SUSE

Working with systemd timers

From running a backup script at regular intervals to starting a specific process as soon as the machine boots, there are plenty of tasks that require scheduling on a Linux system. cron has long been the go-to tool for all scheduling needs, but the switch to systemd introduced a modern way to schedule tasks: systemd timer units.

WHAT?

systemd timer units as a replacement for cron.

WHY?

To give you a flexible mechanism for scheduling and managing jobs and services.

EFFORT?

It takes 10 minutes to create an example systemd timer. You will need up to 30 minutes to fully understand how systemd timers work.

GOAL!

Learn how to create systemd timers and understand how they work.

Requirements

- Basic understanding of systemd.
- `root` privileges. If you are planning to use systemd timers as a regular user, refer to *Section 7, "Using timers as a regular user"* first.

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Contents

1 The systemd timer concept

systemd timer units provide a modern mechanism for scheduling jobs on Linux, replacing cron.

Similar to cron, systemd timer units provide a mechanism for scheduling jobs on Linux. Although systemd timer units serve the same purpose as cron, they offer several advantages.

- Jobs scheduled using a timer unit can depend on other systemd services. Timer units are treated as regular systemd services, so can be managed with **`systemctl`**.
- Timers can be realtime (being triggered on calendar events) and monotonic being triggered at a specified time elapsed from a certain starting point.
- Time units are logged to the system journal, which makes it easier to monitor and troubleshoot them.
- Uses the centralized systemd management services.
- If the system is off during the expected execution time, the timer is executed once the system is running again.

systemd timer units are identified by the `.timer` file name extension. Each timer file requires a corresponding service file it controls. In other words, a timer file activates and manages the corresponding service file. For a full refernce on systemd timers including advanced configuration options (like delays or handling clock or time zone changes) refer to **`man 5 systemd.timer`**.

2 Creating a timer

The following example shows how to set up a timer that triggers the `helloworld.sh` shell script after boot time and repeats its execution every 24 hours relative to it's activation time. It also runs Monday to Friday at 10am.

2.1 "Hello World" example

1. Create the file `/etc/systemd/system/helloworld.service` with the following content:

```
[Unit]
Description="Hello World script"
```

```
[Service]
ExecStart=/usr/local/bin/helloworld.sh
```

This is a $systemd; service file that tells systemd which application to run.

2. Create the file /etc/systemd/system/helloworld.timer with the following content:

```
[Unit]
Description="Run helloworld.service 5min after boot and every 24 hours relative to
 activation time"

[Timer]
OnBootSec=5min
OnUnitActiveSec=24h
OnCalendar=Mon..Fri 10:00
Unit=helloworld.service

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

This is the timer file that controls when to activate the respective service file.

3. Verify that the files you created above contain no errors:

```
systemd-analyze verify /etc/systemd/system/helloworld.*
```

If the command returns no output, the files have passed the verification successfully.

4. Start the timer:

```
systemctl start helloworld.timer
```

This will activate the timer for the current session only.

5. To ensure the timer is automatically activated each time when booting the machine, you need to enable it:

```
systemctl enable helloworld.timer
```

2.1.1 The example explained

EXAMPLE 1: THE SERVICE FILE

```
[Unit]
Description="Hello World script" (1)
```

```
[Service]
ExecStart=/usr/local/bin/helloworld.sh❷
```

❶ A brief description explaining the service file's purpose.

❷ The application to execute.

Usually this is all you would need for a service file in this context. In case you require a more complex configuratioon refer to ??? for more information.

Note: Service files for timer do not require an `INSTALL` section

systemd service files usually contain an `[Install]` section determining with which target(s) a service is loaded. This section is not needed in service files for timers, since this information is provided with the timer file.

EXAMPLE 2: THE TIMER FILE

```
[Unit]
Description="Run helloworld.service 5min after boot and every 24 hours relative to
 activation time""❶

[Timer]
OnBootSec=5min❷
OnUnitActiveSec=24h❸
OnCalendar=Mon..Fri *-*-* 10:00❹
Unit=helloworld.service❺

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

❶ A brief description explaining the timer file's purpose.

❷ Specifies a timer that triggers the service five minutes after the system boot.

❸ Specifies a timer that triggers the service 24 hours after the service has been activated (that is, the timer will trigger the service once a day).

❹ Specifies a timer that triggers the service at fixed points in time (here: Monday to Friday at 10 am).

❺ The service file that is to be executed.

❻ The system target in which the timer get activated. For more information on systemd targets refer to ???.

Tip: Migrating from cron

The equivalent of the helloworld example above in cron would be the following lines:

```
@reboot sleep 300 && /usr/local/bin/helloworld.sh
0 10 * * * 1-5 /usr/local/bin/helloworld.sh
```

Note that there is now equivalent for `OnUnitActiveSec` in cron.

3 Timer types

systemd supports two types of timers: realtime (based on calendar) and monotonic (based on events)

Realtime timer

Similar to cronjobs, realtime timers are triggered on calendar events. Realtime timers are defined using the option `OnCalendar`..
Using a syntax similar to cron, you can specify when to trigger an event based on date and time. the following general syntax applies:

```
OnCalendar=DayOfWeek Year-Month-Day Hour:Minute:Second
```

`DayOfWeek` is optional, each value in `Year-Month-Day` can be replaced by the wildcard `*` to match every occurence. Continuous ranges can be specified using `..`, a list of separated values needs to be delimited by `,`.

- 6pm on every Friday: `OnCalendar=Fri *-*-* 18:00:00`
- 5am every day: `OnCalendar=Mon..Sun *-*-* 5:00:00`
- 1am and 3am on Sundays and Tuesdays: `OnCalendar=Tue,Sun *-*-* 01,03:00:00`
- Single date: `OnCalendar=Mo..Sun 2023-09-23 00:00:01`

To specify triggers at different times, you may create more than one OnCalendar entries in a single timer file:

- 10am on week days and at 10pm on weekends:

  ```
  OnCalendar=Mon..Fri *-*-* 10:00
  ```

```
OnCalendar=Sat,Sun *-*-* 22:00
```

The syntax is very flexible and offers many more advanced features. Refer to **`man 7 systemd.time`** to, among others, learn how to:

- shorten the syntax and use abbreviations..
- specify repetitions.
- find specific days in a month (last day of month, last Sunday,...).
- apply time zones.

Monotonic timers

Monotonic timers are triggered at a specified time elapsed from a certain event. The latter could be a system boot or system unit activation event. There are several options for defining monotonic timers:

- `OnActiveSec`: time after unit activation

```
OnActiveSec=50minutes
```

- `OnBootSec`: time after system boot.

```
OnBootSec=10hours
```

- `OnStartupSec`: timer after service manager is started. For systemservices this is almost equal to `OnActiveSec`. Use this for user services, where the service manager is started at user login.

```
OnStartupSec=5minutes 20seconds
```

- `OnUnitActiveSec`: time after the corresponding service was last activated

```
OnUnitActiveSec=10seconds
```

- `OnUnitInactiveSec`: time after the corresponding service was last deactivated

```
OnUnitInactiveSec=2hours 15minutes 18 seconds
```

Values are to be defined as a time. Minutes, hours, days, month, years etc. may be used . If no unit is specified, seconds are assumed. The following units can be used:

- usec
- msec
- seconds
- minutes
- hours
- days
- weeks
- months
- years

4 Testing calendar entries

systemd provides a tool for testing and creating calendar timer entries for realtime timers

When it comes to creating complex date entries for realtime timers, systemd provides you with a tool that will help you with this task: **`systemd-analyze calendar`**. It accepts the same argument than the `OnCalendar` entry required to set up realtime timers.

Here are some examples. You can concatenate several arguments separated by space. If the term to test is correct, the output will show you when the timer is triggered next (in loca tuime and UTC). It will also show the string in `Normalized form`, it is recommended to use that string in the timer file.

```
root # systemd-analyze calendar "Tue,Sun *-*-* 01,03:00:00"
Normalized form: Tue,Sun *-*-* 01,03:00:00
Next elapse: Sun 2021-10-31 01:00:00 CEST
(in UTC): Sat 2021-10-30 23:00:00 UTC
From now: 3 days left

root # systemd-analyze calendar "Mon..Fri *-*-* 10:00" "Sat,Sun *-*-* 22:00"
Original form: Mon..Fri *-*-* 10:00
Normalized form: Mon..Fri *-*-* 10:00:00
```

```
Next elapse: Thu 2021-10-28 10:00:00 CEST
(in UTC): Thu 2021-10-28 08:00:00 UTC
From now: 19h left

Original form: Sat,Sun *-*-* 22:00
Normalized form: Sat,Sun *-*-* 22:00:00
Next elapse: Sat 2021-10-30 22:00:00 CEST
(in UTC): Sat 2021-10-30 20:00:00 UTC
From now: 3 days left
```

If you have reoccuring timers, you can use the `–iterations N` switch to list trigger times and test whether they met your expectations. The argument `N` specifies the number of iterations you would like to test. The following example string triggers every 8 hours (starting at 00:00:00) on Sundays:

```
root # systemd-analyze calendar --iterations 5 "Sun *-*-* 0/08:00:00"
Original form: Sun *-*-* 0/08:00:00
Normalized form: Sun *-*-* 00/8:00:00
Next elapse: Sun 2021-10-31 00:00:00 CEST
(in UTC): Sat 2021-10-30 22:00:00 UTC
From now: 3 days left
Iter. #2: Sun 2021-10-31 08:00:00 CET
(in UTC): Sun 2021-10-31 07:00:00 UTC
From now: 3 days left
Iter. #3: Sun 2021-10-31 16:00:00 CET
(in UTC): Sun 2021-10-31 15:00:00 UTC
From now: 4 days left
Iter. #4: Sun 2021-11-07 00:00:00 CET
(in UTC): Sat 2021-11-06 23:00:00 UTC
From now: 1 week 3 days left
Iter. #5: Sun 2021-11-07 08:00:00 CET
(in UTC): Sun 2021-11-07 07:00:00 UTC
From now: 1 week 3 days left
```

5 Catching up on missed runs

With systemd timers you can make leeway for missed timer events.

If a systemd timer was inactive or the system was off during the expected execution time, missed events can optionally be triggered immediately when the timer is activated again. To enable this, add the configuration option `Persisten=true` to the Timer section:

```
[Timer]
OnCalendar=Mon..Fri 10:00
```

```
Persistent=true
Unit=helloworld.service
```

6 Testing calendar entries

Timers can be managed with general systemd commands using the **`systemctl`**. In addition to that, **`systemctl list-timers`** shows you all timers available on a host.

Starting and stopping timers

```
root # systemctl start TIMER.timer
root # systemctl restart TIMER.timer
root # systemctl stop TIMER.timer
```

Enabling and disabling timers

```
root # systemctl enable TIMER.timer
root # systemctl disable TIMER.timer
```

Showing the timer file contents

```
root # systemctl cat TIMER.timer
```

Checking on a specific timer

```
root # systemctl status helloworld.timer
● helloworld.timer - "Run helloworld.service 5min after boot and every 24 hours
relative to activation time" ❶
Loaded: loaded (/etc/systemd/system/helloworld.timer; disabled; vendor preset:
 disabled) ❷
Active: active (waiting) since Tue 2021-10-26 18:35:41 CEST; 6s ago ❸
Trigger: Wed 2021-10-27 18:35:41 CEST; 23h left ❹
Triggers: ● helloworld.service ❺
❻
Oct 26 18:35:41 neo systemd[1]: Started "Run helloworld.service 5min after boot and
 every 24 hours relative to activation time". ❼
```

❶ The timer's file name and it's description.

❷ Lists whether a timer has been successfully parsed and is kept in memory (loaded), shows the full path to the timer file, Last it shows wether the timer is being started at boot time (enabled) or not (disabled). The first value shows the current system configuration, the second value the vendor preset.

❸ Indicates whether the timer is active (waiting to trigger events) or inactive. If active, it also shows the time that has passed since the last activation (6 seconds in this example).

❹ Date and time the timer will be triggered next.

❺ Name of the service file the timer will trigger.

❻ Optional line pointing to documenattion (for example man pages). If not available shows an empty line (as in this example).

❼ Latest journal entry created by the timer.

To list all timers available on the system, use **`systemctl list-timers`**. The following options are available:

List all active timers:

```
root # systemctl list-timers
```

List all timers including inactive ones:

```
root # systemctl list-timers --all
```

List all timers matching a pattern:

```
root # systemctl list-timers hello*
root # systemctl list-timers --all hello*
```

Tthe pattern can be a name or a shell globbing expression as above. The operators `*`, `?`, and `[]` may be used.

List timers matching a certain state:

```
root # systemctl list-timers --state=failed
```

`--state=` takes the following values: `active`, `failed`, `load`, `sub`, see **`man systemctl`** for details.

EXAMPLE 3: LISTING TIMERS

Running **`systemctl list-timers`** will result in a table similar to this example.

```
root # systemctl list-timers snapp*
NEXT                         LEFT       LAST                         PASSED    UNIT
                 ACTIVATES
```

```
------------------------------------------------------------------------------------------------
Tue 2021-10-26 19:00:00 CEST 39min left Tue 2021-10-26 18:00:29 CEST 19min ago
 snapper-timeline.timer snapper-timeline.service
Wed 2021-10-27 08:33:04 CEST 14h   left Tue 2021-10-26 08:33:04 CEST 9h ago
 snapper-cleanup.timer  snapper-cleanup.service
```

- `NEXT` shows the next time the timer will run.
- `LEFT` shows how long till the next time the timer runs.
- `LAST` shows the last time the timer ran.
- `PASSED` shows how long has passed since the timer last ran.
- `UNIT` shows the name of the timer.
- `ACTIVATES` shows the name the service the timer activates when it runs.

7 Using timers as a regular user

systemd timers can also be used by regular users to, for example, automate reoccurring tasks.

Similar to cron, you can also use systemd timers as a regular users. It will help you to automate reoccuring tasks like regular backups, processing images, or moving data to the cloud. The same procedures and tasks as mentioned above are valid, however the following differences apply:

- Timer and service files need to be placed in `~/.config/systemd/user/`.
- All **`systemctl`** and **`journalctl`** command need to be run with the `--user` switch. Note that **`systemd-analyze`** does *not* support this option.

```
tux > systemctl --user start ~/.config/systemd/user/helloworld.timer
tux > systemctl --user enable ~/.config/systemd/user/helloworld.timer
tux > systemctl --user list-timers
tux > journalctl --user -u helloworld.*
tux > systemctl-analyze ~/.config/systemd/user/helloworld.timer
```

Note: Provide the path for the unit files

As a regular user. you should provide the path to the unit files as in the exampüles above, to avoid conffusion with system unit files with the same name.

Important: Environment variables are not inherited

The systemd user instance does not inherit environment variables set by scripts like `~/.profile` or `~/.bashrc`. To check the systemd environment run **`systemctl --user show-environment`**.

To import any variables missing in the systemd environment, specify the following command at the end of you `~/.bashrc`:

```
systemctl --user import-environment VARIABLE1 VARIABLE2
```

8 Troubleshooting

Learn how to find and troubleshoot systemd timers that have failed.

8.1 Avoiding errors

To avoid errors with systemd timers make sure to

- Verify the executable you specify in the service with `ExecStart` file runs without problems
- check the syntax of the service and timer files by running **`systemd-analyze verify`** *FILE* as shown below
- check execution times of calendar entries by running **`systemd-analyze calendar`** *CALENDER_ENTRY*

8.2 Event is not triggered

When you activate a timer that contains non-fatal errors systemda will silently ignore these errors. Given is the following example:

EXAMPLE 4: SYSTEMD TIMER FILE CUTOUT CONTAINING A NON-FATAL ERROR

```
[Timer]
OnBootSec=5min
OnClendar=Mon..Fri 10:00
```

```
Unit=helloworld.service
```

Line 3 contains a syntax error (`OnClendar` instead of `OnCalendar`). Since the `[Timer]` section contains a second timer entry (OnBoot) this error is not fatal and will silently be ignored. As a consequence the Monday to Friday trigger would not be executed. The only way to detect the error is via **`systemd-analyze verify`**:

```
root #  systemd-analyze verify /etc/systemd/system/helloworld.timer
/etc/systemd/system/helloworld.timer:7: Unknown key name 'OnClendar' in section
 'Timer', ignoring.
```

8.3 Checking the system journal

As with every systemd service, events and actions triggered by timers are looged with the system journal. In case a trigger does not behave as expected, check the log messages with **`journalctl`**. To filter the journal for what matters, use the `-u` switch to specify the systemd timers and service files. You should use it in a way that it shows the log entries for the timer *and* the corresponding service file:

```
journalctl -u  helloworld.timer -u helloworld.service
```

or shorter (if applicable):

```
journalctl -u  helloworld.*
```

`journalctl` is a tool that supports many options and filters. Please refer to man journalctl for in-depth information. The following options will be helpful when troublewshooting timers:

- `-b`: Only show entries for the current boot.
- `-S today`: only show entries from today.
- `-x`: Show explanatory help texts alongside the log entry.
- `-f`: Start with the most recent entries and continuously print the log as new entries get added. Useful to check triggers that occur in short intervals. Exit with Ctrl–C.

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