



## Guest Shell

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- [About the Guest Shell, on page 1](#)
- [Guidelines and Limitations, on page 2](#)
- [Accessing the Guest Shell, on page 7](#)
- [Resources Used for the Guest Shell, on page 7](#)
- [Capabilities in the Guestshell, on page 8](#)
- [Security Posture for Virtual Services Guest Shell, on page 18](#)
- [Guest File System Access Restrictions , on page 22](#)
- [Managing the Guest Shell, on page 22](#)
- [Verifying Virtual Service and Guest Shell Information, on page 35](#)
- [Persistently Starting Your Application From the Guest Shell, on page 36](#)
- [Procedure for Persistently Starting Your Application from the Guest Shell, on page 37](#)
- [An Example Application in the Guest Shell, on page 37](#)
- [Troubleshooting Guest Shell Issues, on page 38](#)

## About the Guest Shell

In addition to the NX-OS CLI and Bash access on the underlying Linux environment, switches support access to a decoupled execution space running within a Linux Container (LXC) called the “Guest Shell”.

From within the Guest Shell the network-admin has the following capabilities:

- Access to the network over Linux network interfaces.
- Access to the switch's bootflash.
- Access to the switch's volatile tmpfs.
- Access to the switch's CLI.
- Access to the switch's host file system.
- Access to Cisco NX-API REST.
- The ability to install and run python scripts.
- The ability to install and run 32-bit and 64-bit Linux applications.

Decoupling the execution space from the native host system allows customization of the Linux environment to suit the needs of the applications without impacting the host system or applications running in other Linux Containers.

On NX-OS devices, Linux Containers are installed and managed with the virtual-service commands. The Guest Shell will appear in the virtual-service show command output.




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**Note** By default, the Guest Shell occupies approximately 5 MB of RAM and 200 MB of bootflash when enabled. Beginning with Cisco NX-OS Release 7.0(3)I2(1) the Guest Shell occupies approximately 35 MB of RAM. Use the **guestshell destroy** command to reclaim resources if the Guest Shell is not used.

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**Note** By default, the Guest Shell occupies approximately 35 MB of RAM and 350 MB of bootflash when enabled. Use the **guestshell destroy** command to reclaim resources if the Guest Shell is not used.

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**Note** Beginning with Cisco NX-OS 7.0(3)F3(1)NX-OS 7.0(3)I7(1), the Guest Shell is supported on the Cisco Nexus 95083500 switch.

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## Guidelines and Limitations

### Common Guidelines Across All Releases




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**Important** If you have performed custom work inside your installation of the Guest Shell, save your changes to the bootflash, off-box storage, or elsewhere outside the Guest Shell root file system before performing a `guestshell upgrade`.

The `guestshell upgrade` command essentially performs a `guestshell destroy` and `guestshell enable` in succession.

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- If you are running a third-party DHCPD server in Guest Shell, there might be issues with offers reaching the client if used along with SVI. A possible workaround is to use broadcast responses.
- Use the `run guestshell` CLI command to access the Guest Shell on the switch: The `run guestshell` command parallels the `run bash` command that is used to access the host shell. This command allows you to access the Guest Shell and get a Bash prompt or run a command within the context of the Guest Shell. The command uses password-less SSH to an available port on the localhost in the default network namespace.
- The `sshd` utility can secure the pre-configured SSH access into the Guest Shell by listening on `localhost` to avoid connection attempts from outside the network. The `sshd` has the following features:
  - It is configured for key-based authentication without fallback to passwords.
  - Only `root` can read keys use to access the Guest Shell after Guest Shell restarts.

- Only `root` can read the file that contains the key on the host to prevent a nonprivileged user with host Bash access from being able to use the key to connect to the Guest Shell. Network-admin users may start another instance of `sshd` in the Guest Shell to allow remote access directly into the Guest Shell, but any user that logs into the Guest Shell is also given network-admin privilege.



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**Note** Introduced in Guest Shell 2.2 (0.2), the `key` file is readable for whom the user account was created for.

In addition, the Guest Shell accounts are not automatically removed, and must be removed by the network administrator when no longer needed.

Guest Shell installations before 2.2 (0.2) will not dynamically create individual user accounts.

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- Installing the Cisco NX-OS software release on a fresh out-of-the-box switch will automatically enable the Guest Shell. Subsequent upgrades to the switch software will not automatically upgrade Guest Shell.
- Guest Shell releases increment the major number when distributions or distribution versions change.
- Guest Shell releases increment the minor number when CVEs have been addressed. The Guest Shell updates CVEs only when CentOS makes them publicly available.
- Cisco recommends using **`dnf update`** to pick up third-party security vulnerability fixes directly from the CentOS repository. This provides the flexibility of getting updates as, and when, available without needing to wait for a Cisco NX-OS software update.

Alternatively, using the **`guestshell update`** command would replace the existing Guest Shell rootfs. Any customizations and software package installations would then need to be performed again within the context of this new Guest Shell rootfs.

### Guest Shell 3.0

Beginning with Jacksonville release 10.1(1), Guest Shell 3.0 is introduced with CentOS 8 software, as CentOS 7 which is packaged into Guest Shell 2.x has reached end of life. CentOS 8 also comes with python 3.6 and will replace the python 2.7 support in Guestshell 2.x. The functionality between Guest Shell 2.x and Guest Shell 3.0 remains the same. However, the internal implementation that varies is that Python 3.6 library of Guest Shell 3.0 replaces the Python 2.7 library of Guest Shell 2.x. This means `/usr/lib/python3.6` and `/usr/lib64/python3.6` libraries are used.



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**Note** The rootfs size in Guestshell 3.0 is 220 MB versus the 170 MB in Guestshell 2.0.

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### Upgrading from Guest Shell 1.0 to Guest Shell 2.x

Guest Shell 2.x is based on a CentOS 7 root file system. If you have an off-box repository of `.conf` files or utilities that pulled the content down into Guest Shell 1.0, you must repeat the same deployment steps in Guest Shell 2.x. Your deployment script may need to be adjusted to account for the CentOS 7 differences.

### Downgrading NX-OS from Jacksonville release with Guest Shell 3.0

Beginning with Jacksonville release 10.1(1), infrastructure version for Guest Shell 3.0 support is increased to 1.11 (check with `show virtual-service` command). Therefore, Guestshell 3.0 OVA cannot be used in previous releases. If used, the **Install all** command will validate version mismatch and throws an error. It is recommended to destroy Guest Shell 3.0 before downgrading to previous releases so that Guest Shell 3.0 does not come up in previous releases.

### Guest Shell 2.x

The Cisco NX-OS automatically installs and enables the Guest Shell by default on systems with sufficient resources. However, if the device is reloaded with a Cisco NX-OS image that does not provide Guest Shell support, the installer will automatically remove the existing Guest Shell and issue a `%VMAN-2-INVALID_PACKAGE`.



**Note** Systems with 4 GB of RAM will not enable Guest Shell by default. Use the **guestshell enable** command to install and enable Guest Shell.

The **install all** command validates the compatibility between the current Cisco NX-OS image against the target Cisco NX-OS image.

The following is an example output from installing an incompatible image:

```
switch#
Installer will perform compatibility check first. Please wait.
uri is: /
2014 Aug 29 20:08:51 switch %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE:
Successfully activated virtual service 'guestshell+'
Verifying image bootflash:/n9kpregs.bin for boot variable "nxos".
[#####] 100% -- SUCCESS
Verifying image type.
[#####] 100% -- SUCCESS
Preparing "" version info using image bootflash:/.
[#####] 100% -- SUCCESS
Preparing "bios" version info using image bootflash:/.
[#####] 100% -- SUCCESS
Preparing "" version info using image bootflash:/.
[#####] 100% -- SUCCESS
Preparing "" version info using image bootflash:/.
[#####] 100% -- SUCCESS
Preparing "" version info using image bootflash:/.
[#####] 100% -- SUCCESS
Preparing "" version info using image bootflash:/.
[#####] 100% -- SUCCESS
Preparing "" version info using image bootflash:/.
[#####] 100% -- SUCCESS
Preparing "" version info using image bootflash:/.
[#####] 100% -- SUCCESS
"Running-config contains configuration that is incompatible with the new image (strict
incompatibility).
Please run 'show incompatibility-all nxos <image>' command to find out which feature
needs to be disabled.".
Performing module support checks.
[#####] 100% -- SUCCESS
Notifying services about system upgrade.
[# ] 0% -- FAIL.
Return code 0x42DD0006 (null).
"Running-config contains configuration that is incompatible with the new image (strict
incompatibility).
Please run 'show incompatibility-all nxos <image>' command to find out
```

```

which feature needs to be disabled."
Service "vman" in vdc 1: Guest shell not supported, do 'guestshell destroy' to remove
it and then retry ISSU
Pre-upgrade check failed. Return code 0x42DD0006 ((null)).
switch#

```




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**Note** As a best practice, remove the Guest Shell with the **guestshell destroy** command before reloading an older Cisco NX-OS image that does not support the Guest Shell.

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### Pre-Configured SSHD Service

The Guest Shell starts an OpenSSH server upon boot up. The server listens on a randomly generated port on the localhost IP address interface 127.0.0.1 only. This provides the password-less connectivity into the Guest Shell from the NX-OS virtual-shell when the **guestshell** keyword is entered. If this server is killed or its configuration (residing in `/etc/ssh/sshd_config-cisco`) is altered, access to the Guest Shell from the NX-OS CLI might not work.

The following steps instantiate an OpenSSH server within the Guest Shell as root:

1. Determine which network namespace or VRF you want to establish your SSH connections through.
2. Determine the port that you want OpenSSH to listen on. Use the NX-OS command **show socket connection** to view ports already in use.




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**Note** The Guest Shell sshd service for password-less access uses a randomized port starting at 17680 through 49150. To avoid port conflict, choose a port outside this range.

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The following steps start the OpenSSH server. The examples start the OpenSSH server for management netns on IP address 10.122.84.34:2222:

1. Create the following files: `/usr/lib/systemd/system/sshd-mgmt.service` and `/etc/ssh/sshd-mgmt_config`. The files should have the following configurations:
 

```

-rw-r--r-- 1 root root 394 Apr 7 14:21 /usr/lib/systemd/system/sshd-mgmt.service
-rw----- 1 root root 4478 Apr 7 14:22 /etc/ssh/sshd-mgmt_config

```
2. Copy the Unit and Service contents from the `/usr/lib/systemd/system/ssh.service` file to `sshd-mgmt.service`.
3. Edit the `sshd-mgmt.service` file to match the following:

```

[Unit]
Description=OpenSSH server daemon
After=network.target sshd-keygen.service
Wants=sshd-keygen.service

[Service]
EnvironmentFile=/etc/sysconfig/ssh
ExecStartPre=/usr/sbin/sshd-keygen
ExecStart=/sbin/ip netns exec management /usr/sbin/sshd -f /etc/ssh/sshd-mgmt_config
-D $OPTIONS
ExecReload=/bin/kill -HUP $MAINPID
KillMode=process
Restart=on-failure
RestartSec=42s

```

```
[Install]
WantedBy=multi-user.target
```

- Copy the contents of `/etc/ssh/sshd-config` to `/etc/ssh/sshd-mgmt_config`. Modify the ListenAddress IP and port as necessary.

```
Port 2222
ListenAddress 10.122.84.34
```

- Start the `systemctl` daemon using the following commands:

```
sudo systemctl daemon-reload
sudo systemctl start sshd-mgmt.service
sudo systemctl status sshd-mgmt.service -l
```

- (Optional) Check the configuration.

```
ss -tnldp | grep 2222
```

- SSH into Guest Shell:

```
ssh -p 2222 guestshell@10.122.84.34
```

- Save the configuration across multiple Guest Shell or switch reboots.

```
sudo systemctl enable sshd-mgmt.service
```

- For passwordless SSH/SCP and remote execution, generate the public and private keys for the user ID you want to use for SSH/SCP using the `ssh-keygen -t dsa` command.

The key is then stored in the `id_rsa` and `id_rsa.pub` files in the `/.ssh` directory:

```
[root@node01 ~]# cd ~/.ssh
[root@node02 .ssh]# ls -l
total 8
-rw-----. 1 root root 1675 May 5 15:01 id_rsa
-rw-r--r--. 1 root root 406 May 5 15:01 id_rsa.pub
```

- Copy the public key into the machine you want to SSH into and fix permissions:

```
cat id_rsa.pub >> /root/.ssh/authorized_keys
chmod 700 /root/.ssh
chmod 600 /root/.ssh/*
```

- SSH or SCP into the remote switch without a password:

```
ssh -p <port#> userid@hostname [<remote command>]
scp -P <port#> userid@hostname/filepath /destination
```

## localtime

The Guest Shell shares `/etc/localtime` with the host system.




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**Note** If you do not want to share the same `localtime` with the host, this symlink can be broken and a Guest Shell specific `/etc/localtime` can be created.

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```
switch(config)# clock timezone PDT -7 0
switch(config)# clock set 10:00:00 27 Jan 2017
Fri Jan 27 10:00:00 PDT 2017
switch(config)# show clock
10:00:07.554 PDT Fri Jan 27 2017
switch(config)# run guestshell
```

```
guestshell:~$ date
Fri Jan 27 10:00:12 PDT 2017
```

## Accessing the Guest Shell

In Cisco NX-OS, only network-admin users can access the Guest Shell by default. It is automatically enabled in the system and can be accessed using the **run guestshell** command. Consistent with the **run bash** command, these commands can be issued within the Guest Shell with the **run guestshell *command*** form of the NX-OS CLI command.



**Note** The Guest Shell is automatically enabled on systems with more than 4 GB of RAM.

```
switch# run guestshell ls -al /bootflash/*.ova
-rw-rw-rw- 1 2002 503 83814400 Aug 21 18:04 /bootflash/pup.ova
-rw-rw-rw- 1 2002 503 40724480 Apr 15 2012 /bootflash/red.ova
```



**Note** The Guest Shell starting in 2.2(0.2) will dynamically create user accounts with the same as the user logged into switch. However, all other information is NOT shared between the switch and the Guest Shell user accounts.

In addition, the Guest Shell accounts are not automatically removed, and must be removed by the network administrator when no longer needed.

## Resources Used for the Guest Shell

By default, the resources for the Guest Shell have a small impact on resources available for normal switch operations. If the network-admin requires additional resources for the Guest Shell, the **guestshell resize {cpu | memory | roofs}** command changes these limits.

Resource	Default	Minimum/Maximum
CPU	1%	1/620%
Memory	400 MB	256/3840 MB
Storage	200 MB	200/2000 MB

The CPU limit is the percentage of the system compute capacity that tasks running within the Guest Shell are given when there is contention with other compute loads in the system. When there is no contention for CPU resources, the tasks within the Guest Shell are not limited.



**Note** A Guest Shell reboot is required after changing the resource allocations. This can be accomplished with the **guestshell reboot** command.

## Capabilities in the Guestshell

The Guestshell has a number of utilities and capabilities available by default.

The Guestshell is populated with CentOS 7 Linux which provides the ability to yum install software packages built for this distribution. The Guestshell is pre-populated with many of the common tools that would naturally be expected on a networking device including **net-tools**, **iproute**, **tcpdump** and OpenSSH. For Guestshell 2.x, python 2.7.5 is included by default as is the PIP for installing additional python packages. In Guestshell 2.11, by default, python 3.6 is also included.

By default the Guestshell is a 64-bit execution space. If 32-bit support is needed, the `glibc.i686` package can be yum installed.

The Guestshell has access to the Linux network interfaces used to represent the management and data ports of the switch. Typical Linux methods and utilities like **ifconfig** and **ethtool** can be used to collect counters. When an interface is placed into a VRF in the NX-OS CLI, the Linux network interface is placed into a network namespace for that VRF. The name spaces can be seen at `/var/run/netns` and the **ip netns** utility can be used to run in the context of different namespaces. A couple of utilities, **chvrf** and **vrinfo**, are provided as a convenience for running in a different namespace and getting information about which namespace/vrf a process is running in.

systemd is used to manage services in CentOS 8 environments, including the Guestshell.

## NX-OS CLI in the Guest Shell

The Guest Shell provides an application to allow the user to issue NX-OS commands from the Guest Shell environment to the host network element. The **dohost** application accepts any valid NX-OS configuration or exec commands and issues them to the host network element.

When invoking the **dohost** command each NX-OS command may be in single or double quotes:

```
dohost "<NXOS CLI>"
```

The NX-OS CLI can be chained together:

```
[guestshell@guestshell ~]$ dohost "sh lldp time | in Hold" "show cdp global"
Holdtime in seconds: 120
Global CDP information:
CDP enabled globally
Refresh time is 21 seconds
Hold time is 180 seconds
CDPv2 advertisements is enabled
DeviceID TLV in System-Name(Default) Format
[guestshell@guestshell ~]$
```

The NX-OS CLI can also be chained together using the NX-OS style command chaining technique by adding a semicolon between each command. (A space on either side of the semicolon is required.):

```
[guestshell@guestshell ~]$ dohost "conf t ; cdp timer 13 ; show run | inc cdp"
Enter configuration commands, one per line. End with CNTL/Z.
cdp timer 13
[guestshell@guestshell ~]$
```





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- Note** For release 7.0(3)I5(2) using Starting with Guest Shell 2.2 (0.2), commands issued on the host through the **dohost** command are run with privileges based on the effective role of the Guest Shell user.
- Prior versions of Guest Shell will run command with network-admin level privileges.
- The **dohost** command fails when the number of UDS connections to NX-API are at the maximum allowed.
- 

## Network Access in Guest Shell

The NX-OS switch ports are represented in the Guest Shell as Linux network interfaces. Typical Linux methods like view stats in `/proc/net/dev`, through `ifconfig` or `ethtool` are all supported:

The Guest Shell has a number of typical network utilities included by default and they can be used on different VRFs using the **chvrf vrf command** command.

```
[guestshell@guestshell bootflash]$ ifconfig Eth1-47
Eth1-47: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 13.0.0.47 netmask 255.255.255.0 broadcast 13.0.0.255
ether 54:7f:ee:8e:27:bc txqueuelen 100 (Ethernet)
RX packets 311442 bytes 21703008 (20.6 MiB)
RX errors 0 dropped 185 overruns 0 frame 0
TX packets 12967 bytes 3023575 (2.8 MiB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

Within the Guest Shell, the networking state can be monitored, but may not be changed. To change networking state, use the NX-OS CLI or the appropriate Linux utilities in the host bash shell.

The **tcpdump** command is packaged with the Guest Shell to allow packet tracing of punted traffic on the management or switch ports.

The **sudo ip netns exec management ping** utility is a common method for running a command in the context of a specified network namespace. This can be done within the Guest Shell:

```
[guestshell@guestshell bootflash]$ sudo ip netns exec management ping 10.28.38.48
PING 10.28.38.48 (10.28.38.48) 56(84) bytes of data.
64 bytes from 10.28.38.48: icmp_seq=1 ttl=48 time=76.5 ms
```

The **chvrf** utility is provided as a convenience:

```
guestshell@guestshell bootflash]$ chvrf management ping 10.28.38.48
PING 10.28.38.48 (10.28.38.48) 56(84) bytes of data.
64 bytes from 10.28.38.48: icmp_seq=1 ttl=48 time=76.5 ms
```



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- Note** Commands that are run without the **chvrf** command are run in the current VRF/network namespace.
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For example, to ping IP address 10.0.0.1 over the management VRF, the command is “**chvrf management ping 10.0.0.1**”. Other utilities such as **scp** or **ssh** would be similar.

Example:

```
switch# guestshell
[guestshell@guestshell ~]$ cd /bootflash
```

```
[guestshell@guestshell bootflash]$ chvrf management scp foo@10.28.38.48:/foo/index.html
index.html
foo@10.28.38.48's password:
index.html 100% 1804 1.8KB/s 00:00
[guestshell@guestshell bootflash]$ ls -al index.html
-rw-r--r-- 1 guestshe users 1804 Sep 13 20:28 index.html
[guestshell@guestshell bootflash]$
[guestshell@guestshell bootflash]$ chvrf management curl cisco.com
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html><head>
<title>301 Moved Permanently</title>
</head><body>
<h1>Moved Permanently</h1>
<p>The document has moved <a href="http://www.cisco.com/">here</a>.</p>
</body></html>
[guestshell@guestshell bootflash]$
```

To obtain a list of VRFs on the system, use the **show vrf** command natively from NX-OS or through the **dohost** command:

Example:

```
[guestshell@guestshell bootflash]$ dohost 'sh vrf'
VRF-Name  VRF-ID  State  Reason
default   1        Up     --
management 2        Up     --
red       6        Up     --
```

Within the Guest Shell, the network namespaces associated with the VRFs are what is actually used. It can be more convenient to just see which network namespaces are present:

```
[guestshell@guestshell bootflash]$ ls /var/run/netns
default management red
[guestshell@guestshell bootflash]$
```

To resolve domain names from within the Guest Shell, the resolver needs to be configured. Edit the `/etc/resolv.conf` file in the Guest Shell to include a DNS nameserver and domain as appropriate for the network.

Example:

```
nameserver 10.1.1.1
domain cisco.com
```

The nameserver and domain information should match what is configured through the NX-OS configuration.

Example:

```
switch(config)# ip domain-name cisco.com
switch(config)# ip name-server 10.1.1.1
switch(config)# vrf context management
switch(config-vrf)# ip domain-name cisco.com
switch(config-vrf)# ip name-server 10.1.1.1
```

If the switch is in a network that uses an HTTP proxy server, the **http\_proxy** and **https\_proxy** environment variables must be set up within the Guest Shell also.

Example:

```
export http_proxy=http://proxy.esl.cisco.com:8080
export https_proxy=http://proxy.esl.cisco.com:8080
```

These environment variables should be set in the `.bashrc` file or in an appropriate script to ensure that they are persistent.

## Access to Bootflash in Guest Shell

Network administrators can manage files with Linux commands and utilities in addition to using NX-OS CLI commands. By mounting the system bootflash at `/bootflash` in the Guest Shell environment, the `network-admin` can operate on these files with Linux commands.

Example:

```
find . -name "foo.txt"
rm "/bootflash/junk/foo.txt"
```



---

**Note** While the name of the user within the Guest Shell is the same as when on the host, the Guest Shell is in a separate user namespace, and the uid does not match that of the user on the host. The file permissions for group and others will control the type of access the Guest Shell user has on the file.

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## Python in Guest Shell

Python can be used interactively or python scripts can be run in the Guest Shell.

Example:

```
guestshell:~$ python
Python 2.7.5 (default, Jun 24 2015, 00:41:19)
[GCC 4.8.3 20140911 (Red Hat 4.8.3-9)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>>
guestshell:~$
```

The pip python package manager is included in the Guest Shell to allow the `network-admin` to install new python packages.

Example:

```
[guestshell@guestshell ~]$ sudo su
[root@guestshell guestshell]# pip install Markdown
Collecting Markdown
  Downloading Markdown-2.6.2-py2.py3-none-any.whl (157kB)
    100% |#####| 159kB 1.8MB/s
Installing collected packages: Markdown
Successfully installed Markdown-2.6.2
[root@guestshell guestshell]# pip list | grep Markdown
Markdown (2.6.2)
[root@guestshell guestshell]#
```



**Note** You must enter the **sudo su** command before entering the **pip install** command.

## Python 3 in Guest Shell versions up to 2.10 (CentOS 7)

Guest Shell 2.X provides a CentOS 7.1 environment, which does not have Python 3 installed by default. There are multiple methods of installing Python 3 on CentOS 7.1, such as using third-party repositories or building from source. Another option is using the Red Hat Software Collections, which supports installing multiple versions of Python within the same system.

To install the Red Hat Software Collections (SCL) tool:

1. Install the `scl-utils` package.
2. Enable the CentOS SCL repository and install one of its provided Python 3 RPMs.

```
[admin@guestshell ~]$ sudo su
[root@guestshell admin]# dnf install -y scl-utils | tail
Running transaction test
Transaction test succeeded
Running transaction
  Installing : scl-utils-20130529-19.el7.x86_64      1/1
  Verifying  : scl-utils-20130529-19.el7.x86_64      1/1

Installed:
  scl-utils.x86_64 0:20130529-19.el7

Complete!

[root@guestshell admin]# dnf install -y centos-release-scl | tail
  Verifying : centos-release-scl-2-3.el7.centos.noarch      1/2
  Verifying : centos-release-scl-rh-2-3.el7.centos.noarch   2/2

Installed:
  centos-release-scl.noarch 0:2-3.el7.centos

Dependency Installed:
  centos-release-scl-rh.noarch 0:2-3.el7.centos

Complete!

[root@guestshell admin]# dnf install -y rh-python36 | tail
warning: /var/cache/dnf/x86_64/7/centos-scl-rh/packages/rh-python36-2.0-1.el7.x86_64.rpm:
  Header V4 RSA/SHA1 Signature, key ID f2ee9d55: NOKEY
http://centos.sonn.com/7.7.1908/os/x86_64/Packages/groff-base-1.22.2-8.el7.x86_64.rpm:
[Errno 12] Timeout on
http://centos.sonn.com/7.7.1908/os/x86_64/Packages/groff-base-1.22.2-8.el7.x86_64.rpm: (28,
'Operation too slow. Less than 1000 bytes/sec transferred the last 30 seconds')
Trying other mirror.
Importing GPG key 0xF2EE9D55:
  Userid      : "CentOS SoftwareCollections SIG
(https://wiki.centos.org/SpecialInterestGroup/SCLo) <security@centos.org>"
  Fingerprint: c4db d535 b1fb ba14 f8ba 64a8 4eb8 4e71 f2ee 9d55
  Package     : centos-release-scl-rh-2-3.el7.centos.noarch (@extras)
  From        : /etc/pki/rpm-gpg/RPM-GPG-KEY-CentOS-SIG-SCLo
  rh-python36-python-libs.x86_64 0:3.6.9-2.el7
  rh-python36-python-pip.noarch 0:9.0.1-2.el7
  rh-python36-python-setuptools.noarch 0:36.5.0-1.el7
  rh-python36-python-virtualenv.noarch 0:15.1.0-2.el7
```

```
rh-python36-runtime.x86_64 0:2.0-1.e17
scl-utils-build.x86_64 0:20130529-19.e17
xml-common.noarch 0:0.6.3-39.e17
zip.x86_64 0:3.0-11.e17
```

Complete!

Using SCL, it is possible to create an interactive bash session with Python 3's environment variables automatically setup.



**Note** The root user is not needed to use the SCL Python installation.

```
[admin@guestshell ~]$ scl enable rh-python36 bash
[admin@guestshell ~]$ python3
Python 3.6.9 (default, Nov 11 2019, 11:24:16)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-39)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

The Python SCL installation also provides the pip utility.

```
[admin@guestshell ~]$ pip3 install requests --user
Collecting requests
  Downloading
https://files.pythonhosted.org/packages/51/bd/23c926cd341ee67cd1b2a00aba99ae0f823e89c72b2190f27c11cd4b7fb/requests-2.22.0-py2.py3-none-any.whl
(57kB)
 100% |#####| 61kB 211kB/s
Collecting idna<2.9,>=2.5 (from requests)
  Downloading
https://files.pythonhosted.org/packages/14/2c/c551b81dce15200be1cf41cd03869a46fe7226e7450af7a6545bfc474c9/idna-2.8-py2.py3-none-any.whl
(58kB)
 100% |#####| 61kB 279kB/s
Collecting chardet<3.1.0,>=3.0.2 (from requests)
  Downloading
https://files.pythonhosted.org/packages/bc/a9/01ffebfb562e4274b6487b4dbbbdc7ca55ec7510b22b4c51f14098443b8/chardet-3.0.4-py2.py3-none-any.whl
(133kB)
 100% |#####| 143kB 441kB/s
Collecting certifi>=2017.4.17 (from requests)
  Downloading
https://files.pythonhosted.org/packages/b9/63/d50ca96a08b00655a399c3ff1db9a7b75a24be7890bc9cf5b9e99/certifi-2019.11.28-py2.py3-none-any.whl
(156kB)
 100% |#####| 163kB 447kB/s
Collecting urllib3!=1.25.0,!1.25.1,<1.26,>=1.21.1 (from requests)
  Downloading
https://files.pythonhosted.org/packages/e8/74/6e4f91745020f967d09332b2b8c9b10090957334692a68ea4afe91b77f/urllib3-1.25.8-py2.py3-none-any.whl
(125kB)
 100% |#####| 133kB 656kB/s
Installing collected packages: idna, chardet, certifi, urllib3, requests
Successfully installed certifi-2019.11.28 chardet-3.0.4 idna-2.8 requests-2.22.0
urllib3-1.25.8
You are using pip version 9.0.1, however version 20.0.2 is available.
You should consider upgrading via the 'pip install --upgrade pip' command.
[admin@guestshell ~]$ python3
Python 3.6.9 (default, Nov 11 2019, 11:24:16)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-39)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import requests
>>> requests.get("https://cisco.com")
<Response [200]>
```

The default Python 2 installation can be used alongside the SCL Python installation.

```
[admin@guestshell ~]$ which python3
/opt/rh/rh-python36/root/usr/bin/python3
[admin@guestshell ~]$ which python2
/bin/python2
[admin@guestshell ~]$ python2
Python 2.7.5 (default, Aug 7 2019, 00:51:29)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-39)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> print 'Hello world!'
Hello world!
```

Software Collections makes it possible to install multiple versions of the same RPM on a system. In this case, it is possible to install Python 3.5 in addition to Python 3.6.

```
[admin@guestshell ~]$ sudo dnf install -y rh-python35 | tail
Dependency Installed:
  rh-python35-python.x86_64 0:3.5.1-13.e17
  rh-python35-python-devel.x86_64 0:3.5.1-13.e17
  rh-python35-python-libs.x86_64 0:3.5.1-13.e17
  rh-python35-python-pip.noarch 0:7.1.0-2.e17
  rh-python35-python-setuptools.noarch 0:18.0.1-2.e17
  rh-python35-python-virtualenv.noarch 0:13.1.2-2.e17
  rh-python35-runtime.x86_64 0:2.0-2.e17
```

Complete!

```
[admin@guestshell ~]$ scl enable rh-python35 python3
Python 3.5.1 (default, May 29 2019, 15:41:33)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-36)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```



**Note** Creating new interactive bash sessions when multiple Python versions are installed in SCL can cause an issue where the libpython shared object file cannot be loaded. There is a workaround where you can use the **source scl\_source enable python-installation** command to properly set up the environment in the current bash session.

The default Guest Shell storage capacity is not sufficient to install Python 3. Use the **guestshell resize rootfs size-in-MB** command to increase the size of the file system. Typically, setting the rootfs size to 550 MB is sufficient.

## Python 3 in Guest Shell versions up to 2.10 (CentOS 7)

Guest Shell 2.X provides a CentOS 7.1 environment, which does not have Python 3 installed by default. There are multiple methods of installing Python 3 on CentOS 7.1, such as using third-party repositories or building from source. Another option is using the Red Hat Software Collections, which supports installing multiple versions of Python within the same system.

To install the Red Hat Software Collections (SCL) tool:

1. Install the `scl-utils` package.
2. Enable the CentOS SCL repository and install one of its provided Python 3 RPMs.

```
[admin@guestshell ~]$ sudo su
[root@guestshell admin]# dnf install -y scl-utils | tail
Running transaction test
Transaction test succeeded
Running transaction
```

```

Installing : scl-utils-20130529-19.el7.x86_64          1/1
Verifying  : scl-utils-20130529-19.el7.x86_64          1/1

Installed:
scl-utils.x86_64 0:20130529-19.el7

Complete!

[root@guestshell admin]# dnf install -y centos-release-scl | tail
Verifying  : centos-release-scl-2-3.el7.centos.noarch    1/2
Verifying  : centos-release-scl-rh-2-3.el7.centos.noarch 2/2

Installed:
centos-release-scl.noarch 0:2-3.el7.centos

Dependency Installed:
centos-release-scl-rh.noarch 0:2-3.el7.centos

Complete!

[root@guestshell admin]# dnf install -y rh-python36 | tail
warning: /var/cache/dnf/x86_64/7/centos-scl-rh/packages/rh-python36-2.0-1.el7.x86_64.rpm:
Header V4 RSA/SHA1 Signature, key ID f2ee9d55: NOKEY
http://centos.sonn.com/7.7.1908/os/x86_64/Packages/groff-base-1.22.2-8.el7.x86_64.rpm:
[Errno 12] Timeout on
http://centos.sonn.com/7.7.1908/os/x86_64/Packages/groff-base-1.22.2-8.el7.x86_64.rpm: (28,
'Operation too slow. Less than 1000 bytes/sec transferred the last 30 seconds')
Trying other mirror.
Importing GPG key 0xF2EE9D55:
Userid      : "CentOS SoftwareCollections SIG
(https://wiki.centos.org/SpecialInterestGroup/SCLo) <security@centos.org>"
Fingerprint: c4db d535 b1fb ba14 f8ba 64a8 4eb8 4e71 f2ee 9d55
Package     : centos-release-scl-rh-2-3.el7.centos.noarch (@extras)
From        : /etc/pki/rpm-gpg/RPM-GPG-KEY-CentOS-SIG-SCLo
rh-python36-python-libs.x86_64 0:3.6.9-2.el7
rh-python36-python-pip.noarch 0:9.0.1-2.el7
rh-python36-python-setuptools.noarch 0:36.5.0-1.el7
rh-python36-python-virtualenv.noarch 0:15.1.0-2.el7
rh-python36-runtime.x86_64 0:2.0-1.el7
scl-utils-build.x86_64 0:20130529-19.el7
xml-common.noarch 0:0.6.3-39.el7
zip.x86_64 0:3.0-11.el7

```

Complete!

Using SCL, it is possible to create an interactive bash session with Python 3's environment variables automatically setup.




---

**Note** The root user is not needed to use the SCL Python installation.

---

```

[admin@guestshell ~]$ scl enable rh-python36 bash
[admin@guestshell ~]$ python3
Python 3.6.9 (default, Nov 11 2019, 11:24:16)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-39)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>

```

The Python SCL installation also provides the pip utility.

```

[admin@guestshell ~]$ pip3 install requests --user
Collecting requests
  Downloading

```

```

https://files.pythonhosted.org/packages/51/td/23c926cc841ea67cd0b2a00aba99ae0f828be89c72b2190f27c11d4b7fb/requests-2.22.0-py2.py3-none-any.whl
(57kB)
100% |#####| 61kB 211kB/s
Collecting idna<2.9,>=2.5 (from requests)
  Downloading
https://files.pythonhosted.org/packages/14/2c/cd551d81d8e15200b6c4f41cd03869a46fe7226e7450af7a6545bfc474c9/idna-2.8-py2.py3-none-any.whl
(58kB)
100% |#####| 61kB 279kB/s
Collecting chardet<3.1.0,>=3.0.2 (from requests)
  Downloading
https://files.pythonhosted.org/packages/cc/a9/01ffebfb562e4274b6487b4bb1dbbc7ca55ac7510b22e4c51f14098443c8/chardet-3.0.4-py2.py3-none-any.whl
(133kB)
100% |#####| 143kB 441kB/s
Collecting certifi>=2017.4.17 (from requests)
  Downloading
https://files.pythonhosted.org/packages/b9/63/cf50cac98a0fb006c55a3993bffd9ba765a24b7890c9cf5fb9e99/certifi-2019.11.28-py2.py3-none-any.whl
(156kB)
100% |#####| 163kB 447kB/s
Collecting urllib3!=1.25.0,!1.25.1,<1.26,>=1.21.1 (from requests)
  Downloading
https://files.pythonhosted.org/packages/e8/74/6e4f91745020f967d093321d289b10090957334692d88ea4afe91b77f/urllib3-1.25.8-py2.py3-none-any.whl
(125kB)
100% |#####| 133kB 656kB/s
Installing collected packages: idna, chardet, certifi, urllib3, requests
Successfully installed certifi-2019.11.28 chardet-3.0.4 idna-2.8 requests-2.22.0
urllib3-1.25.8
You are using pip version 9.0.1, however version 20.0.2 is available.
You should consider upgrading via the 'pip install --upgrade pip' command.
[admin@guestshell ~]$ python3
Python 3.6.9 (default, Nov 11 2019, 11:24:16)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-39)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import requests
>>> requests.get("https://cisco.com")
<Response [200]>

```

The default Python 2 installation can be used alongside the SCL Python installation.

```

[admin@guestshell ~]$ which python3
/opt/rh/rh-python36/root/usr/bin/python3
[admin@guestshell ~]$ which python2
/bin/python2
[admin@guestshell ~]$ python2
Python 2.7.5 (default, Aug 7 2019, 00:51:29)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-39)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> print 'Hello world!'
Hello world!

```

Software Collections makes it possible to install multiple versions of the same RPM on a system. In this case, it is possible to install Python 3.5 in addition to Python 3.6.

```

[admin@guestshell ~]$ sudo dnf install -y rh-python35 | tail
Dependency Installed:
  rh-python35-python.x86_64 0:3.5.1-13.e17
  rh-python35-python-devel.x86_64 0:3.5.1-13.e17
  rh-python35-python-libs.x86_64 0:3.5.1-13.e17
  rh-python35-python-pip.noarch 0:7.1.0-2.e17
  rh-python35-python-setuptools.noarch 0:18.0.1-2.e17
  rh-python35-python-virtualenv.noarch 0:13.1.2-2.e17
  rh-python35-runtime.x86_64 0:2.0-2.e17

Complete!

[admin@guestshell ~]$ scl enable rh-python35 python3

```



```
Python 3.5.1 (default, May 29 2019, 15:41:33)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-36)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```



**Note** Creating new interactive bash sessions when multiple Python versions are installed in SCL can cause an issue where the libpython shared object file cannot be loaded. There is a workaround where you can use the **source scl\_source enable python-installation** command to properly set up the environment in the current bash session.

The default Guest Shell storage capacity is not sufficient to install Python 3. Use the **guestshell resize rootfs size-in-MB** command to increase the size of the file system. Typically, setting the rootfs size to 550 MB is sufficient.

## Installing RPMs in the Guest Shell

The `/etc/dnf/repos.d/CentOS-Base.repo` file is set up to use the CentOS mirror list by default. Follow instructions in that file if changes are needed.

Dnf can be pointed to one or more repositories at any time by modifying the `yumrepo_x86_64.repo` file or by adding a new `.repo` file in the `repos.d` directory.

For applications to be installed inside Guest Shell 2.x, go to the CentOS 7 repo at [http://mirror.centos.org/centos/7/os/x86\\_64/Packages/](http://mirror.centos.org/centos/7/os/x86_64/Packages/).

For applications to be installed inside Guest Shell 4.0, go to the RockyLinux 9.2 repo at [https://mirrors.rockylinux.org/mirrorlist?arch=x86\\_64&repo=rocky-BaseOS-9.2](https://mirrors.rockylinux.org/mirrorlist?arch=x86_64&repo=rocky-BaseOS-9.2). Choose any one of mirror link and view the packages.

Dnf resolves the dependencies and installs all the required packages.

```
[guestshell@guestshell ~]$ sudo chvrf management dnf -y install glibc.i686
Loaded plugins: fastestmirror
Loading mirror speeds from cached hostfile
* base: bay.uchicago.edu
* extras: pubmirrors.dal.corespace.com
* updates: mirrors.cmich.edu
Resolving Dependencies
"--> Running transaction check
"---> Package glibc.i686 0:2.17-78.e17 will be installed
"---> Processing Dependency: libfreebl3.so(NSSRAWHASH_3.12.3) for package:
glibc-2.17-78.e17.i686
"---> Processing Dependency: libfreebl3.so for package: glibc-2.17-78.e17.i686
"---> Running transaction check
"---> Package nss-softokn-freebl.i686 0:3.16.2.3-9.e17 will be installed
"---> Finished Dependency Resolution
```

Dependencies Resolved

```
=====
Package Arch Version Repository Size
=====
```

```
Installing:
glibc i686 2.17-78.e17 base 4.2 M
Installing for dependencies:
nss-softokn-freebl i686 3.16.2.3-9.e17 base 187 k
```

```
Transaction Summary
=====
```

```

Install 1 Package (+1 Dependent package)

Total download size: 4.4 M
Installed size: 15 M
Downloading packages:
Delta RPMs disabled because /usr/bin/applydeltarpm not installed.
(1/2): nss-softokn-freebl-3.16.2.3-9.el7.i686.rpm | 187 kB 00:00:25
(2/2): glibc-2.17-78.el7.i686.rpm | 4.2 MB 00:00:30
-----
Total 145 kB/s | 4.4 MB 00:00:30
Running transaction check
Running transaction test
Transaction test succeeded
Running transaction
Installing : nss-softokn-freebl-3.16.2.3-9.el7.i686 1/2
Installing : glibc-2.17-78.el7.i686 2/2
error: lua script failed: [string "%triggerin(glibc-common-2.17-78.el7.x86_64)"]:1: attempt
to compare number with nil
Non-fatal "<"unknown">" scriptlet failure in rpm package glibc-2.17-78.el7.i686
Verifying : glibc-2.17-78.el7.i686 1/2
Verifying : nss-softokn-freebl-3.16.2.3-9.el7.i686 2/2

Installed:
glibc.i686 0:2.17-78.el7

Dependency Installed:
nss-softokn-freebl.i686 0:3.16.2.3-9.el7

Complete!

```




---

**Note** When more space is needed in the Guest Shell root file system for installing or running packages, the **guestshell resize roots *size-in-MB*** command is used to increase the size of the file system.

---




---

**Note** Some open source software packages from the repository might not install or run as expected in the Guest Shell as a result of restrictions that have been put into place to protect the integrity of the host system.

---

## Security Posture for Virtual ServicesGuest Shell

Use of the Guest Shell and virtual services in switches are only two of the many ways that the network-admin can manage or extend the functionality of the system. These options are geared toward providing an execution environment that is decoupled from the native host context. This separation allows the introduction of software into the system that may not be compatible with the native execution environment. It also allows the software to run in an environment that does not interfere with the behavior, performance, or scale of the system.

Use of the Guest Shell in switches is just one of the many ways the network admin can manage or extend the functionality of the system. The Guest Shell is intended to provide an execution environment that is decoupled from the native host context. This separation allows the introduction of software into the system that may not be compatible with the native execution environment. It also allows the software to run in an environment that does not interfere with the behavior, performance, or scale of the system.

## Digitally Signed Application Packages

By default, Cisco network elements require applications to provide a valid Cisco digital signature at runtime. The Cisco digital signature ensures the integrity of Cisco-developed packages and applications.

The Cisco Nexus 30009000 Series switches support the configuration of a signing level policy to allow for unsigned OVA software packages. To allow unsigned and Cisco-signed packages for creating virtual-services, the network-admin can configure the following:

```
virtual-service
  signing level unsigned
```



---

**Note** The Guest Shell software package has a Cisco signature and does not require this configuration.

---

## Kernel Vulnerability Patches

Cisco responds to pertinent Common Vulnerabilities and Exposures (CVEs) with platform updates that address known vulnerabilities.



---

**Note** Cisco tracks the vulnerabilities for Guestshell 4.0 (Rocky Linux 9.2) environment and will include future fixes when they are available from Rocky Linux.

---

## ASLR and X-Space Support

Cisco 30009000 NX-OS supports the use of Address Space Layout Randomization (ASLR) and Executable Space Protection (X-Space) for runtime defense. The software in Cisco-signed packages make use of this capability. If other software is installed on the system, it is recommended that it be built using a host OS and development toolchain that supports these technologies. Doing so reduces the potential attack surface that the software presents to potential intruders.

## Namespace Isolation

The host and virtual service are separated into separate namespaces. This provides the basis of separating the execution spaces of the virtual services from the host. Namespace isolation helps to protect against data loss and data corruption due to accidental or intentional data overwrites between trust boundaries. It also helps to ensure the integrity of confidential data by preventing data leakage between trust boundaries: an application in one virtual service cannot access data in another virtual service

## Namespace Isolation

The Guest Shell environment runs within a Linux container that makes use of various namespaces to decouple the Guest Shell execution space from that of the host. Starting in the NX-OS 9.2(1) release, the Guest Shell is run in a separate user namespace, which helps protect the integrity of the host system, as processes running as root within the Guest Shell are not root of the host. These processes appear to be running as uid 0 within

the Guest Shell due to uid mapping, but the kernel knows the real uid of these processes and evaluates the POSIX capabilities within the appropriate user namespace.

When a user enters the Guest Shell from the host, a user of the same name is created within the Guest Shell. While the names match, the uid of the user within the Guest Shell is not the same as the uid on the host. To still allow users within the Guest Shell to access files on shared media (for example, `/bootflash` or `/volatile`), the common NX-OS gids used on the host (for example, `network-admin` or `network-operator`) are mapped into the Guest Shell such that the values are the same and the Guest Shell instance of the user is associated with the appropriate groups based on group membership on the host.

As an example, consider user `bob`. On the host, `bob` has the following uid and gid membership:

```
bash-4.3$ id
uid=2004(bob) gid=503(network-admin) groups=503(network-admin),504(network-operator)
```

When user `bob` is in the Guest Shell, the group membership from the host is set up in the Guest Shell:

```
[bob@guestshell ~]$ id
uid=1002(bob) gid=503(network-admin)
groups=503(network-admin),504(network-operator),10(wheel)
```

Files created by user `bob` in the host Bash shell and the Guest Shell have different owner ids. The example output below shows that the file created from within the Guest Shell has owner id 12002, instead of 1002 as shown in the example output above. This is due to the command being issued from the host Bash shell and the id space for the Guest Shell starting at id 11000. The group id of the file is `network-admin`, which is 503 in both environments.

```
bash-4.3$ ls -ln /bootflash/bob_*
-rw-rw-r-- 1 12002 503 4 Jun 22 15:47 /bootflash/bob_guestshell
-rw-rw-r-- 1 2004 503 4 Jun 22 15:47 /bootflash/bob_host
```

```
bash-4.3$ ls -l /bootflash/bob_*
-rw-rw-r-- 1 12002 network-admin 4 Jun 22 15:47 /bootflash/bob_guestshell
-rw-rw-r-- 1 bob network-admin 4 Jun 22 15:47 /bootflash/bob_host
```

The user is allowed to access the file due to the file permission settings for the `network-admin` group, and the fact that `bob` is a member of `network-admin` in both the host and Guest Shell.

Inside the Guest Shell environment, the example output below shows that the owner id for the file created by `bob` from the host is 65534. This indicates the actual id is in a range that is outside range of ids mapped into the user namespace. Any unmapped id will be shown as this value.

```
[bob@guestshell ~]$ ls -ln /bootflash/bob_*
-rw-rw-r-- 1 1002 503 4 Jun 22 15:47 /bootflash/bob_guestshell
-rw-rw-r-- 1 65534 503 4 Jun 22 15:47 /bootflash/bob_host
```

```
[bob@guestshell ~]$ ls -l /bootflash/bob_*
-rw-rw-r-- 1 bob network-admin 4 Jun 22 15:47 /bootflash/bob_guestshell
-rw-rw-r-- 1 65534 network-admin 4 Jun 22 15:47 /bootflash/bob_host
```

## Root-User Restrictions

As a best practice for developing secure code, it is recommend running applications with the least privilege needed to accomplish the assigned task. To help prevent unintended accesses, software added into the Guest Shell should follow this best practice.

All processes within a virtual servicethe Guest Shell are subject to restrictions imposed by reduced Linux capabilities. If your application must perform operations that require root privileges, restrict the use of the root account to the smallest set of operations that absolutely requires root access, and impose other controls such as a hard limit on the amount of time that the application can run in that mode.

The set of Linux capabilities that are dropped for root within virtual servicethe Guest Shell follow:

CAP_SYS_BOOT	CAP_MKNOD	CAP_SYS_PACCT
CAP_SYS_MODULE	CAP_MAC_OVERRIDE	CAP_SYS_RESOURCE
CAP_SYS_TIME	CAP_SYS_RAWIO	CAP_AUDIT_WRITE
CAP_AUDIT_CONTROL	CAP_SYS_NICE	CAP_NET_ADMIN
CAP_MAC_ADMIN	CAP_SYS_PTRACE	

- cap\_audit\_control
- cap\_audit\_write
- cap\_mac\_admin
- cap\_mac\_override
- cap\_mknod
- cap\_net\_broadcast
- cap\_sys\_boot
- cap\_syslog
- cap\_sys\_module
- cap\_sys\_nice
- cap\_sys\_pacct
- cap\_sys\_ptrace
- cap\_sys\_rawio
- cap\_sys\_resource
- cap\_sys\_time
- cap\_wake\_alarm

As root within a virtual service, bind mounts may be used as well as tmpfs and ramfs mounts. Other mounts are prevented.

While the `net_admin` capability is not dropped, user namespace and the host ownership of the network namespaces prevents the Guest Shell user from modifying the interface state. As root within the Guest Shell, bind mounts may be used as well as `tmpfs` and `ramfs` mounts. Other mounts are prevented.

## Resource Management

A Denial-of-Service (DoS) attack attempts to make a machine or network resource unavailable to its intended users. Misbehaving or malicious application code can cause DoS as the result of over-consumption of connection bandwidth, disk space, memory, and other resources. The host provides resource-management features that ensure fair allocation of resources among all virtual services between Guest Shell and services on the host.

## Guest File System Access Restrictions

To preserve the integrity of the files within the virtual services, the file systems of the virtual services are not accessible from the NX-OS CLI. If a given virtual-service allows files to be modified, it needs to provide an alternate means by which this can be done (i.e. **yum install**, **scp**, **ftp**, etc).

To preserve the integrity of the files within the Guest Shell, the file systems of the Guest Shell are not accessible from the NX-OS CLI.

The Guest Shell mounts the `bootflash` of the host system at `/bootflash`. The network-admin can access the file using an NX-OS CLI or Linux command from within the Guest Shell.

`bootflash:` and `volatile:` of the host are mounted as `/bootflash` and `/volatile` within the Guest Shell. A network-admin can access files on this media using the NX-OS `exec` commands from the host or using Linux commands from within the Guest Shell.

## Managing the Guest Shell

The following are commands to manage the Guest Shell:

*Table 1: Guest Shell CLI Commands*

Commands	Description

Commands	Description
<b>guestshell enable</b> { <b>package</b> [ <i>guest shell OVA file</i>   <i>rootfs-file-URI</i> ]}	<ul style="list-style-type: none"> <li>• When <i>guest shell OVA file</i> is specified:            Installs and activates the Guest Shell using the OVA that is embedded in the system image.             Installs and activates the Guest Shell using the specified software package (OVA file) or the embedded package from the system image (when no package is specified). Initially, Guest Shell packages are only available by being embedded in the system image.             When the Guest Shell is already installed, this command enables the installed Guest Shell. Typically this is used after a <b>guestshell disable</b> command.</li> <li>• When <i>rootfs-file-URI</i> is specified:            Imports a Guest Shell <b>rootfs</b> when the Guest Shell is in a destroyed state. This command brings up the Guest Shell with the specified package.</li> </ul>
<b>guestshell export rootfs package</b> <i>destination-file-URI</i>	Exports a Guest Shell <b>rootfs</b> file to a local URI (bootflash, USB1, etc.). (7.0(3)I7(1) and later releases)
<b>guestshell disable</b>	Shuts down and disables the Guest Shell.

Commands	Description
<p><b>guestshell upgrade</b> {<b>package</b> [<i>guest shell OVA file</i>   <i>rootfs-file-URI</i>]}</p>	<ul style="list-style-type: none"> <li>When <i>guest shell OVA file</i> is specified: <p>Deactivates and upgrades the Guest Shell using the specified software package (OVA file) or the embedded package from the system image (if no package is specified). Initially Guest Shell packages are only available by being embedded in the system image.</p> <p>The current rootfs for the Guest Shell is replaced with the rootfs in the software package. The Guest Shell does not make use of secondary filesystems that persist across an upgrade. Without persistent secondary filesystems, a <b>guestshell destroy</b> command followed by a <b>guestshell enable</b> command could also be used to replace the rootfs. When an upgrade is successful, the Guest Shell is activated.</p> <p>You are prompted for a confirmation prior to carrying out the upgrade command.</p> </li> <li>When <i>rootfs-file-URI</i> is specified: <p>Imports a Guest Shell <b>rootfs</b> file when the Guest Shell is already installed. This command removes the existing Guest Shell and installs the specified package.</p> </li> </ul>
<p><b>guestshell reboot</b></p>	<p>Deactivates the Guest Shell and then reactivates it.</p> <p>You are prompted for a confirmation prior to carrying out the reboot command.</p> <p><b>Note</b> This is the equivalent of a <b>guestshell disable</b> command followed by a <b>guestshell enable</b> command in exec mode.</p> <p>This is useful when processes inside the Guest Shell have been stopped and need to be restarted. The <b>run guestshell</b> command relies on <code>sshd</code> running in the Guest Shell.</p> <p>If the command does not work, the <code>sshd</code> process may have been inadvertently stopped. Performing a reboot of the Guest Shell from the NX-OS CLI allows it to restart and restore the command.</p>



Commands	Description
<b>guestshell destroy</b>	<p>Deactivates and uninstalls the Guest Shell. All resources associated with the Guest Shell are returned to the system. The <b>show virtual-service global</b> command indicates when these resources become available.</p> <p>Issuing this command results in a prompt for a confirmation prior to carrying out the destroy command.</p>
<b>guestshell</b> <b>run guestshell</b>	Connects to the Guest Shell that is already running with a shell prompt. No username/password is required.
<b>guestshell run</b> <i>command</i> <b>run guestshell</b> <i>command</i>	<p>Executes a Linux/UNIX command within the context of the Guest Shell environment.</p> <p>After execution of the command you are returned to the switch prompt.</p>
<b>guestshell resize</b> [cpu   memory   rootfs]	<p>Changes the allotted resources available for the Guest Shell. The changes take effect the next time the Guest Shell is enabled or rebooted.</p> <p><b>Note</b>      Resize values are cleared when the <b>guestshell destroy</b> command is used.</p>
<b>guestshell sync</b>	On systems that have active and standby supervisors, this command synchronizes the Guest Shell contents from the active supervisor to the standby supervisor. The network-admin issues this command when the Guest Shell rootfs has been set up to a point that they would want the same rootfs used on the standby supervisor when it becomes the active supervisor. If this command is not used, the Guest Shell is freshly installed when the standby supervisor transitions to an active role using the Guest Shell package available on that supervisor.
<b>virtual-service reset force</b>	<p>In the event that the guestshell or virtual-services cannot be managed, even after a system reload, the reset command is used to force the removal of the Guest Shell and all virtual-services. The system needs to be reloaded for the cleanup to happen. No Guest Shell or additional virtual-services can be installed or enabled after issuing this command until after the system has been reloaded.</p> <p>You are prompted for a confirmation prior to initiating the reset.</p>




---

**Note** Administrative privileges are necessary to enable/disable and to gain access to the Guest Shell environment.

---




---

**Note** The Guest Shell is implemented as a Linux container (LXC) on the host system. On NX-OS devices, LXC's are installed and managed with the virtual-service commands. The Guest Shell appears in the virtual-service commands as a virtual service named `guestshell+`.

---




---

**Note** Virtual-service commands that do not pertain to the Guest Shell are being deprecated. These commands have been hidden in the NX-OS 9.2(1) release and will be removed in future releases.

The following exec keywords are being deprecated:

```
# virtual-service ?
connect Request a virtual service shell
install Add a virtual service to install database
uninstall Remove a virtual service from the install database
upgrade Upgrade a virtual service package to a different version
```

```
# show virtual-service ?
detail Detailed information config)
```

The following config keywords are being deprecated:

```
(config) virtual-service ?
WORD Virtual service name (Max Size 20)
```

```
(config-virt-serv)# ?
activate Activate configured virtual service
description Virtual service description
```

---

## Disabling the Guest Shell

The **guestshell disable** command shuts down and disables the Guest Shell.

When the Guest Shell is disabled and the system is reloaded, the Guest Shell remains disabled.

Example:

```
switch# show virtual-service list
Virtual Service List:
Name                               Status           Package Name
-----
guestshell+                         Activated        guestshell.ova
switch# guestshell disable
You will not be able to access your guest shell if it is disabled. Are you sure you want
to disable the guest shell? (y/n) [n] y

2014 Jul 30 19:47:23 switch %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Deactivating virtual
service 'guestshell+'
```

```

2014 Jul 30 18:47:29 switch %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Successfully deactivated
virtual service 'guestshell+'
switch# show virtual-service list
Virtual Service List:
Name                Status                Package Name
guestshell+         Deactivated           guestshell.ova

```




---

**Note** The Guest Shell is reactivated with the **guestshell enable** command.

---

## Destroying the Guest Shell

The **guestshell destroy** command uninstalls the Guest Shell and its artifacts. The command does not remove the Guest Shell OVA.

When the Guest Shell is destroyed and the system is reloaded, the Guest Shell remains destroyed.

```

switch# show virtual-service list
Virtual Service List:
Name                Status                Package Name
-----
guestshell+         Deactivated           guestshell.ova

```

```
switch# guestshell destroy
```

```

You are about to destroy the guest shell and all of its contents. Be sure to save your work.
Are you sure you want to continue? (y/n) [n] y
2014 Jul 30 18:49:10 switch %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Destroying virtual service
'guestshell+'
2014 Jul 30 18:49:10 switch %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Successfully destroyed
virtual service 'guestshell +'

```

```

switch# show virtual-service list
Virtual Service List:

```




---

**Note** The Guest Shell can be re-enabled with the **guestshell enable** command.

---




---

**Note** If you do not want to use the Guest Shell, you can remove it with the **guestshell destroy** command. Once the Guest Shell has been removed, it remains removed for subsequent reloads. This means that when the Guest Shell container has been removed and the switch is reloaded, the Guest Shell container is not automatically started.

---

## Enabling the Guest Shell

The **guestshell enable** command installs the Guest Shell from a Guest Shell software package. By default, the package embedded in the system image is used for the installation. The command is also used to reactivate the Guest Shell if it has been disabled.

When the Guest Shell is enabled and the system is reloaded, the Guest Shell remains enabled.

Example:

```
switch# show virtual-service list
Virtual Service List:
switch# guestshell enable
2014 Jul 30 18:50:27 switch %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Installing virtual service
'guestshell+'
2014 Jul 30 18:50:42 switch %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Install success virtual
service 'guestshell+'; Activating

2014 Jul 30 18:50:42 switch %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Activating virtual service
'guestshell+'
2014 Jul 30 18:51:16 switch %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Successfully activated
virtual service 'guestshell+'

switch# show virtual-service list
Virtual Service List:
Name                               Status           Package Name
guestshell+                         Activated        guestshell.ova
```

### Enabling the Guest Shell in Base Boot Mode

Beginning in the NX-OS 9.2(1) release, you can choose to boot your system in *base boot mode*. When you boot your system in base boot mode, the Guest Shell is not started by default. In order to use the Guest Shell in this mode, you must activate the RPMs containing the virtualization infrastructure as well as the Guest Shell image. Once you have done this, the Guest Shell and virtual-service commands will be available.

If the RPM activation commands are run in this order:

1. `install activate guestshell`
2. `install activate virtualization`

The Guest Shell container will be activated automatically as it would have been if the system had been booted in full mode.

If the RPM activation commands are run in the reverse order:

1. `install activate virtualization`
2. `install activate guestshell`

Then the Guest Shell will not be enabled until you run the **guestshell enable** command.

### Enabling the Guest Shell on Cisco Nexus 3000 with Compacted Image

The Guest Shell software is not available in a Cisco NX-OS image that has been compacted for the Cisco Nexus 3000 Series switches with 1.6 GB bootflash and 4 GB RAM. You can still use the Guest Shell in this case, but you will need to download the software package from [software.cisco.com](http://software.cisco.com) for the Cisco NX-OS release, then you will need to copy it onto the Cisco Nexus 3000 Series switch and enable it.

For more information on compacted images, refer to the *Cisco Nexus 3000 Series NX-OS Software Upgrade and Downgrade Guide, Release 9.2(1)*.

The Guest Shell software installs onto the bootflash of the switch. To create as much free bootflash space as possible, put the downloaded `guestshell.ova` file onto the `volatile:` storage media. Once the Guest

Shell is successfully activated, the `guestshell.ova` file can be deleted. It will not be needed again unless the Guest Shell is destroyed at some point and needs to be re-installed.

For example:

```
switch# copy scp://admin@1.2.3.4/guestshell.ova volatile: vrf management
guestshell.ova 100% 55MB 10.9MB/s 00:05
Copy complete, now saving to disk (please wait)...
Copy complete.

switch# dir volatile: | inc .ova
57251840 Jun 22 11:56:51 2018 guestshell.ova

switch# guestshell enable package volatile:guestshell.ova
2018 Jun 7 19:13:03 n3x-164 %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Installing virtual service
'guestshell+'
2018 Jun 7 19:13:56 n3x-164 %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Install success virtual
service 'guestshell+'; Activating
2018 Jun 7 19:13:56 n3x-164 %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Activating virtual service
'guestshell+'
2018 Jun 7 19:15:34 n3x-164 %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Successfully activated
virtual service 'guestshell+'

switch# del volatile:guestshell.ova
Do you want to delete "/guestshell.ova" ? (yes/no/abort) [y] y

switch# guestshell
[admin@guestshell ~]$
```

## Replicating the Guest Shell

Beginning with Cisco NX-OS release 7.0(3)I7(1), a Guest Shell **rootfs** that is customized on one switch can be deployed onto multiple switches.

The approach is to customize and then export the Guest Shell **rootfs** and store it on a file server. A POAP script can download (import) the Guest Shell **rootfs** to other switches and install the specific Guest Shell across many devices simultaneously.

### Exporting Guest Shell **rootfs**

Use the `guestshell export rootfs package destination-file-URI` command to export a Guest Shell **rootfs**.

The *destination-file-URI* parameter is the name of the file that the Guest Shell **rootfs** is copied to. This file allows for local URI options (bootflash, USB1, etc.).

The `guestshell export rootfs package` command:

- Disables the Guest Shell (if already enabled).
- Creates a Guest Shell import YAML file and inserts it into the `/cisco` directory of the **rootfs** ext4 file.
- Copies the **rootfs** ext4 file to the target URI location.
- Re-enables the Guest Shell if it had been previously enabled.

### Importing Guest Shell **rootfs**

When importing a Guest Shell **rootfs**, there are two situations to consider:

- Use the **guestshell enable package** *rootfs-file-URI* command to import a Guest Shell **rootfs** when the Guest Shell is in a destroyed state. This command brings up the Guest Shell with the specified package.
- Use the **guestshell upgrade package** *rootfs-file-URI* command to import a Guest Shell **rootfs** when the Guest Shell is already installed. This command removes the existing Guest Shell and installs the specified package.

The *rootfs-file-URI* parameter is the **rootfs** file stored on local storage (bootflash, USB, etc.).

When this command is executed with a file that is on bootflash, the file is moved to a storage pool on bootflash.

As a best practice, you should copy the file to the bootflash and validate the md5sum before using the **guestshell upgrade package** *rootfs-file-URI* command.




---

**Note** The **guestshell upgrade package** *rootfs-file-URI* command can be executed from within the Guest Shell.

---




---

**Note** The *rootfs* file is not a Cisco signed package, you must configure to allow unsigned packages before enabling as shown in the example:

```
(config-virt-serv-global)# signing level unsigned
Note: Support for unsigned packages has been user-enabled. Unsigned packages are not endorsed
by Cisco. User assumes all responsibility.
```

---




---

**Note** To restore the embedded version of the *rootfs*:

- Use the **guestshell upgrade** command (without additional parameters) when the Guest Shell has already been installed.
  - Use the **guestshell enable** command (without additional parameters) when the Guest Shell had been destroyed.
- 




---

**Note** When running this command from within a Guest Shell, or outside a switch using NX-API, you must set **terminal dont-ask** to skip any prompts.

---

The **guestshell enable package** *rootfs-file-URI* command:

- Performs basic validation of the **rootfs** file.
- Moves the **rootfs** into the storage pool.
- Mounts the **rootfs** to extract the YAML file from the */cisco* directory.
- Parses the YAML file to obtain VM definition (including resource requirements).
- Activates the Guest Shell.

### Example workflow for **guestshell enable** :

```
switch# copy scp://user@10.1.1.1/my_storage/gs_rootfs.ext4 bootflash: vrf management
switch# guestshell resize cpu 8
Note: System CPU share will be resized on Guest shell enable
switch# guestshell enable package bootflash:gs_rootfs.ext4
Validating the provided rootfs
switch# 2017 Jul 31 14:58:01 switch %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Installing virtual
service 'guestshell+'
2017 Jul 31 14:58:09 switch %$ VDC-1 %$ %VMAN-2-INSTALL_STATE: Install success virtual
service 'guestshell+'; Activating
2017 Jul 31 14:58:09 switch %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Activating virtual service
'guestshell+'
2017 Jul 31 14:58:33 switch %$ VDC-1 %$ %VMAN-2-ACTIVATION_STATE: Successfully activated
virtual service 'guestshell+'
```




---

**Note** Workflow for **guestshell upgrade** is preceded by the existing Guest Shell being destroyed.

---




---

**Note** Resize values are cleared when the **guestshell upgrade** command is used.

---

## Importing YAML File

A YAML file that defines some user modifiable characteristics of the Guest Shell is automatically created as a part of the export operation. It is embedded into the Guest Shell **rootfs** in the `/cisco` directory. It is not a complete descriptor for the Guest Shell container. It only contains some of the parameters that are user modifiable.

Example of a Guest Shell import YAML file:

```
---
import-schema-version: "1.0"
info:
  name: "GuestShell"
  version: "2.2(0.3)"
  description: "Exported GuestShell: 20170216T175137Z"
app:
  apptype: "lxc"
  cpuarch: "x86_64"
  resources:
    cpu: 3
    memory: 307200
    disk:
      - target-dir: "/"
        capacity: 250
  ...
```

The YAML file is generated when the **guestshell export rootfs package** command is executed. The file captures the values of the currently running Guest Shell.

The info section contains non-operational data that is used to help identify the Guest Shell. Some of the information will be displayed in the output of the **show guestshell detail** command.

The description value is an encoding of the UTC time when the YAML file was created. The time string format is the same as DTSTAMP in RFC5545 (iCal).

The resources section describes the resources required for hosting the Guest Shell. The value "/" for the target-dir in the example identifies the disk as the **rootfs**.



**Note** If resized values were specified while the Guest Shell was destroyed, those values take precedence over the values in the import YAML file when the **guestshell enable package** command is used.

The cpuarch value indicates the CPU architecture that is expected for the container to run.

You can modify the YAML file (such as the description or increase the resource parameters, if appropriate) after the export operation is complete .

Cisco provides a python script that you can run to validate a modified YAML file with a JSON schema. It is not meant to be a complete test (for example, device-specific resource limits are not checked), but it is able to flag common errors. The python script with examples is located at [Guest Shell Import Export](#). The following JSON file describes the schema for version 1.0 of the Guest Shell import YAML .

```
{
  "$schema": "http://json-schema.org/draft-04/schema#",
  "title": "Guest Shell import schema",
  "description": "Schema for Guest Shell import descriptor file - ver 1.0",
  "copyright": "2017 by Cisco systems, Inc. All rights reserved.",
  "id": "",
  "type": "object",
  "additionalProperties": false,
  "properties": {
    "import-schema-version": {
      "id": "/import-schema-version",
      "type": "string",
      "minLength": 1,
      "maxLength": 20,
      "enum": [
        "1.0"
      ]
    },
    "info": {
      "id": "/info",
      "type": "object",
      "additionalProperties": false,
      "properties": {
        "name": {
          "id": "/info/name",
          "type": "string",
          "minLength": 1,
          "maxLength": 29
        },
        "description": {
          "id": "/info/description",
          "type": "string",
          "minLength": 1,
          "maxLength": 199
        },
        "version": {
          "id": "/info/version",
          "type": "string",
          "minLength": 1,
          "maxLength": 63
        },
        "author-name": {
          "id": "/info/author-name",
```



```

        "type": "string",
        "minLength": 1,
        "maxLength": 199
    },
    "author-link": {
        "id": "/info/author-link",
        "type": "string",
        "minLength": 1,
        "maxLength": 199
    }
}
},
"app": {
    "id": "/app",
    "type": "object",
    "additionalProperties": false,
    "properties": {
        "apptype": {
            "id": "/app/apptype",
            "type": "string",
            "minLength": 1,
            "maxLength": 63,
            "enum": [
                "lxc"
            ]
        },
        "cpuarch": {
            "id": "/app/cpuarch",
            "type": "string",
            "minLength": 1,
            "maxLength": 63,
            "enum": [
                "x86_64"
            ]
        },
        "resources": {
            "id": "/app/resources",
            "type": "object",
            "additionalProperties": false,
            "properties": {
                "cpu": {
                    "id": "/app/resources/cpu",
                    "type": "integer",
                    "multipleOf": 1,
                    "maximum": 100,
                    "minimum": 1
                },
                "memory": {
                    "id": "/app/resources/memory",
                    "type": "integer",
                    "multipleOf": 1024,
                    "minimum": 1024
                },
                "disk": {
                    "id": "/app/resources/disk",
                    "type": "array",
                    "minItems": 1,
                    "maxItems": 1,
                    "uniqueItems": true,
                    "items": {
                        "id": "/app/resources/disk/0",
                        "type": "object",
                        "additionalProperties": false,
                        "properties": {

```

```

        "target-dir": {
          "id": "/app/resources/disk/0/target-dir",
          "type": "string",
          "minLength": 1,
          "maxLength": 1,
          "enum": [
            "/"
          ]
        },
        "file": {
          "id": "/app/resources/disk/0/file",
          "type": "string",
          "minLength": 1,
          "maxLength": 63
        },
        "capacity": {
          "id": "/app/resources/disk/0/capacity",
          "type": "integer",
          "multipleOf": 1,
          "minimum": 1
        }
      }
    }
  },
  "required": [
    "memory",
    "disk"
  ]
}
},
"required": [
  "apptype",
  "cpuarch",
  "resources"
]
}
},
"required": [
  "app"
]
}

```

## show guestshell Command

The output of the **show guestshell detail** command includes information that indicates whether the Guest Shell was imported or was installed from an OVA.

Example of the **show guestshell detail** command after importing **rootfs**.

```

switch# show guestshell detail
Virtual service guestshell+ detail
State          : Activated
Package information
Name           : rootfs_puppet
Path           : usb2:/rootfs_puppet
Application
Name           : GuestShell
Installed version : 3.0(0.0)
Description    : Exported GuestShell: 20170613T173648Z
Signing
Key type       : Unsigned
Method        : Unknown

```

```
Licensing
  Name      : None
  Version   : None
```

## Verifying Virtual Service and Guest Shell Information

You can verify virtual service and Guest Shell information with the following commands:

Command	Description
<pre><b>show virtual-service global</b>  switch# <b>show virtual-service global</b>  Virtual Service Global State and Virtualization Limits:  Infrastructure version : 1.11 Total virtual services installed : 1 Total virtual services activated : 1  Machine types supported : LXC Machine types disabled : KVM  Maximum VCPUs per virtual service : 1  Resource virtualization limits: Name Quota Committed Available ----- system CPU (%) 20 1 19 memory (MB) 3840 256 3584 bootflash (MB) 8192 200 7992 switch#</pre>	<p>Displays the global state and limits for virtual services.</p>
<pre><b>show virtual-service list</b>  switch# <b>show virtual-service list *</b>  Virtual Service List:  Name                Status      Package Name ----- guestshell+        Activated   guestshell.ova chef                Installed   chef-0.8.1-n9000-spa-k9.ova</pre>	<p>Displays a summary of the virtual services, the status of the virtual services, and installed software packages.</p>

Command	Description
<pre> <b>show guestshell detail</b>  switch# <b>show guestshell detail</b> Virtual service guestshell+ detail   State           : Activated   Package information     Name           : guestshell.ova     Path           : /isan/bin/guestshell.ova   Application     Name           : GuestShell     Installed version : 3.0(0.0)     Description    : Cisco Systems Guest Shell   Signing     Key type       : Cisco key     Method         : SHA-1   Licensing     Name           : None     Version        : None   Resource reservation     Disk           : 400 MB     Memory         : 256 MB     CPU            : 1% system CPU    Attached devices   Type           Name           Alias   -----   Disk           _rootfs   Disk           /cisco/core   Serial/shell   Serial/aux   Serial/Syslog           serial2   Serial/Trace           serial3 </pre>	<p>Displays details about the guestshell package (such as version, signing resources, and devices).</p>

## Persistently Starting Your Application From the Guest Shell

Your application should have a `systemd / systemctl` service file that gets installed in `/usr/lib/systemd/system/application_name.service`. This service file should have the following general format:

```

[Unit]
Description=Put a short description of your application here

[Service]
ExecStart=Put the command to start your application here
Restart=always
RestartSec=10s

[Install]
WantedBy=multi-user.target

```



**Note** To run `systemd` as a specific user, add `User=<username>` to the `[Service]` section of your service.

# Procedure for Persistently Starting Your Application from the Guest Shell

- 
- Step 1** Install your application service file that you created above into `/usr/lib/systemd/system/application_name.service`
  - Step 2** Start your application with `systemctl start application_name`
  - Step 3** Verify that your application is running with `systemctl status -l application_name`
  - Step 4** Enable your application to be restarted on reload with `systemctl enable application_name`
  - Step 5** Verify that your application is running with `systemctl status -l application_name`
- 

## An Example Application in the Guest Shell

The following example demonstrates an application in the Guest Shell:

```

root@guestshell guestshell]# cat /etc/init.d/hello.sh
#!/bin/bash

OUTPUTFILE=/tmp/hello

rm -f $OUTPUTFILE
while true
do
    echo $(date) >> $OUTPUTFILE
    echo 'Hello World' >> $OUTPUTFILE
    sleep 10
done
[root@guestshell guestshell]#
[root@guestshell guestshell]#
[root@guestshell system]# cat /usr/lib/systemd/system/hello.service
[Unit]
Description=Trivial "hello world" example daemon

[Service]
ExecStart=/etc/init.d/hello.sh &
Restart=always
RestartSec=10s

[Install]
WantedBy=multi-user.target
[root@guestshell system]#
[root@guestshell system]# systemctl start hello
[root@guestshell system]# systemctl enable hello
[root@guestshell system]# systemctl status -l hello
hello.service - Trivial "hello world" example daemon
   Loaded: loaded (/usr/lib/systemd/system/hello.service; enabled)
   Active: active (running) since Sun 2015-09-27 18:31:51 UTC; 10s ago
 Main PID: 355 (hello.sh)
   CGroup: /system.slice/hello.service
           ##355 /bin/bash /etc/init.d/hello.sh &
           ##367 sleep 10

```

```
Sep 27 18:31:51 guestshell hello.sh[355]: Executing: /etc/init.d/hello.sh &
[root@guestshell system]#
[root@guestshell guestshell]# exit
exit
[guestshell@guestshell ~]$ exit
logout
switch# reload
This command will reboot the system. (y/n)? [n] y
```

### After reload

```
[root@guestshell guestshell]# ps -ef | grep hello
root      20      1  0 18:37 ?        00:00:00 /bin/bash /etc/init.d/hello.sh &
root     123    108  0 18:38 pts/4    00:00:00 grep --color=auto hello
[root@guestshell guestshell]#
[root@guestshell guestshell]# cat /tmp/hello
Sun Sep 27 18:38:03 UTC 2015
Hello World
Sun Sep 27 18:38:13 UTC 2015
Hello World
Sun Sep 27 18:38:23 UTC 2015
Hello World
Sun Sep 27 18:38:33 UTC 2015
Hello World
Sun Sep 27 18:38:43 UTC 2015
Hello World
[root@guestshell guestshell]#
```

Running under `systemd` / `systemctl`, your application is automatically restarted if it dies (or if you kill it). The Process ID is originally 226. After killing the application, it is automatically restarted with a Process ID of 257.

```
[root@guestshell guestshell]# ps -ef | grep hello
root      226      1  0 19:02 ?        00:00:00 /bin/bash /etc/init.d/hello.sh &
root     254    116  0 19:03 pts/4    00:00:00 grep --color=auto hello
[root@guestshell guestshell]#
[root@guestshell guestshell]# kill -9 226
[root@guestshell guestshell]#
[root@guestshell guestshell]# ps -ef | grep hello
root      257      1  0 19:03 ?        00:00:00 /bin/bash /etc/init.d/hello.sh &
root     264    116  0 19:03 pts/4    00:00:00 grep --color=auto hello
[root@guestshell guestshell]#
```

## Troubleshooting Guest Shell Issues

### Unable to Get Into Guest Shell After Downgrade to 7.0(3)I7

If you downgrade from the NX-OS 9.2(1) release to the NX-OS 7.0(3)7 release image (which does not have user namespace support) while the Guest Shell is in the process of activating or deactivating, you may run into the following condition where the Guest Shell activates, but you are unable to get into the Guest Shell. The reason for this issue is that if a reload is issued while the Guest Shell is in transition, the files within the Guest Shell can't get shifted back into an id range that is usable for NX-OS releases that don't have user namespace support.

```
switch# guestshell
Failed to mkdir .ssh for admin
admin RSA add failed
ERROR: Failed to connect with Virtual-service 'guestshell+'
switch#
```

```
switch# sh virt list

Virtual Service List:
Name                Status             Package Name
-----
guestshell+        Activated          guestshell.ova

switch# run bash ls -al /isan/vdc_1/virtual-instance/guestshell+/rootfs/
drwxr-xr-x  24 11000 11000 1024 Apr 11 10:44 .
drwxrwxrwx   4 root  root   80 Apr 27 20:08 ..
-rw-r--r--   1 11000 11000   0 Mar 21 16:24 .autorelabel
lrwxrwxrwx   1 11000 11000   7 Mar 21 16:24 bin -> usr/bin
```

To recover from this issue without losing the contents of the Guest Shell, reload the system with the previously-running NX-OS 9.2(x) image and let the Guest Shell get to the `Activated` state before reloading the system with the NX-OS 7.0(3)I7 image. Another option is to disable the Guest Shell while running NX-OS 9.2(x) and re-enable it after reloading with 7.0(3)I7.

If you do not have anything to preserve in the Guest Shell and you just want to recover it, you can destroy and recreate it without needing to change images.

### Unable to Access Files on bootflash from root in the Guest Shell

You may find that you are unable to access files on bootflash from root in the Guest Shell.

From the host:

```
root@switch# ls -al /bootflash/try.that
-rw-r--r-- 1 root root 0 Apr 27 20:55 /bootflash/try.that
root@switch#
```

From the Guest Shell:

```
[root@guestshellbootflash]# ls -al /bootflash/try.that
-rw-r--r-- 1 65534 host-root 0 Apr 27 20:55 /bootflash/try.that
[root@guestshellbootflash]# echo "some text" >> /bootflash/try.that
-bash: /bootflash/try.that: Permission denied
[root@guestshellbootflash]#
```

This may be due to the fact that, because the user namespace is being used to protect the host system, root in the Guest Shell is not actually the root of the system.

To recover from this issue, verify that the file permissions and group-id of the files allow for shared files on bootflash to be accessed as expected. You may need to change the permissions or group-id from the host Bash session.

