

# LPI 108.1 - Maintain System Time

Curs 2021 - 2022

ASIX M01-ISO 108 Essential System Services

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# Maintain system time

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## Description

### Key concepts:

- ☐ Set the system date and time.
- ☐ Set the hardware clock to the correct time in UTC.
- ☐ Configure the correct timezone.
- ☐ Basic NTP configuration using ntpd and chrony.
- ☐ Knowledge of using the pool.ntp.org service.
- ☐ Awareness of the ntpq command.

### Commands and files:

- ☐ /usr/share/zoneinfo/
- ☐ /etc/timezone
- ☐ /etc/localtime
- ☐ /etc/ntp.conf
- ☐ /etc/chrony.conf
- ☐ date
- ☐ hwclock
- ☐ timedatectl
- ☐ ntpd
- ☐ ntpdate
- ☐ chronyc
- ☐ pool.ntp.org

## System Time

Linux-based systems have two types of clocks:

- System clock
- Hardware clock

### System Clock

This is a clock maintained by the kernel and is interrupt-driven. The value of this clock is initialized from the hardware clock at boot time. The system time is calculated as the number of seconds since January 1st 1970 00:00:00. (This reference time is known as epoch time or sometimes [UNIX time](#).) The system clock contains the current time as well as time zone information.

Main purpose: used by the kernel.

## Hardware Clock

This is a battery-powered clock that keeps time even when the system is shut down. When the system boots, the system clock is set using the value of the hardware clock. When the system is shut down, the hardware clock is set to the value of the system clock. This ensures that both the clocks are [synchronized](#). The hardware clock is also known as the [real time clock \(RTC\)](#) or the CMOS/BIOS clock. The hardware clock stores the following values: [year](#), [month](#), [day](#), [hour](#), [minute](#), and [seconds](#).

Main purpose: maintain the time when the system is off.

## Time Standards and concepts

- UTC Coordinated Universal Time
- GMT Greenwich Mean Time
- Daylight Saving

## UTC (Coordinated Universal Time)

Is the standard time used globally. The various time zones are expressed in terms of positive or negative offsets with regards to UTC. The local time is set to the current time zone and has to adjust by individual software programs to the UTC time accordingly.

## GMT (Greenwich Mean Time)

Is often confused with UTC, is a time zone that coincides with UTC. Neither GMT nor UTC changes with Daylight Saving Time, although some places that use GMT do.

## Daylight Saving

Changes to time depending on the part of year. Changes of daylight saving affect the system clock but not the hardware clock.

## adjust

It is normal for the clocks to slowly diverge as time passes because of the way that time is calculated differently for the hardware clock and the system clock.

## drift

The hardware clock drift is how much time the hardware clock gains or loses at a regular rate.

# Hardware Clock

## [hwclock](#)

Command to maintaining the hardware clock (root). Is an administration tool for the time clocks. It can: display the Hardware Clock time; set the Hardware Clock to a specified time; set the Hardware Clock from the System Clock; set the System Clock from the Hardware Clock; compensate for Hardware Clock drift; correct the System

Clock timescale; set the kernel's timezone, NTP timescale, and epoch (Alpha only); and predict future Hardware Clock values based on its drift rate.

Commands and files:

- hwclock
  - hwclock --set --date "01/01/2022 15:00"
  - hwclock --systohc | hwclock -w
  - hwclock --hctosys | hwclock -s
  - hwclock -r
  - hwclock --utc
  - hwclock --localtime
  - hwclock --adjust
- 
- /etc/adjtime
  - /etc/localtime

Concepts:

- establishes the hardware or RTC clock
- it must be in local time
- It is normal for the clocks to slowly diverge as time passes because of the way that time is calculated differently for the hardware clock and the system clock. So it may be necessary to synchronize manually on systems permanently on.
- the hwclock is copied to the system clock on startup, and on poweroff the system clock is copied to the hwclock.

```
#1
# hwclock
2021-10-31 13:05:41.341243+01:00

# date
Sun 31 Oct 2021 01:06:15 PM CET
```

```
#2
# hwclock --set --date "01/01/2022 15:00"

# hwclock
2022-01-01 15:00:05.263048+01:00

# date
Sun 31 Oct 2021 01:09:06 PM CET
```

```
# hwclock --systohc

# hwclock
2021-10-31 13:10:12.356884+01:00

# date
Sun 31 Oct 2021 01:10:15 PM CET

# hwclock -r
2021-10-31 13:15:54.919341+01:00
```

Adjust / drift / times

- UTC
- localtime
- /etc/localtime
- /etc/adjtime
- if not specified hwclock uses the type of time established in /etc/adjtime (UTC or LOCAL).
- this file contains information about past times and the drift. How does the hardware clock differ to the time.
- contains the last type of time used in the last order and the default to use in commands if the type of time (utc or local) is not specified).

```
#3
# ls -l /etc/localtime
lrwxrwxrwx. 1 root root 35 Apr  7 2021 /etc/localtime ->
../usr/share/zoneinfo/Europe/Madrid

# file /etc/localtime
/etc/localtime: symbolic link to ../usr/share/zoneinfo/Europe/Madrid

# cat /etc/adjtime
0.000000 1635682209 0.000000
1635682209
UTC
```

```
#4
# hwclock --set --utc --date "12/25/2021"

# hwclock
2021-12-25 00:00:03.622497+01:00

# hwclock --set --localtime --date "12/31/2021"

# hwclock
2021-12-31 00:00:02.059910+01:00

# cat /etc/adjtime
0.000000 1640905200 0.000000
1640905200
LOCAL
```

## System Clock

The `date` command is used to display and set the system date and time. In addition to displaying and setting the date, the date command is regularly used in scripts for assigning filenames with timestamps suffixed to them.

Should not be used to attempt to update the system clock if the NTP (Network Time Protocol) service, which syncs the software clock with internet time servers, has been set up on the server.

date commands:

- date
- date +%d-%m-%y
- date +"%d/%m/%Y"
- date --set "01/01/2022 12:00"
- date +%s

date format:

%d	Day of month (e.g., 30)
%H	Hour (0-23)
%I	Hour (1-12)
%m	Month (1-12)
%M	Minute (0-59)
%S	Seconds (0-60)
%T	Time (%H:%M:%S)
%u	Day of week (1-7, 1=Monday)
%Y	Year
%F	Full date; same as %Y-%m-%d

```
#5
$ date
Sun 31 Oct 2021 01:43:15 PM CET

$ date +%d-%m-%y
31-10-21

$ date +"%d/%m/%Y"
31/10/2021

$ date +%F
2021-10-31

$ date +%D
10/31/21

$ date +%b
Oct

$ date +"%u %b"
7 Oct

$ date +"%H:%m"
13:10

$ date +"The time is: %H:%m"
The time is: 13:10

$ date +%s
1635688488
```

```
#6
# date --set "01/25/2022 12:05"
Tue 25 Jan 2022 12:05:00 PM CET

# hwclock
2021-10-31 12:47:55.918840+01:00

# hwclock --hctosys

# date
Sun 31 Oct 2021 12:48:32 PM CET

#### attention: setting wrong time may cause the host not able to connect to internet
```

```
# date +%Y%m%d -s "20111125"
# date +%T -s "13:11:00"
```



## Your clock is ahead

A private connection to **www.google.com** can't be established because your computer's date and time (Tuesday, January 25, 2022 at 12:07:07 PM) are incorrect.

NET::ERR\_CERT\_DATE\_INVALID



To get Chrome's highest level of security, [turn on enhanced protection](#)

Advanced

Update date and time

```
#7
$ touch file-$(date +"%Y%m%d")
$ ls file-20211031
file-20211031
```

## Time Zones

- /etc/localtime
- /usr/share/zoneinfo
- Debian: /etc/timezone
- TZ variable (export TZ=America/New\_York)

The file /etc/localtime is a symbolic link to the appropriate timezone file in /usr/share/zoneinfo. Changing the link manually is a way to change the timezone.

```
#8
$ ls -l /etc/localtime
```

```
lrwxrwxrwx. 1 root root 35 Apr  7 2021 /etc/localtime ->
../usr/share/zoneinfo/Europe/Madrid

$ ls /usr/share/zoneinfo/
Africa      Australia  Cuba      Etc        GMT+0      Iceland    Japan      MST
Poland      right      UCT        zone1970.tab
America     Brazil    EET        Europe     GMT-0      Indian     Kwajalein  MST7MDT
Portugal    ROC       Universal  zone.tab
Antarctica  Canada    Egypt     Factory    GMT0       Iran       leapseconds Navajo
posix       ROK       US         Zulu
Arctic      CET       Eire      GB          Greenwich  iso3166.tab Libya      NZ
posixrules  Singapore UTC
Asia        Chile     EST       GB-Eire     Hongkong   Israel     MET        NZ-CHAT
PRC         Turkey    WET
Atlantic    CST6CDT   EST5EDT   GMT         HST        Jamaica    Mexico     Pacific
PST8PDT     tzdata.zi W-SU

$ ls -l /usr/share/zoneinfo/Europe/Madrid
-rw-r--r--. 1 root root 2628 Jan 26 2021 /usr/share/zoneinfo/Europe/Madrid

$ file /usr/share/zoneinfo/Europe/Madrid
/usr/share/zoneinfo/Europe/Madrid: timezone data, version 2, 11 gmt time flags, 11 std
time flags, no leap seconds, 163 transition times, 11 abbreviation chars
```

```
#9
$ tzselect
Please identify a location so that time zone rules can be set correctly.
Please select a continent, ocean, "coord", or "TZ".
1) Africa                                     7) Europe
2) Americas                                  8) Indian Ocean
3) Antarctica                                9) Pacific Ocean
4) Asia                                       10) coord - I want to use
geographical coordinates.
5) Atlantic Ocean                           11) TZ - I want to specify
the timezone using the Posix TZ format.
6) Australia
```

## Command timedatectl

Timedatectl may be used to query and change the system clock and its settings, and enable or disable time synchronization services. May be used to show the current status of time synchronization services, for example `systemd-timesyncd.service`(8).

```
#10
$ timedatectl
          Local time: Sun 2021-10-31 14:09:54 CET
          Universal time: Sun 2021-10-31 13:09:54 UTC
              RTC time: Sun 2021-10-31 13:09:54
          Time zone: Europe/Madrid (CET, +0100)
System clock synchronized: yes
              NTP service: active
          RTC in local TZ: no
```

```
$ timedatectl show
Timezone=Europe/Madrid
LocalRTC=no
CanNTP=yes
NTP=yes
NTPSynchronized=yes
TimeUSec=Sun 2021-10-31 14:13:04 CET
RTCTimeUSec=Sun 2021-10-31 14:13:04 CET
```



From the previous command observe:

- local time is 1h after UTC (14h)
- RTC time, hardware clock is in UTC and not in TZ.
- Time zone is Madrid with +1h of daylight time saving.
- NTP is active

Commands:

**show | --status**

Show time and time zone information

**set time**

Set the system clock to the specified time. This will also update the RTC time accordingly.

**set timezone**

Set the system time zone to the specified value. Available time zones can be listed with list-timezones. If the RTC is configured to be the local time, this will also update the RTC time. This call will alter the /etc/localtime symlink.

**list-timezones**

List available time zones,

**timesync-status**

Show the current status of synchronization to the current Network Time Protocol (NTP).

**set-ntp yes|no**

Controls whether network time synchronization is active and enabled.

```
#11
$ timedatectl list-timezones
Africa/Abidjan
Africa/Accra
Africa/Algiers
Africa/Bissau
Africa/Cairo

# timedatectl timesync-status
Failed to query server: Could not activate remote peer.
```

```
#12
# timedatectl set-timezone Europe/Andorra

# timedatectl
          Local time: Sun 2021-10-31 14:21:02 CET
          Universal time: Sun 2021-10-31 13:21:02 UTC
              RTC time: Sun 2021-10-31 13:21:02
          Time zone: Europe/Andorra (CET, +0100)
System clock synchronized: yes
              NTP service: active
          RTC in local TZ: no

# timedatectl show
Timezone=Europe/Andorra
LocalRTC=no
CanNTP=yes
NTP=yes
NTPSynchronized=yes
TimeUSec=Sun 2021-10-31 14:21:16 CET
RTCTimeUSec=Sun 2021-10-31 14:21:16 CET
```

```
#13
# timedatectl set-time '2021-11-31 14:00:00'
```

### Win trick

Dual boot systems with Linux and Windows can be off by the difference between the timezone in which they are set and UTC every time the user switches operating systems.

```
$ sudo timedatectl set-local-rtc 1 --adjust-system-clock
```

## NPT Network Time Protocol

The NTP daemon, `ntpd`, sets and updates the system time in synchronization with one or more reference time servers. This daemon sends messages to and receives messages from preconfigured servers at certain intervals. The `ntpd` daemon can also be configured to act as a server, so other clients may query this server to synchronize their system time.

- `/etc/ntpd.conf`
- `ntpq` (client tool to query)
- `ntptrace`
- `ntpd -q` | `ntpdate` | `ntpdate -q`

```
#14
#List of public NTP servers to be queried
server 0.pool.ntp.org iburst
server 1.pool.ntp.org iburst
server 2.pool.ntp.org iburst

restrict default ignore

restrict 127.0.0.1

driftfile /var/lib/ntp/ntp.drift
logfile /var/log/ntpser.log
```

### Description of `/etc/ntpd.conf`

#### `server`

The server lines indicate the NTP servers to synchronize with.

#### `iburst`

indicates that if the server is unreachable, then send a burst of eight requests instead of the usual one.

#### `restrict`

restrict access to other computers. This means that this computer will not act as an NTP server for other machines.

#### `restrict`

that the localhost (127.0.0.1) will be able to monitor the `ntpd` daemon.

#### `driftfile`

indicates the file that is used to store the drift time. This file contains a value that is an average over time of how much the local time “drifts” from the NTP server time.

#### `logfile`

the location where the NTP log file is stored.

```
#15
$ ntpq -pn
$ ntptrace
```

A reference clock should have the most accurate possible time (for example, an atomic clock). A reference clock is referred to as a Stratum-0 clock. An NTP server that updates its time to a reference clock is referred to as a Stratum-1 clock...

NTP uses a hierarchical structure to disseminate time. Reference clocks are connected to servers at the top of the hierarchy. These servers are Stratum 1 machines and typically are not accessible to the public. Stratum 1 machines are however accessible to Stratum 2 machines, which are accessible to Stratum 3 machines and so on. Stratum 2 servers are accessible to the public, as are any machines lower in the hierarchy.

```
#16
# ntpd -q
31 Oct 14:37:18 ntpd[18305]: ntpd 4.2.8p15@1.3728-o Tue Jun 23 00:00:00 UTC 2020 (1):
Starting
31 Oct 14:37:18 ntpd[18305]: Command line: ntpd -q
31 Oct 14:37:18 ntpd[18305]: -----
31 Oct 14:37:18 ntpd[18305]: ntp-4 is maintained by Network Time Foundation,
31 Oct 14:37:18 ntpd[18305]: Inc. (NTF), a non-profit 501(c)(3) public-benefit
31 Oct 14:37:18 ntpd[18305]: corporation. Support and training for ntp-4 are
31 Oct 14:37:18 ntpd[18305]: available at https://www.nwtime.org/support
31 Oct 14:37:18 ntpd[18305]: -----
31 Oct 14:37:18 ntpd[18305]: proto: precision = 0.042 usec (-24)
31 Oct 14:37:18 ntpd[18305]: basedate set to 2020-06-11
31 Oct 14:37:18 ntpd[18305]: gps base set to 2020-06-14 (week 2110)
31 Oct 14:37:18 ntpd[18305]: Listen and drop on 0 v6wildcard [::]:123
31 Oct 14:37:18 ntpd[18305]: Listen and drop on 1 v4wildcard 0.0.0.0:123
31 Oct 14:37:18 ntpd[18305]: Listen normally on 2 lo 127.0.0.1:123
31 Oct 14:37:18 ntpd[18305]: Listen normally on 3 wlp0s20f3 192.168.1.113:123
31 Oct 14:37:18 ntpd[18305]: Listen normally on 4 lo [::1]:123
31 Oct 14:37:18 ntpd[18305]: Listen normally on 5 wlp0s20f3
[fe80::908a:2e01:c206:c081%3]:123
31 Oct 14:37:18 ntpd[18305]: Listening on routing socket on fd #22 for interface updates
31 Oct 14:37:19 ntpd[18305]: Soliciting pool server 51.68.44.27
31 Oct 14:37:20 ntpd[18305]: Soliciting pool server 213.110.203.168
31 Oct 14:37:21 ntpd[18305]: Soliciting pool server 5.39.184.5
31 Oct 14:37:22 ntpd[18305]: Soliciting pool server 80.151.186.5
31 Oct 14:37:23 ntpd[18305]: Soliciting pool server
2604:ed40:1000:1711:d862:f5ff:fe4e:41c4
31 Oct 14:37:28 ntpd[18305]: ntpd: time slew -0.000453 s
ntpd: time slew -0.000453s
```

The [pool.ntp.org](https://pool.ntp.org) domain is a virtual cluster of time servers providing NTP service to systems across the globe.

## Service chronyd

chrony lends itself to working well in environments with intermittent network connectivity, such as on a laptop or virtual system that may be created through an automated process. Chrony is a set of programs that are used to ensure that the clock on a system is accurate.

The daemon portion of chrony is the command chronyd. The daemon synchronizes the system with time retrieved from NTP servers. Along with synchronizing time on the system it is running, chronyd can also operate as an NTP server providing time service to other systems that are allowed network access.

- chronyd (daemon)
  - chronyc (client)
  - /etc/chrony.conf
- 
- chronyc sources
  - chronyc activity
  - chronyc tracking
  - chronyc settime

```
#17
# chronyc
accheck          cmdallow      exit          maxdelaydevratio  offline      reselect      smoothing
waitsync         cmddeny       help          maxdelayratio     online       reselectdist  smoothtime
writertc         cyclelogs     keygen        maxpoll           onoffline    retries        sources
allow            delete        local         maxupdateskew     polltarget   rtcddata      sourcestats
burst            deny          makestep      minpoll           quit         serverstats   timeout
clients          dns           manual        minstratum        refresh      settime       tracking
cmdaccheck       dump          maxdelay      ntpdata           rekey        shutdown      trimrtc
```

```
#18
# chronyc tracking
Reference ID      : D95B2C11 (www.kashra.com)
Stratum          : 3
Ref time (UTC)    : Sun Oct 31 13:45:41 2021
System time      : 0.001218522 seconds slow of NTP time
Last offset      : -0.001224374 seconds
RMS offset       : 0.000762375 seconds
Frequency        : 3.952 ppm slow
Residual freq    : -0.048 ppm
Skew             : 0.422 ppm
Root delay       : 0.047982555 seconds
Root dispersion  : 0.003313234 seconds
Update interval  : 385.7 seconds
Leap status      : Normal

# chronyc activity
200 OK
4 sources online
0 sources offline
0 sources doing burst (return to online)
0 sources doing burst (return to offline)
0 sources with unknown address

# chronyc sources
210 Number of sources = 4
MS Name/IP address      Stratum Poll Reach LastRx Last sample
=====
^- tick.chil.ntfo.org    3    9   377    50  -1291us[-1408us] +/-  126ms
^- ntp5.doctor.com       2    8   377   234   +786us[-512us] +/-   83ms
^* www.kashra.com        2    7   373    47  -1144us[-1261us] +/-   24ms
^+ clock.nyc.he.net      1    9   377   242   +309us[-986us] +/-   47ms
```

```
#19
systemctl status chronyd
• chronyd.service - NTP client/server
   Loaded: loaded (/usr/lib/systemd/system/chronyd.service; enabled; vendor preset:
   enabled)
   Active: active (running) since Sun 2021-10-31 12:45:43 CET; 2h 3min ago
```

```

Docs: man:chronyd(8)
      man:chrony.conf(5)
Main PID: 844 (chronyd)
Tasks: 1 (limit: 8916)
Memory: 1.6M
CPU: 103ms
CGroup: /system.slice/chronyd.service
        └─844 /usr/sbin/chronyd

Oct 31 12:45:56 localhost.localdomain chronyd[844]: System clock TAI offset set to 37
seconds
Jan 25 12:05:51 localhost.localdomain chronyd[844]: Forward time jump detected!
Jan 25 12:05:51 localhost.localdomain chronyd[844]: Can't synchronise: no selectable
sources
Oct 31 12:48:32 localhost.localdomain chronyd[844]: Backward time jump detected!
Oct 31 13:50:42 localhost.localdomain chronyd[844]: Forward time jump detected!
Oct 31 13:52:51 localhost.localdomain chronyd[844]: Selected source 204.93.207.12
Oct 31 13:52:54 localhost.localdomain chronyd[844]: Selected source 50.205.244.24
Oct 31 13:53:58 localhost.localdomain chronyd[844]: Source 38.229.59.9 replaced with
217.91.44.17
Oct 31 13:55:03 localhost.localdomain chronyd[844]: Selected source 209.51.161.238
Oct 31 14:01:32 localhost.localdomain chronyd[844]: Selected source 217.91.44.17

```

```

#20
# head -n20 /etc/chrony.conf
# Use public servers from the pool.ntp.org project.
# Please consider joining the pool (http://www.pool.ntp.org/join.html).
pool 2.fedora.pool.ntp.org iburst

# Record the rate at which the system clock gains/losses time.
driftfile /var/lib/chrony/drift

# Allow the system clock to be stepped in the first three updates
# if its offset is larger than 1 second.
makestep 1.0 3

# Enable kernel synchronization of the real-time clock (RTC).
rtcsync

# Enable hardware timestamping on all interfaces that support it.
#hwtimestamp *

# Increase the minimum number of selectable sources required to adjust
# the system clock.
#minsources 2

```

Some definitions:

provider

A computer that will share network time with you

stratum

Distance from a reference clock, in hops or steps

offset

Difference between system time and network time

jitter

Difference between system time and network time since the last NTP poll

pol

Group of servers that provide network time and share the load between them

## Example Exercises

### [ Software clock]

1. Show the date and time.
2. Show the Date in the format YYYY-MM-DD HH:mm
3. Set the software clock to the date 06-06-2022.
4. Set the system clock (increment) two month and four days from now.
5. Decrement the system clock 60 days.
6. Copy the hardware clock to the system clock.

### [Hardware clock]

7. Show the RTC or hardware clock.
8. Set the hardware clock to 25-12-2022.
9. Copy the system clock to the hardware clock

### [timedatectl]

10. Show the timedatectl information.
11. Show the timedatectl status.
12. Answer the following questions:
  - a. Is the local time and UTC time the same?
  - b. Is the RTC in local time?
  - c. Is the NTP active and synchronized?
  - d. Which is the time zone?
  - e. Is your time zone using daylight saving?
13. List the time zones
14. Change your time zone to Europe/Andorra

### [NTP / chrony]

15. Show the chronyc activity.
16. Show the chronyc sources
17. Show the chronyc tracking

18. Realitza els exercicis indicats a: [108.1 Maintain system time](#)
19. Realitza els exercicis del Question-Topics 108.1.