SUSE

使用 `systemd` 计时器

内容

从定期运行备份脚本，到计算机引导后立即启动特定进程，Linux 系统上有大量的任务需要调度。`systemd` 计时器为调度和管理作业及服务提供了灵活的机制。

原因

本文旨在提供 `systemd` 计时器的完整概述，涵盖创建、维护、测试、查错以及从 cron 迁移等方面的信息。

工作量

创建示例 `systemd` 计时器需要 10 分钟。最多花费 30 分钟即可完全了解 `systemd` 计时器的工作原理。

要求

- 基本了解 `systemd`。

- `root` 或 `sudo` 特权。要以普通用户的身份使用 `systemd` 计时器，请先参见第 7 节 "以普通用户身份使用计时器"。

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1 systemd 计时器概念

systemd 计时器单元提供了用于在 Linux 上调度作业的机制。这些作业的执行时间可以基于时间和日期或基于事件。

systemd 计时器单元通过 .timer 文件扩展名标识。每个计时器文件都需要一个由它控制的相应服务文件。也就是说，计时器文件将激活并管理相应的服务文件。systemd 计时器支持以下功能：

- 使用计时器单元安排的作业可以依赖其他 systemd 服务。计时器单元被视为常规 systemd 服务，因此可以使用 **systemctl** 进行管理。

- 计时器可以是实时的（基于日历事件触发），也可以是单调性的（自特定起始时刻经过指定的时间后触发）。

- 时间单元将记录到系统日志中，这样用户便能更轻松地对时间单元进行监视和查错。

- 计时器使用集中式 systemd 管理服务。

- 如果系统在预期执行期间关闭，则一旦系统再次运行，就会执行计时器。

2 创建计时器

以下示例说明如何设置下面这样的计时器：在引导后触发 helloworld.sh 外壳脚本，并相对于其激活时间每隔 24 小时重复执行一次。此外，计时器会在星期一至星期五上午 10 点运行。

2.1 **Hello World** 示例

1. 创建包含以下内容的可执行文件 /usr/local/bin/helloworld.sh:

```
#!/bin/sh
  # This is bash program to display Hello World
```

```
echo " Hello World "
```

这是一个可执行的 `.sh` 文件，其中包含您希望 `systemd` 运行和管理的命令。

2. 创建包含以下内容的 `/etc/systemd/system/helloworld.service` 文件：

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

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

这是一个 `systemd` 服务文件，告知 `systemd` 要运行哪个应用程序。

3. 创建包含以下内容的 `/etc/systemd/system/helloworld.timer` 文件：

```
[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
```

这是计时器文件，用于控制相应服务文件的激活。

4. 校验您先前创建的文件是否不含错误：

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

如果命令未返回任何输出，则表示文件成功通过了校验。

5. 启动计时器：

```
> sudo systemctl start helloworld.timer
```

> 仅针对当前会话激活计时器。

6. 启用计时器以确保在引导时将其激活：

```
> sudo systemctl enable helloworld.timer
```

2.2 示例解释

例 1：**服务文件**

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

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

❶ 解释服务文件用途的简短说明。

❷ 要执行的应用程序。

`[Unit]` 和 `[Service]` 部分是服务文件能够正常运行所需的最基础部分。`systemd` 服务文件通常还包含 `[Install]` 部分，该部分用于指定服务加载时对应的一个或多个目标。计时器的服务文件中不需要此部分，因为此信息已在计时器文件中提供。有关高级配置，请参见如何使用 systemctl 管理 `systemd` 目标的文章 (https://documentation.suse.com/smart/systems-management/html/reference-managing-systemd-targets-systemctl/reference-systemctl-managing-targets.html) ↗。

例 2：**计时器文件**

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

[Timer]
OnBootSec=5min ❷
OnUnitActiveSec=24h ❸
OnCalendar=Mon..Fri *-*-* 10:00 ❹
Unit=helloworld.service ❺
```

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

❶ 解释计时器文件用途的简短说明。

❷ 指定一个用于在系统引导 5 分钟后触发服务的计时器。有关详细信息，请参见单调计时
器。

❸ 指定一个用于在激活服务 24 小时后触发服务（即每天触发一次）的计时器。有关详细信
息，请参见实时计时器。

❹ 指定一个在固定时间点（在本示例中为星期一至星期五上午 10 点）触发服务的计时器。有
关详细信息，请参见实时计时器。

❺ 要执行的服务文件。

❻ 要在其中激活计时器的 `systemd` 目标。有关 `systemd` 目标的详细信息，请参见如何
使用 systemctl 管理 `systemd` 目标的文章 (https://documentation.suse.com/smart/
systems-management/html/reference-managing-systemd-targets-systemctl/
reference-systemctl-managing-targets.html) ↗。

3 管理计时器

可以使用 **systemctl** 命令管理计时器。

启动和停止计时器

```
> sudo systemctl start TIMER.timer
> sudo systemctl restart TIMER.timer
> sudo systemctl stop TIMER.timer
```

启用和禁用计时器

```
> sudo systemctl enable TIMER.timer
> sudo systemctl disable TIMER.timer
```

显示计时器文件内容

```
> sudo systemctl cat TIMER.timer
```

检查特定的计时器

```
> sudo systemctl status TIMER.timer
```

例 3： 计时器状态

```
> sudo 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 2022-10-26 18:35:41 CEST; 6s ago ❸
Trigger: Wed 2022-10-27 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 计时器的文件名和说明。

❷ 列出计时器是否已成功分析并保留在内存中（已加载），显示计时器文件的完整路径，以及计时器在系统引导时会启动（已启用）还是不会启动（已禁用）。第一个值显示当前系统配置，第二个值显示供应商预设的值。

❸ 指示计时器是处于活动状态（正在等待触发事件）还是非活动状态。如果处于活动状态，它还会显示自上次激活以来经过的时间（在本示例中为 6 秒）。

❹ 下次触发计时器的日期和时间。

❺ 计时器触发的服务文件的名称。

❻ 指向文档（例如手册页）的可选行。如果不可用，则显示空行（如本示例中所示）。

❼ 计时器创建的最新日记项。

要列出系统上所有可用的计时器，请使用 **systemctl list-timers**。下列选项可用：

列出所有活动计时器：

```
> sudo systemctl list-timers
```

列出所有计时器，包括非活动的计时器：

```
> sudo systemctl list-timers --all
```

列出与模式匹配的所有计时器：

```
> sudo systemctl list-timers PATTERN> sudo systemctl list-timers --
all PATTERN
```

PATTERN 必须是一个名称或外壳通配表达式。可以使用运算符 *、? 和 []。有关通配模式的详细信息，请参见 **man 7 glob**。

列出与特定状态匹配的计时器：

```
> sudo systemctl list-timers --state=STATE
```

STATE 接受以下值：active、failed、load、sub。有关详细信息，请参见 **man systemctl**。

例 4： **列出计时器**

运行任何 **systemctl list-timers** 都会生成如下所示的表。此示例列出了与模式 snapper* 匹配的所有活动计时器：

```
> sudo systemctl list-timers snapper*
NEXT ❶                          LEFT ❷      LAST ❸
 PASSED ❹   UNIT ❺                          ACTIVATES ❻


-------------------------------------------------------------------------------
Tue 2022-10-26 19:00:00 CEST 39min left Tue 2022-10-26 18:00:29 CEST 19min
 ago snapper-timeline.timer snapper-timeline.service
Wed 2022-10-27 08:33:04 CEST 14h   left Tue 2022-10-26 08:33:04 CEST 9h ago
    snapper-cleanup.timer  snapper-cleanup.service
```

❶ 下次运行计时器的时间点。

❷ 距离下次运行计时器的剩余时间。

❸ 上次运行计时器的时间点。

❹ 自上次运行计时器以来经过的时间。

❺ 计时器单元的名称。

❻ 计时器激活的服务的名称。

4 计时器类型

`systemd` 支持两种类型的计时器：实时（基于日历）和单调（基于事件）计时器。尽管计时器通常是永久性的，但 `systemd` 还允许设置仅对当前会话有效的瞬态计时器。

实时计时器

实时计时器由日历事件触发。它们是使用选项 `OnCalendar` 定义的。

您可以基于日期和时间指定何时触发事件。使用以下模板：

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

❶ 星期日期。可能的值为 `Sun`、`Mon`、`Tue`、`Wed`、`Thu`、`Fri`、`Sat`。留空会忽略星期日期。

❷ 日期。用两位数指定月和日，用四位数指定年。可以用通配符 `*` 替换每个值，以匹配每个出现的值。

❸ 时间。用两位数指定每个值。可以用通配符 `*` 替换每个值，以匹配每个出现的值。

应用于所有值：用两个点定义连续范围 (`Mon..Fri`)。用逗号分隔各个不同值的列表 (`Mon,Wed,Fri`)。

例 5：实时计时器示例

- 每个星期五的下午 6 点：

  ```
  OnCalendar=Fri *-*-* 18:00:00
  ```

- 每天上午 5 点：

  ```
  OnCalendar=Mon..Sun *-*-* 5:00:00
  ```

- 星期日和星期二凌晨 1 点和 3 点：

  ```
  OnCalendar=Tue,Sun *-*-* 01,03:00:00
  ```

- 单个日期：

```
OnCalendar=Mo..Sun 2023-09-23 00:00:01
```

- 要指定不同时间的触发器，可以在单个计时器文件中创建多个 OnCalendar 项：

```
OnCalendar=Mon..Fri *-*-* 10:00
OnCalendar=Sat,Sun *-*-* 22:00
```

有关可用功能和选项的完整列表，请参见 `man 7 systemd.time`，其中提供了有关以下主题的其他信息：

- 缩短语法并使用缩写

- 指定重复次数

- 查找一个月中的特定日期（如月末最后一天、当月最后一个周日等）

- 应用时区

单调计时器

单调计时器在发生特定事件（例如系统引导或系统单元激活事件）后经过指定的时间时触发。值按时间单位（分钟、小时、日、月、年等）定义。支持以下单位：usec、msec、seconds、minutes、hours、days、weeks、months、years。可以使用多个选项来定义单调计时器：

- OnActiveSec：激活单元后经过的时间

  ```
  OnActiveSec=50minutes
  ```

- OnBootSec：系统引导后经过的时间

  ```
  OnBootSec=10hours
  ```

- OnStartupSec：启动服务管理器后经过的时间。对于系统服务，此选项大致相当于 OnActiveSec。请将此选项用于相应服务管理器会在用户登录时启动的用户服务。

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

- OnUnitActiveSec：上次激活相应服务后经过的时间

  ```
  OnUnitActiveSec=10seconds
  ```

- OnUnitInactiveSec：上次停用相应服务后经过的时间

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

瞬态计时器

瞬态计时器是仅对当前会话有效的临时计时器。借助这些计时器，可以使用现有的服务文件或直接启动程序。可以运行 **systemd-run** 来调用瞬态计时器。

以下示例每隔两小时运行一次 helloworld.service 单元：

```
> sudo systemd-run --on-active="2hours" --unit="helloworld.service"
```

要直接运行某个命令，请使用以下语法。此示例直接调用脚本 /usr/local/bin/helloworld.sh：

```
> sudo systemd-run --on-active="2hours" /usr/local/bin/helloworld.sh
```

如果命令接受参数，请用空格分隔添加的参数：

```
> sudo systemd-run --on-active="2hours" /usr/local/bin/helloworld.sh --language=pt_BR
```

瞬态计时器可以是单调的，也可以是实时的。支持以下开关，其工作方式如单调计时器中所述：

- --on-active

- --on-startup

- --on-unit-active

- --on-unit-inactive

- --on-calendar

有关详细信息，请参见 **man 1 systemd-run**。

5   测试日历项

systemd 提供了用于为实时计时器测试和创建日历计时器项的工具，即 **systemd-analyze calendar**。此工具接受的参数与用于设置实时计时器的 OnCalendar 项相同。

您可以串联多个参数（用空格分隔）。如果要测试的字词正确，则输出会显示下次触发计时器的时间（以本地时间和 UTC 表示）。其中还会显示 Normalized form 的字符串，建议在计时器文件中使用该字符串。考虑下列示例：

```
> 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


> 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
```

对于重复性计时器，请使用 —iterations N 开关列出触发时间，然后测试计时器是否按预期工作。参数 N 指定您要测试的迭代次数。以下示例字符串在星期日每隔 8 小时（从 00:00:00 开始）触发一次计时器：

```
> 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
```

6 当计时器失败时接收电子邮件通知

`systemd` 未提供与 cron 的 MAILTO 类似的功能。以下过程介绍了当计时器失败时启用电子邮件通知的解决方法。

该过程包括以下步骤：

1. 创建一个用于发送电子邮件的脚本。

2. 创建运行电子邮件脚本的 `systemd` 服务文件。

3. 测试电子邮件服务文件。

4. 在计时器控制的服务中，通过 `OnFailure` 调用创建的电子邮件服务文件。

   以下示例将使用软件包 `mailx` 中的 **mailx** 命令。这需要安装并正确配置 Postfix 电子邮件服务器。

1. 创建脚本 `/usr/local/bin/send_systemd_email`。

   a. 该脚本需要两个参数：`$1`（电子邮件地址）和 `$2`（用于接收失败通知的服务文件的名称）。这两个参数均由运行邮件脚本的单元文件提供。

```
#!/bin/sh
systemctl status --full "$2" | mailx -S sendwait\
 -s "Service failure for $2" -r root@$HOSTNAME $1
```

   b. 确保该脚本可执行：

   > **sudo** chmod 755 /usr/local/bin/send_systemd_email

2. 创建文件 /etc/systemd/system/send_email_to_USER@.service。

```
[Unit]
Description=Send systemd status information by email for %i to USER

[Service]
Type=oneshot
ExecStart=/usr/local/bin/send_systemd_email EMAIL_ADDRESS %i
User=root
Group=systemd-journal
```

将文件中的 USER 和 EMAIL_ADDRESS 分别替换为要接收电子邮件的用户的登录名和电子邮件地址。%i 是失败的服务名称（通过 %n 参数传递给电子邮件服务)。

3. 校验服务文件并修复报告的问题：

   > systemd-analyze verify /etc/systemd/system/send_email_to_USER@.service

如果命令未返回任何输出，则表示文件成功通过了校验。

4. 要校验整个过程，请使用 dbus 实例启动服务进行测试。（您可以使用当前正在运行的任何其他服务。本示例使用 dbus，是因为该服务在所有安装环境中都能确保运行。）

   > **sudo** systemctl start send_email_to_USER@dbus.service

如果成功，EMAIL_ADDRESS 会收到一封电子邮件，其主题为 Service failure for dbus，正文包含 dbus 状态消息。（这只是一项测试，dbus 服务本身并未出现问题。您可以放心删除该电子邮件，无需执行任何操作）。
如果测试电子邮件已成功发送，请将其集成到您的服务文件中。

5. 要向服务添加电子邮件通知，请将 `OnFailure` 选项添加到在发生失败时用于接收通知的服务文件的 `Unit` 部分：

```
[Unit]
Description="Hello World script"
OnFailure❶=send_email_to_USER❷@%n❸.service

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

❶ `OnFailure` 选项接受将某个服务作为参数。

❷ 将此服务单元文件名部分替换为登录名。

❸ 指定服务的名称（在本示例中为 `helloworld`）。此名称在电子邮件服务文件中以 %i 形式提供。

您已成功为 `systemd` 服务设置失败通知。

💡 提示：向多个用户发送电子邮件通知

电子邮件服务文件已将收件人的电子邮件地址硬编码。要向其他用户发送通知电子邮件，请复制电子邮件服务文件，并替换文件名中的用户登录名，以及抄送行中的电子邮件地址。

要同时向多个收件人发送失败通知，请将相应的服务文件添加到该服务文件（使用空格作为分隔符）：

```
OnFailure=send_email_to_tux@%n.service send_email_to_wilber@%n.service
```

7 以普通用户身份使用计时器

普通用户也可以使用 `systemd` 计时器。这些计时器可帮助您自动完成重复性任务，例如备份、处理图像或将数据移到云中。

适用于系统范围计时器的过程和任务同样适用于 systemd 计时器。但是，两者存在以下差异：

- 计时器和服务文件必须放在 ~/.config/systemd/user/ 中。

- 必须结合 --user 开关运行所有 **systemctl** 和 **journalctl** 命令。**systemd-analyze** **不**需要此选项。

  作为普通用户，您必须提供单元文件的路径，如以下示例中所示。否则，如果存在同名的系统范围计时器，则会执行或列出该系统范围计时器。

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

❗ 重要：用户计时器仅在活动会话期间运行

与以普通用户身份启动的其他 systemd 服务一样，用户计时器仅在用户登录后才运行。

若要让用户计时器在系统引导时启动，且在用户注销后仍保持运行状态，需要为每个相关用户启用**用户驻留**模式：

```
sudo loginctl enable-linger USER
```

有关详细信息，请参见 **man 1 loginctl**。

❗ 重要：不继承环境变量

systemd 用户实例不会继承 ~/.profile 或 ~/.bashrc 等脚本设置的环境变量。要检查 systemd 环境，请运行 **systemctl --user show-environment**。

要导入 systemd 环境中缺少的任何变量，请在 ~/.bashrc 末尾指定以下命令：

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

8 从 cron 迁移到 systemd 计时器

所有 cron 作业都可以迁移到 systemd 计时器。下面提供了说明和示例。

1. 创建执行脚本的服务文件。有关详细信息，请参见例 1 "服务文件"。

2. 创建执行服务文件的计时器文件。有关一般说明，请参见例 2 "计时器文件"。

   a. 转换日历项。在 cron 和 systemd 中，时间的指定方式不同。使用以下模式作为转换模板：

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

   要测试转换后的日历项，请按照第 5 节 "测试日历项"中的说明操作。

   b. 转换 cron 别名 (@NICK)：

   ```
   Cron     : systemd timer
   -------- : ---------------------------
   @reboot  : OnBootSec=1s
   @yearly  : OnCalendar=*-01-01 00:00:00
   @annually: OnCalendar=*-01-01 00:00:00
   @monthly : OnCalendar=*-*-01 00:00:00
   @weekly  : OnCalendar=Sun *-*-* 00:00:00
   @daily   : OnCalendar=*-*-* 00:00:00
   @hourly  : OnCalendar=*-*-* *:00:00
   ```

   c. 转换变量赋值。systemd 变量赋值必须在 [Service] 部分中定义。不能以这种方式转换 MAILTO - 具体请参见下一步。

   ```
   cron: VARIABLE=VALUE
   systemd: Environment="VARIABLE=VALUE"
   ```

   d. 按照第 6 节 "当计时器失败时接收电子邮件通知"中的说明设置电子邮件通知，以替换 cron 的 MAILTO 功能。

例 6：**从 CRON 迁移到** `systemd` **计时器**

> 下面是在引导后经过 5 分钟并在每个星期一至星期五 10 点调用脚本 `helloworld.sh` 的 crontab 项：
>
> ```
> @reboot sleep 300 && /usr/local/bin/helloworld.sh
> 0 10 * * * 1-5 /usr/local/bin/helloworld.sh
> ```
>
> 调用脚本的 `systemd` 服务文件 (`helloworld.service`) 如下所示：
>
> ```
> [Unit]
> Description="Hello World script"
> [Service]
> ExecStart=/usr/local/bin/helloworld.sh
> ```
>
> 计时器文件 (`helloworld.timer`) 如下所示：
>
> ```
> [Unit]
> Description="Run helloworld.service 5min after boot and at 10am every Mon-Fri"
> [Timer]
> OnBootSec=5min
> OnCalendar=Mon..Fri *-*-* 10:00
> Unit=helloworld.service
> [Install]
> WantedBy=multi-user.target
> ```

9 查错和常见问题

了解如何对失败的 `systemd` 计时器进行调试和查错。查找有关 `systemd` 计时器的常见问题解答。

9.1 避免错误

为了避免 `systemd` 计时器出现错误，请确保遵循以下最佳实践：

- 校验您在服务中使用 `ExecStart` 指定的可执行文件是否正确运行。

- 运行 **`systemd-analyze verify`** `FILE` 来检查服务和计时器文件的语法。

- 运行 **`systemd-analyze calendar`** `CALENDER_ENTRY` 来检查日历项的执行时间。

9.2   事件未触发

当您激活包含非严重错误的计时器时，`systemd` 将静默忽略这些错误。例如：

例 7：**包含非致命错误的** `systemd` **计时器文件中断**

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

第 3 行包含语法错误（应该是 `OnClendar`，而不是 `OnCalendar`）。由于 `[Timer]` 部分包含另一个计时器项 (OnBoot)，因此该错误并不严重，将被静默忽略。因此，星期一至星期五的触发器不会执行。检测错误的唯一方法是使用命令 **`systemd-analyze verify`**：

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

9.3   在系统日记中检查错误

与每个 `systemd` 服务一样，计时器触发的事件和操作将记录到系统日志中。如果触发器未按预期运行，请使用 **`journalctl`** 检查日志消息。要过滤日志以显示相关信息，请使用 `-u` 开关指定 `systemd` 计时器和服务文件。使用此选项可显示计时器**和**相应服务文件的日志项：

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

或使用更短的选项格式（如果适用）：

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

journalctl 是支持许多选项和过滤器的工具。请参见 **man 1 journalctl** 获取深入信息。以下选项对于计时器查错非常有用：

- `-b`：仅显示当前引导对应的项。

- `-S today`：仅显示当日的项。

- `-x`：显示帮助文本以及日志项。

- `-f`：从最新的项开始，随着新项的不断添加持续列显日志。非常适合用于检查以较短间隔执行的触发器。按 `Ctrl – C` 键退出。

9.4　systemd 计时器：弥补错过的轮次

如果 systemd 计时器处于非活动状态或系统在预期执行期间关闭，可以选择性地在计时器再次激活后立即触发错过的事件。要启用此功能，请将配置选项 Persistent=true 添加到 [Timer] 部分：

```
[Timer]
OnCalendar=Mon..Fri 10:00
Persistent=true
Unit=helloworld.service
```

9.5　如何从 cron 迁移到 systemd 计时器？

所有 cron 作业都可以迁移到 systemd 计时器。下面是有关迁移 cron 作业的一般说明：

1. 创建执行脚本的服务文件。有关详细信息，请参见例 1 "服务文件"。

2. 创建执行服务文件的计时器文件。有关一般说明，请参见例 2 "计时器文件"。

   a. 转换日历项。在 cron 和 systemd 中，时间的指定方式不同。使用以下模式作为转换模板：

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

要测试转换后的日历项，请按照第 5 节 "测试日历项" 中的说明操作。

b. 转换 cron 别名 (@NICK)：

```
Cron      : systemd timer
-------- : --------------------------
@reboot  : OnBootSec=1s
@yearly  : OnCalendar=*-01-01 00:00:00
@annually: OnCalendar=*-01-01 00:00:00
@monthly : OnCalendar=*-*-01 00:00:00
@weekly  : OnCalendar=Sun *-*-* 00:00:00
@daily   : OnCalendar=*-*-* 00:00:00
@hourly  : OnCalendar=*-*-* *:00:00
```

c. 转换变量赋值。systemd 变量赋值必须在 [Service] 部分中定义。不能以这种方式转换 MAILTO - 具体请参见下一步。

```
cron: VARIABLE=VALUE
systemd: Environment="VARIABLE=VALUE"
```

d. 按照第 6 节 "当计时器失败时接收电子邮件通知" 中的说明设置电子邮件通知，以替换 cron 的 MAILTO 功能。

例 8：**从 CRON 迁移到** systemd **计时器**

下面是在引导后经过 5 分钟并在每个星期一至星期五 10 点调用脚本 helloworld.sh 的 crontab 项：

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

调用脚本的 systemd 服务文件 (helloworld.service) 如下所示：

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

```
ExecStart=/usr/local/bin/helloworld.sh
```

计时器文件 (`helloworld.timer`) 如下所示：

```
[Unit]
Description="Run helloworld.service 5min after boot and at 10am every Mon-
Fri"
[Timer]
OnBootSec=5min
OnCalendar=Mon..Fri *-*-* 10:00
Unit=helloworld.service
[Install]
WantedBy=multi-user.target
```

10 更多信息

- 有关 `systemd` 计时器的完整参考，包括高级配置选项（例如延迟或者处理时钟或时区更改），请参见 **`man 5 systemd.timer`**。

- `systemd` 的基本概念 (https://documentation.suse.com/smart/systems-management/html/concept-systemd/concept-systemd.html) ↗

- 启动和停止 `systemd` 服务 (https://documentation.suse.com/smart/systems-management/html/reference-systemctl-start-stop-services/reference-systemctl-start-stop-services.html) ↗

- 启用和禁用 `systemd` 服务 (https://documentation.suse.com/smart/systems-management/html/reference-systemctl-enable-disable-services/reference-systemctl-enable-disable-services.html) ↗

- 调试失败的 `systemd` 服务 (https://documentation.suse.com/smart/systems-management/html/task-debug-failed-systemd-services/index.html) ↗

- 向 `systemd` 服务发送终止信号 (https://documentation.suse.com/smart/systems-management/html/task-send-termination-signals-systemd/task-send-termination-signals-systemd.html) ↗

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