Managing systemd Services

systemd is the central system and service manager in SUSE Linux Enterprise Server for NVIDIA used to control background daemons, system settings and operational targets. By using declarative unit files and the systemctl utility, systemd streamlines service administration, enables automated boot-time service execution and provides precise dependency tracking, allowing administrators to efficiently start, stop, enable and troubleshoot system services.

Prerequisites

- Basic understanding of Linux processes, daemons and control groups
- Understanding unit files

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1 What is systemd?

systemd is a system and service manager for Linux operating systems. It is the default initialization system for major Linux distributions. systemd is not directly initiated by the user, but installed through the /sbin/init and started during the early boot. systemd acts as the init system that brings up and maintains user space services when run as the first process on boot (PID 1). PID 1 is known as *init* and is the first Linux user-mode process created. It runs until the system shutdown.

systemd owns PID 1, and is started directly by the kernel. All other processes are started directly by systemd or one of its child processes. systemd mounts the host's file system and manages temporary files. It is backward compatible with the SysV init scripts. SysV is an initialization system that predates systemd.

In systemd, a unit is a resource that the system knows how to operate on and manage. This is the primary object that the systemd tools use. These resources are defined with configuration files called unit files.

systemctl is the central management tool for controlling the init system. It is used to examine and control the state of the systemd system and service manager.

Targets in systemd are groups of related units that act as synchronization points during a system boot. Target unit files have a .target file extension. Target units group together various systemd units through a chain of dependencies.

For troubleshooting, you can use **journalctl**, which is used to query and display log messages from the systemd journal.

For more information on systemd, you can refer to https://systemd.io and **man 1 systemd**.

2 Converting SysV init to systemd

SysV init is the traditional initialization system used by older Linux distributions. It is often referred to as init. Converting a legacy SysV init script to a systemd service unit involves replacing a procedural shell script with a declarative configuration file. In the SysV model, services are managed via scripts in /etc/init.d/ using case statements to handle start, stop and restart actions. In systemd, unit files are used and located at /etc/systemd/system/ to define the service's behavior through key-value pairs.

1. Open your existing script in /etc/init.d/and look for the LSB (Linux Standard Base) header. This block contains the configuration you need for your new unit file.
2. Create a new .service file at /etc/systemd/system/ and use the gathered metadata.

3. Load and test the new service. Before finalizing, tell `systemd` to scan for the new file and then attempt to start it.
4. Create the `.service` unit file using the metadata you gathered.
5. Enable the new service at boot:

```
> sudo  systemctl enable NEW_SERVICE
```

You can now safely remove or move the old script from `/etc/init.d/` to prevent confusion.

In the following example, `boot.local` and `after.local` are used.

EXAMPLE 1: CONVERTING `boot.local` AND `after.local` TO `systemd`

The SysV init script files like `/etc/init.d/boot.local` and `/etc/init.d/after.local` were used for running custom commands or scripts at the end of the boot process.

In a `systemd` environment, to run your own startup script,we recommended creating a custom `systemd` service unit file. The `boot.local` script typically runs very early in the boot process, while `after.local` runs later, after most system services are up.

1. **Create the scripts:** Create script files with the commands and make them executable. For example:
   - For `boot.local` actions, create `/usr/local/bin/my.early-boot.sh`
   - For `after.local` actions, create `/usr/local/bin/my.late-boot.sh`
2. **Create the `systemd` unit files:** Create the `.service` unit files in the `/etc/systemd/system/` directory. For example:
   - For `boot.local`, this service should run before basic system initialization. Create a service file, `/etc/systemd/system/my-early-boot.service`:

```
[Unit]
  Description=My early startup script
  DefaultDependencies=no
  After=basic.target
  Before=basic.target sysinit.target shutdown.target

  [Service]
  Type=oneshot
  ExecStart=/usr/local/bin/my-early-boot.sh
  RemainAfterExit=yes
```

```
[Install]
WantedBy=basic.target
```

- `Type=oneshot` is suitable for scripts that run once and then exit.
- `DefaultDependencies=no` and `After/Before` ensures it runs at an equivalent time to `boot.local`.

- For `after.local`, this service should run later, typically when the multi-user environment is ready. If it depends on the network being up, add `After=network-online.target`. Create `/etc/systemd/system/my-late-boot.service:`:

```
[Unit]
  Description=My late startup script
  # Add After=network-online.target if your script needs network access
  After=multi-user.target

  [Service]
  Type=oneshot
  ExecStart=/usr/local/bin/my-late-boot.sh
  RemainAfterExit=yes

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

3. **Reload the `systemd` manager:** After creating the files, reload the `systemd` manager configuration and enable your new services to run at boot:

```
> sudo  systemctl daemon-reload
```

```
> sudo  systemctl enable my-early-boot.service
```

```
> sudo  systemctl enable my-late-boot.service
```

4. **Enable the services:** Enable your new services to run at boot:

```
> sudo  systemctl enable my-early-boot.service
```

```
> sudo  systemctl enable my-late-boot.service
```

5. **Verification:** To verify that your new services are working as expected:

```
> sudo  systemctl status my-early-boot.service
```

```
> sudo  systemctl status my-late-boot.service
```

The expected output is that both should show `Active: inactive (dead)` with a successful exit code, because they are `Type=oneshot` and execute only once.

`systemd` is now the default and only initialization system for .

3 Starting and stopping `systemd` services

You can start and stop `systemd` services by using units which are resources. The target units are service units, which have a `.service` suffix. For service management tasks, you do not have to add the `.service` because `systemd` knows that you want to execute a service.

To start and stop `systemd` services, use the following commands:

- To start a `systemd` service:

  ```
  > sudo  systemctl start SERVICE
  ```

- To check the status of a `systemd` service:

  ```
  > sudo  systemctl status  SERVICE
  ```

- To stop a currently running `systemd` service:

  ```
  > sudo  systemctl stop SERVICE
  ```

You can also use the following **`systemctl`** commands:

- Stops the service and then starts it. If the service is not running, it is started.

  ```
  > sudo  systemctl restart SERVICE
  ```

- Reloads the `systemd` service's configuration file without interrupting operations.

  ```
  >  systemctl reload SERVICE
  ```

- Reloads the service if it supports reloading, otherwise it restarts the service. If the service is not running, it is started.

  ```
  > sudo  systemctl reload-or-restart SERVICE
  ```

4 Enabling and disabling systemd services

You can enable and disable `systemd` services by using `units` which are resources.

To enable and disable `systemd` services, follow:

1. To enable a service at boot:

```
> sudo  systemctl enable SERVICE
```

   A symbolic link is created usually in `/lib/systemd/system` or `etc/systemd/system` pointing into the location on disk where `systemd`looks for autostart files. This is either in `/lib/systemd/system` or `/etc/systemd/system`, which is usually `/etc/systemd/system/EXAMPLE_TARGET.target`.
   For example:

```
> sudo  systemctl enable firewalld.service
      Created symlink /etc/systemd/system/dbus-org.fedoraproject.FirewallD1.service
 \u2192 /usr/lib/systemd/system/firewalld.service.
      Created symlink /etc/systemd/system/multi-user.target.wants/firewalld.service
 \u2192 /usr/lib/systemd/system/firewalld.service.
```

2. To disable a service from starting automatically:

```
> sudo  systemctl disable SERVICE
```

   This removes the symbolic link that indicates that the service should be started automatically.
   For example:

```
> sudo  systemctl disable firewalld.service
      Removed /etc/systemd/system/multi-user.target.wants/firewalld.service.
      Removed /etc/systemd/system/dbus-org.fedoraproject.FirewallD1.service.
```

3. To check the status of a service:

```
> sudo  systemctl status SERVICE
```

   For example:

```
> sudo  systemctl status firewalld.service
      \u25cf firewalld.service - firewalld - dynamic firewall daemon
      Loaded: loaded (/usr/lib/systemd/system/firewalld.service; enabled; vendor p>
      Active: active (running) since Wed 2024-01-31 01:36:36 EST; 1h 5min ago
      Docs: man:firewalld(1)
```

```
      Main PID: 965 (firewalld)
      Tasks: 2
      CGroup: /system.slice/firewalld.service
      \u2514\u2500965 /usr/bin/python3 -Es /usr/sbin/firewalld --nofork --nopid
```

Enabling or disabling a service does not start it in the current session. You can use **`start`** or **`stop`** to start or stop the service and enable or disable it at boot.

5 Sending termination signals to `systemd` services

Each service in `systemd` is categorized into a control group which makes it easy to identify all parent and child processes of a service. This enables you to send a signal to each of these processes. You can send a signal to a `systemd` service or to the individual processes that belong to a service.



Warning: Do not cancel the D-Bus service in a running system

The D-Bus service is the message bus for communication between `systemd` clients and the `systemd` manager that is running as PID 1. D-Bus is a stand-alone daemon and an integral part of the init infrastructure.

Terminating or restarting the D-Bus service is neither recommended nor supported. This breaks the `systemd` client and server communication and makes most of the `systemd` functions unusable.

The **`systemd-cgls`** command displays all processes that belong to a `systemd` service. It recursively shows the contents of the specific Linux control group hierarchy in a tree.

- Lists all control groups and their processes:

```
> systemd-cgls
```

- Displays all processes that belong to a particular service, for example: the `libvirtd.service` service:

```
> systemd-cgls -u libvirtd.service
```

- Sends a termination signal to the service:

```
> sudo systemctl kill SERVICE
```

- By default, the **`kill`** command sends the signal to `all` processes of the specified control group. You can restrict it to the `control` or the `main` process. The latter is, for example, useful to force a service to reload its configuration by sending `SIGHUP`:

```
> sudo systemctl kill -s SIGHUP --kill-who=main SERVICE
```

- Sends a different signal to a service with the `-s` option, such as `SIGKILL` (9):

```
> sudo systemctl kill -s 9 SERVICE
```

6 Managing `systemd` targets with the **`systemctl`** command

`systemd` targets are special unit files that describe a system or synchronization state. They are used to group units together in order or bring the system to a certain state, just like other init systems use runlevels. You can use the **`systemctl`** command to manage `systemd` targets.

Getting and setting the default target

`systemd` has a default target that is used when booting the system. To find the default target for your system:

```
> sudo systemctl get-default
  multi-user.target
```

You can also change the default target:

```
> sudo systemctl set-default graphical.target
```

Listing the available targets

To get the available targets on your system:

```
> sudo systemctl list-unit-files --type=target
           STATE                     VENDOR PRESET
         basic.target                 static   -
         blockdev@.target             static   -
         bluetooth.target             static   -
         boot-complete.target         static   -
         cryptsetup-pre.target        static   -
```

```
        cryptsetup.target             static   -
        ctrl-alt-del.target           alias    -
        cvs.target                    static   -
        default.target                alias    -
        emergency.target              static   -
        exit.target                   disabled disabled
        final.target                  static   -
        first-boot-complete.target    static   -
        getty-pre.target              static   -
        getty.target                  static   -
        .....
```

Multiple targets can be active at the same time. An active target is when `systemd` attempts to start all the units in a specific target. To see a list of the active targets:

```
> sudo systemctl list-units --type=target
        UNIT              LOAD   ACTIE SUB    DESCRIPTION                    >
  basic.target            loaded active active Basic System
  bluetooth.target        loaded active active Bluetooth Support
  cryptsetup.target       loaded active active Local Encrypted Volumes
  getty.target            loaded active active Login Prompts
  graphical.target        loaded active active Graphical Interface
  local-fs-pre.target     loaded active active Preparation for Local File Syste>
  local-fs.target         loaded active active Local File Systems
  multi-user.target       loaded active active Multi-User System
  network-online.target   loaded active active Network is Online
  network-pre.target      loaded active active Preparation for Network
  network.target          loaded active active Network
  nss-lookup.target       loaded active active Host and Network Name Lookups
  nss-user-lookup.target  loaded active active User and Group Name Lookups
  paths.target            loaded active active Path Units
  remote-fs.target        loaded active active Remote File Systems
  slices.target           loaded active active Slice Units
  snapd.mounts-pre.target loaded active active Mounting snaps
  .....
```

Isolating targets

You can start all the units associated with a target and stop all units that are not part of the dependency tree. For example, if you are using a graphical environment with an active `graphical.target` target, you can stop the graphical system and enable a multiuser command-line system by isolating the `multi-user.target` target. Since the `graphical.target` target depends on the `multi-user.target` target, all the graphical units are stopped.

To take a look at the dependencies of the target you are isolating:

```
> sudo systemctl list-dependencies multi-user.target
```

Output:

```
multi-user.target
  ○ ├─after-local.service
  ● ├─apparmor.service
  ○ ├─appstream-sync-cache.service
  ● ├─auditd.service
  ● ├─avahi-daemon.service
  ● ├─btrfsmaintenance-refresh.path
  ● ├─chronyd.service
  ● ├─cron.service
  ● ├─cups.path
  ● ├─dbus.service
  ● ├─fail2ban.service
  ● ├─firewalld.service
  ● ├─irqbalance.service
  ● ├─kbdsettings.service
  ● ├─libvirtd.service
  ● ├─mcelog.service
  ● ├─ModemManager.service
  ● ├─NetworkManager.service
  ● ├─nscd.service
  ● ├─plymouth-quit-wait.service
  ○ ├─plymouth-quit.service
  ● ├─postfix.service
```

You can isolate the specific target:

```
> sudo sudo systemctl isolate multi-user.target
```

7 Troubleshooting `systemd` management

If you are experiencing problems with `systemd`, try the following troubleshooting tips to identify and resolve issues:

Check the runtime status of a service

To find out the current runtime status of a service:

```
> sudo systemctl status SERVICE
```

Display all processes that belong to a particular service, for example: the `libvirtd.service` service:

```
> systemd-cgls -u libvirtd.service
```

Check the logs for your service with the `journalctl -u SERVICE` command

If you experience any issue with a `systemd` service, check the service's log. For example:

```
> sudo  journalctl -u my-custom-service.service
```

The command displays logs for the specified service, including any error messages, warnings or other relevant information. You can use these logs to identify and fix issues with the service.

8 Best practices for `systemd` management

To manage `systemd` services, try certain best practices that are equipped to handle different situations:

Check the runtime status of a service

To find out the current runtime status of a service:

```
> sudo systemctl status SERVICE
```

Use absolute path in your `systemd` unit file

Use an absolute path for executable files and required files, such as configuration files or scripts in your `systemd` unit file. `systemd` does not rely on the user's environment variables like `$PATH` to locate files. Use the *ExecSearchPath* directive in the `[SERVICE]` section.

```
[Service]
                ExecSearchPath=ABSOLUTE_PATH
```

Use the ExecReload directive

Use the *ExecReload* directive in the `[SERVICE]` section when you want to define a specific command that should be executed when you reload a service with the **`systemctl reload`** command. This is useful for services that can dynamically reload their configuration without a restart.

```
[Service]
ExecStart=PATH_TO_EXECUTABLE
ExecReload=PATH_TO_RELOAD_SCRIPT
```

Use the RestartSec directive

Use the *RestartSec* directive in the `[SERVICE]` section when you want to define a delay (in seconds) before the service is restarted after a failure. This is useful for services that require a specified time to release resources or prevent rapid restart loops that can cause high system load.

```
[Service]
ExecStart=PATH_TO_EXECUTABLE
```

```
Restart=on-failure
RestartSec=5
```

Disable emergency mode on a remote machine

You can disable emergency mode on a remote machine, for example, a virtual machine hosted on Google Cloud. If this mode is enabled, the machine is blocked from connecting to the network. For example:

```
> sudo systemctl mask emergency.service
```

```
> sudo systemctl mask emergency.target
```

9 `systemctl` commands overview

The **`systemctl`** command is used to examine and control the state of `systemd` and service manager.

You can use the following common **`systemctl`** commands and refer to the *man systemctl* page.

9.1 Viewing `systemd` information

To view information about `systemd` components, you can use the following commands:

systemctl list-units

Lists the `systemd` units. You can use the optional arguments: **`--state=running`** to show the active units and **`--type=service`** to show the exited and active units.

systemctl list-unit-files

Lists the `systemd` units and the status, such as static, generated, disabled, alias, masked, and enabled.

systemctl list-dependencies

Lists the dependency tree.

systemctl list-dependencies *`UNIT_FILE`*

Lists the dependencies of a unit file.

9.2 Managing `systemd` services

The **`systemctl`** command enables you to perform the following tasks with services.

systemctl status *SERVICE*

Checks the status of the specific service.

systemctl show *SERVICE*

Displays the service information.

systemctl start *SERVICE*

Instead of manually starting the service, use the **`start`** command. When a change is made to the configuration file, the related service must be started again.

systemctl stop *SERVICE*

Stops a specific running service.

systemctl restart *SERVICE*

Instead of manually restarting the service, use the **`restart`** command. When a change is made to the configuration file, the related service must be restarted again.

systemctl enable *SERVICE*

Enables the service on boot.

systemctl disable *SERVICE*

Disables the service on boot.

systemctl reload-or-restart *SERVICE*

Reload the service if it supports reloading, otherwise it restarts the service. If the service is not running, it is restarted.

systemctl mask *SERVICE*

When a service is masked, this means the unit file is symlinked to `/dev/null`. A symlink for a masked service is created from `/etc/systemd/system` to point to `/dev/null`. This makes it impossible to load the service even if another enabled service requires it. It must be stopped manually, or it continues to run in the background. You can use **`--runtime`** option to only mask temporarily until the next reboot of the system.

```
Created symlink /etc/systemd/system/FOSSLinux.service → /dev/null.
```

systemctl unmask *SERVICE*

Unmasks the service. It is effective when the system is started or restarted manually.

9.3 Managing system states

The **`systemctl`** command enables you to perform power management processes on your system, like restarting, shutting down and so on, as described below.

systemctl reboot

Reboots the system `reboot.target`.

systemctl poweroff

Powers off the system `poweroff.target`.

systemctl emergency

Goes into the emergency mode `emergency.target`.

systemctl default

Goes back to default target `multi-user.target`.

10 More information

- Man 1 systemd
- Man 1 journalctl
- Man 1 systemd-cgls
- Man 1 systemctl
- Man 5 systemd.service
- Man 5 systemd.kill
- Man 7 systemd.boot
- Introduction to `systemd` basics https://documentation.suse.com/smart/systems-management/html/systemd-basics/index.html
- System and Service Manager https://systemd.io/

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