripts directly on the router, thus eliminating the need for an external controller. It allows scripts to leverage Python libraries and access underlying router information. This approach not only accelerates the execution of various types of scripts but also enhances reliability by removing dependencies on the speed and network reachability of an external controller.

The third party script is automatically executed by the xr_script_scheduler.py script upon the installation of third-party RPMs. App manager configuration is required to activate the xr_script_scheduler.py script and run the third party scripts after installation.

Note If you use the **autorun** configuration, the **xr_script_scheduler.py** script activates automatically.

Automatically deploy and activate third party script

NCS 1001 provides CLI commands to perform configurations and operations on the optical devices. If you want to automate the NCS 1001 node operations, you can run third party scripts through App manager.

Follow these steps to deploy and activate third party script.

Procedure

Step 1 Use the **show script status** command to check the list of the OPS scripts that are in-built in XR.

Example:

This command lists the status of *xr_script_scheduler* script. *Ready* status in the output means that the script checksum is verified and is ready to run.

```
RP/0/RP0/CPU0:ios#show script status
Tue Oct 24 18:03:09.220 UTC
======================================================================================================

 Name                               | Type   | Status           | Last Action | Action Time

------------------------------------------------------------------------------------------------------

 show_interfaces_counters_ecn.py | exec   | Ready            | NEW         | Tue Oct 24 07:10:36 2025

 xr_data_collector.py            | exec   | Ready            | NEW         | Tue Oct 24 07:10:36 2025
 xr_script_scheduler.py          | process| Ready            | NEW         | Tue Oct 24 07:10:36 2025
====================================================================================================
RP/0/RP0/CPU0:ios#
```

Step 2 Use the appmgr to automatically run the XR scheduler script.

Activate the scheduler script automatically using the "autorun" option with the configuration.

Example:

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#appmgr
RP/0/RP0/CPU0:ios(config-appmgr)#process-script xr_script_scheduler
RP/0/RP0/CPU0:ios(config-process-script)#executable xr_script_scheduler.py
RP/0/RP0/CPU0:ios(config-process-script)#autorun
RP/0/RP0/CPU0:ios(config-process-script)#commit
```

The 'autorun' configuration has been added to enable automatic activation of the process script. If you prefer manual activation/deactivation using CLI, skip the 'autorun' configuration line. See Manually deploy and activate third party script, on page 12.

Step 3 Verify the scheduler script is running.

a) Run the **show script execution** command to verify the functioning of the debug and monitoring scripts.

Example:

This command displays a list of OPS scripts currently running.

```
RP/0/RP0/CPU0:ios# show script execution
Tue Oct 24 19:41:15.882 UTC
================================================================================================

 Req. ID    | Name (type)                              | Start                     | Duration    |
 Return | Status
------------------------------------------------------------------------------------------------

 1698176223| xr_script_scheduler.py (process)           | Tue Oct 24 19:37:02 2025 | 253.32s     |
 None    | Started

================================================================================================
RP/0/RP0/CPU0:ios#
```

b) Use the **show script execution details** command to verify if the scheduler script is running.

Example:

This command displays a list of OPS scripts currently running. If the scheduler script is correctly configured and activated, the scheduler script execution detail appears in the output.

```
RP/0/RP0/CPU0:ios#show script execution details
Tue Oct 25 18:01:56.590 UTC
================================================================================================

 Req. ID    | Name (type)                              | Start                     | Duration    |
 Return | Status
------------------------------------------------------------------------------------------------

 1698170509| xr_script_scheduler.py (process)           | Tue Oct 25 18:01:49 2023 | 7.68s       |
 None    | Started
------------------------------------------------------------------------------------------------

 Execution Details:
 ------------------
 Script Name   : xr_script_scheduler.py
 Version       : 25.3.1.14Iv1.0.0
 Log location :
/harddisk:/mirror/script-mgmt/logs/xr_script_scheduler.py_process_xr_script_scheduler
 Arguments     :
 Run Options   : Logging level - INFO, Max. Runtime - 0s, Mode - Background
 Events:
 -------
 1.   Event        : New
      Time         : Tue Oct 25 18:01:49 2025
      Time Elapsed : 0.00s Seconds
      Description  : Started by Appmgr
 2.   Event        : Started
      Time         : Tue Oct 25 18:01:49 2025
      Time Elapsed : 0.11s Seconds
      Description  : Script execution started. PID (15985)
================================================================================================

RP/0/RP0/CPU0:ios#
```

Step 4 Copy the third party RPM files to the NCS 1001 node.

a) Use any of the file transfer mechanisms to copy third-party RPM.

Example:

This example shows copying the RPM to the harddisk of the NCS 1001 node using **scp**.

```
RP/0/RP0/CPU0:ios#scp
user@171.xx.xxx.xxx:/users/user/rpm-factory/RPMS/x86_64/nms-1.1-25.3.1.x86_64.rpm /harddisk:
Tue Oct 24 18:02:42.400 UTC
<snip>
Password:
nms-1.1-24.1.1.x86_64.rpm                                          100% 9664   881.5KB/s   00:00

RP/0/RP0/CPU0:ios#
```

b) (Optional) Verify the RPM files using **dir <filepath>**.

Example:

```
RP/0/RP0/CPU0:ios#dir harddisk:/nms-1.1-24.1.1.x86_64.rpm
Wed Oct  24 19:53:54.041 UTC
```

Step 5 Install the third party RPM files to use the required debug and monitoring python scripts.

The third party RPM files have the customized scripts to be executed. The third-party RPM contains two types of files:

- One or more python scripts—For more information on developing python scripts, see IOS XR Programmability with Python and xr-python-scripts.
- Run parameter JSON file—*xr_script_scheduler.json* has instruction for the scheduler script.

Example:

This is an example *xr_script_scheduler.json* file. Customize this file as per your requirements.

```
[
    {
        "name": "__template_entry__.py",
        "description": ["**This is a template entry for documentation purpose. This entry will be
ignored**",
                        "name : Name of the python script to be executed",
                        "       [string][mandatory]",
                        "description:  Description of the script",
                        "              [string or list of strings][optional: default empty string]",
                        "cmd_line_parameters: Script command line parameters" ,
                        "                     [list of strings][optional: default Null][Example: ",
                        "env_variables: Enviromental variables to be set in script run shell",
                        "               [list of key value pairs][optional: default Null][Example:
[['INT_NAME': 'hu0/1/0/1']]",
                        "run_policy: Script restart policy when script exits",
                        "            [string: one of always/once/stop][optional: default 'always']",

                        "            always: restart the script every time it exits",
                        "            once:  do not restart the script if it exits",
                        "            stop:  stop an existing script run "
                        ],
        "cmd_line_parameters": [],
        "env_variables": [],
        "run_policy": "always"
    },
    {
        "name": "monitor_int_rx_cntr.py",
        "description": "Monitoring mgmt interface for Rx threshold of 100 ",
        "cmd_line_parameters": ["MgmtEth0/RP0/CPU0/0", "200", "-log", "debug"],
        "env_variables": [["INT_NAME", "FourHundredGigE0/9/0/0"], ["INT_NAME2",
"FourHundredGigE0/10/0/0"]],
        "run_policy": "always"
    },
    {
        "name": "monitor_int_rx_cntr.py",
        "description": "Monitoring Fo0/0/0/0 interface for Rx threshold of 1000000 ",
        "cmd_line_parameters": ["FourHundredGigE0/0/0/0", "1000000"],
        "run_policy": "once"
    },
    {
        "name": "monitor_int_rx_cntr2.py",
        "description": "Monitoring Fo0/0/0/1 interface for Rx threshold of 5000000 ",
        "cmd_line_parameters": ["FourHundredGigE0/0/0/1", "5000000"],
        "run_policy": "always"
    },
    {
        "name": "monitor_int_rx_cntr2.py",
        "description": "Monitoring Fo0/0/0/2 interface for Rx threshold of 5000000 ",
        "cmd_line_parameters": ["FourHundredGigE0/0/0/2", "8000000"],
        "run_policy": "stop"
    }
]
```

Example:

Use the **appmgr package install rpm <full RPM file path>** command to install the third-party RPMs.

```
RP/0/RP0/CPU0:ios#appmgr package install rpm /harddisk:/nms-1.1-25.3.1.x86_64.rpm
Tue Oct 24 18:03:26.685 UTC
RP/0/RP0/CPU0:ios#
RP/0/RP0/CPU0:ios#show appmgr packages installed
Tue Oct 24 19:42:07.967 UTC
Sno Package
--- ------------------------------------------------------------
1   nms-1.1-25.3.1.x86_64
RP/0/RP0/CPU0:ios#
```

After the scripts and the run parameters file become ready, build the RPM and configure the RPM to install files at `<default exr appmgr rpm install path>/ops-script-repo/exec/<rpm name>/`. RPM build tool for TPA is available at RPM Build Tool.

Note

Install the scripts in directories named after the RPM for smoother execution.

Step 6 Use the **show script status** command to verify that the scripts and the run parameter files contained in the RPM are all installed successfully and added to the script management repository.

Example:

This output shows the status that two scripts (monitor_int_xr_cntr.py and monitor_int_rx_cntr2.py) and a run parameter file (xr_script_scheduler.json) file were installed in the third-party RPM named “nms”.

```
RP/0/RP0/CPU0:ios#show script status

Tue Oct 24 19:41:10.696 UTC
====================================================================================================

 Name                              | Type   | Status           | Last Action | Action Time

----------------------------------------------------------------------------------------------------

 nms/monitor_int_rx_cntr.py        | exec   | Ready            | NEW         | Tue Oct 24 19:38:41 2023

 nms/monitor_int_rx_cntr2.py       | exec   | Ready            | NEW         | Tue Oct 24 19:38:41 2023

 nms/xr_script_scheduler.json      | exec   | Ready            | NEW         | Tue Oct 24 19:38:41 2023

 show_interfaces_counters_ecn.py | exec   | Ready            | NEW         | Tue Oct 24 19:33:52 2023

 xr_data_collector.py            | exec   | Ready            | NEW         | Tue Oct 24 19:33:52 2023

 xr_script_scheduler.py          | process| Ready            | NEW         | Tue Oct 24 19:33:52 2023

====================================================================================================
RP/0/RP0/CPU0:ios#
```

After the scripts are installed, the scheduler script starts reading the run parameter JSON file and executes the required debug and monitoring scripts.

The logs generated by the scripts are available in the directory `/harddisk\:/mirror/script-mgmt/logs/`.

Step 7 Verify that the debug and monitoring scripts are running.

Example:

Use the **show script execution** command to verify that the scripts are running.

```
RP/0/RP0/CPU0:ios#show script execution
Tue Oct 24 19:41:15.882 UTC
====================================================================================================

 Req. ID    | Name (type)                              | Start                      | Duration    |
Return | Status
----------------------------------------------------------------------------------------------------

 1698176223| xr_script_scheduler.py (process)         | Tue Oct 24 19:37:02 2023 | 253.32s    | None
   | Started
 1698176224| nms/monitor_int_rx_cntr.py (exec)        | Tue Oct 24 19:38:43 2023 | 152.46s    | None
   | Started
 1698176225| nms/monitor_int_rx_cntr.py (exec)        | Tue Oct 24 19:38:44 2023 | 152.03s    | None
   | Started
 1698176226| nms/monitor_int_rx_cntr2.py (exec)       | Tue Oct 24 19:38:44 2023 | 151.63s    | None
   | Started
====================================================================================================
RP/0/RP0/CPU0:ios#
```

(Optional) Use the **show script execution** [**name***script-name***detail [output][error]**]