Version : **2021.01**

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LCE502 - Package Management

Contents

- ld-linux.so.2
  - The ldd Command
  - The /etc/ld.so.conf File
  - The ldconfig Command

LAB #1 - Compiling Software

In order to learn how to compile software, download the hello-2.1.1.tar.gz archive:

```
[root@centos8 ~]# wget https://ftp.gnu.org/gnu/hello/hello-2.1.1.tar.gz
--2021-04-20 16:56:18--  https://ftp.gnu.org/gnu/hello/hello-2.1.1.tar.gz
Resolving ftp.gnu.org (ftp.gnu.org)... 209.51.188.20, 2001:470:142:3::b
Connecting to ftp.gnu.org (ftp.gnu.org)|209.51.188.20|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 389363 (380K) [application/x-gzip]
Saving to: 'hello-2.1.1.tar.gz'

hello-2.1.1.tar.gz
100%[=================================================================================================
============================>] 380.24K   941KB/s    in 0.4s

2021-04-20 16:56:19 (941 KB/s) - 'hello-2.1.1.tar.gz' saved [389363/389363]
```

Extract the archive:

```
[root@centos8 ~]# tar xvf hello-2.1.1.tar.gz
hello-2.1.1/
hello-2.1.1/intl/
hello-2.1.1/intl/ChangeLog
hello-2.1.1/intl/Makefile.in
hello-2.1.1/intl/config.charset
hello-2.1.1/intl/locale.alias
```

```
hello-2.1.1/intl/ref-add.sin
hello-2.1.1/intl/ref-del.sin
hello-2.1.1/intl/gmo.h
hello-2.1.1/intl/gettextP.h
hello-2.1.1/intl/hash-string.h
hello-2.1.1/intl/plural-exp.h
hello-2.1.1/intl/eval-plural.h
hello-2.1.1/intl/os2compat.h
hello-2.1.1/intl/libgnuintl.h
hello-2.1.1/intl/loadinfo.h
hello-2.1.1/intl/bindtextdom.c
hello-2.1.1/intl/dcgettext.c
hello-2.1.1/intl/dgettext.c
hello-2.1.1/intl/gettext.c
hello-2.1.1/intl/finddomain.c
hello-2.1.1/intl/loadmsgcat.c
hello-2.1.1/intl/localealias.c
hello-2.1.1/intl/textdomain.c
hello-2.1.1/intl/l10nflist.c
hello-2.1.1/intl/explodename.c
hello-2.1.1/intl/dcigettext.c
hello-2.1.1/intl/dcngettext.c
hello-2.1.1/intl/dngettext.c
hello-2.1.1/intl/ngettext.c
hello-2.1.1/intl/plural.y
hello-2.1.1/intl/plural-exp.c
hello-2.1.1/intl/localcharset.c
hello-2.1.1/intl/localename.c
hello-2.1.1/intl/osdep.c
hello-2.1.1/intl/os2compat.c
hello-2.1.1/intl/intl-compat.c
hello-2.1.1/intl/plural.c
hello-2.1.1/intl/VERSION
hello-2.1.1/po/
```

```
hello-2.1.1/po/Makefile.in.in
hello-2.1.1/po/Makevars
hello-2.1.1/po/remove-potcdate.sin
hello-2.1.1/po/quot.sed
hello-2.1.1/po/boldquot.sed
hello-2.1.1/po/en@quot.header
hello-2.1.1/po/en@boldquot.header
hello-2.1.1/po/insert-header.sin
hello-2.1.1/po/Rules-quot
hello-2.1.1/po/POTFILES.in
hello-2.1.1/po/hello.pot
hello-2.1.1/po/ca.po
hello-2.1.1/po/da.po
hello-2.1.1/po/de.po
hello-2.1.1/po/de_DE.po
hello-2.1.1/po/el.po
hello-2.1.1/po/eo.po
hello-2.1.1/po/es.po
hello-2.1.1/po/et.po
hello-2.1.1/po/fi.po
hello-2.1.1/po/fr.po
hello-2.1.1/po/gl.po
hello-2.1.1/po/he.po
hello-2.1.1/po/hr.po
hello-2.1.1/po/hu.po
hello-2.1.1/po/id.po
hello-2.1.1/po/it.po
hello-2.1.1/po/ja.po
hello-2.1.1/po/ko.po
hello-2.1.1/po/lv.po
hello-2.1.1/po/nb.po
hello-2.1.1/po/nl.po
hello-2.1.1/po/nn.po
hello-2.1.1/po/pl.po
```

```
hello-2.1.1/po/pt.po
hello-2.1.1/po/pt_BR.po
hello-2.1.1/po/ru.po
hello-2.1.1/po/sk.po
hello-2.1.1/po/sl.po
hello-2.1.1/po/sv.po
hello-2.1.1/po/tr.po
hello-2.1.1/po/uk.po
hello-2.1.1/po/ca.gmo
hello-2.1.1/po/da.gmo
hello-2.1.1/po/de.gmo
hello-2.1.1/po/de_DE.gmo
hello-2.1.1/po/el.gmo
hello-2.1.1/po/eo.gmo
hello-2.1.1/po/es.gmo
hello-2.1.1/po/et.gmo
hello-2.1.1/po/fi.gmo
hello-2.1.1/po/fr.gmo
hello-2.1.1/po/gl.gmo
hello-2.1.1/po/he.gmo
hello-2.1.1/po/hr.gmo
hello-2.1.1/po/hu.gmo
hello-2.1.1/po/id.gmo
hello-2.1.1/po/it.gmo
hello-2.1.1/po/ja.gmo
hello-2.1.1/po/ko.gmo
hello-2.1.1/po/lv.gmo
hello-2.1.1/po/nb.gmo
hello-2.1.1/po/nl.gmo
hello-2.1.1/po/nn.gmo
hello-2.1.1/po/pl.gmo
hello-2.1.1/po/pt.gmo
hello-2.1.1/po/pt_BR.gmo
hello-2.1.1/po/ru.gmo
```

```
hello-2.1.1/po/sk.gmo
hello-2.1.1/po/sl.gmo
hello-2.1.1/po/sv.gmo
hello-2.1.1/po/tr.gmo
hello-2.1.1/po/uk.gmo
hello-2.1.1/po/ChangeLog
hello-2.1.1/po/LINGUAS
hello-2.1.1/README
hello-2.1.1/ABOUT-NLS
hello-2.1.1/AUTHORS
hello-2.1.1/COPYING
hello-2.1.1/ChangeLog
hello-2.1.1/INSTALL
hello-2.1.1/Makefile.am
hello-2.1.1/Makefile.in
hello-2.1.1/NEWS
hello-2.1.1/THANKS
hello-2.1.1/TODO
hello-2.1.1/aclocal.m4
hello-2.1.1/config.guess
hello-2.1.1/config.h.in
hello-2.1.1/config.rpath
hello-2.1.1/config.sub
hello-2.1.1/configure
hello-2.1.1/configure.ac
hello-2.1.1/depcomp
hello-2.1.1/install-sh
hello-2.1.1/missing
hello-2.1.1/mkinstalldirs
hello-2.1.1/BUGS
hello-2.1.1/ChangeLog.O
hello-2.1.1/contrib/
hello-2.1.1/contrib/ChangeLog
hello-2.1.1/contrib/Makefile.am
```

```
hello-2.1.1/contrib/Makefile.in
hello-2.1.1/contrib/de_franconian_po.txt
hello-2.1.1/contrib/evolution.txt
hello-2.1.1/contrib/hello.1
hello-2.1.1/doc/
hello-2.1.1/doc/gpl.texi
hello-2.1.1/doc/ChangeLog
hello-2.1.1/doc/Makefile.am
hello-2.1.1/doc/Makefile.in
hello-2.1.1/doc/mdate-sh
hello-2.1.1/doc/stamp-vti
hello-2.1.1/doc/texinfo.tex
hello-2.1.1/doc/version.texi
hello-2.1.1/doc/hello.texi
hello-2.1.1/doc/hello.info
hello-2.1.1/src/
hello-2.1.1/src/ChangeLog
hello-2.1.1/src/Makefile.am
hello-2.1.1/src/Makefile.in
hello-2.1.1/src/alloca.c
hello-2.1.1/src/hello.c
hello-2.1.1/src/version.c
hello-2.1.1/src/getopt.c
hello-2.1.1/src/getopt1.c
hello-2.1.1/src/getopt.h
hello-2.1.1/src/system.h
hello-2.1.1/man/
hello-2.1.1/man/ChangeLog
hello-2.1.1/man/Makefile.am
hello-2.1.1/man/Makefile.in
hello-2.1.1/man/hello.1
hello-2.1.1/man/help2man
hello-2.1.1/m4/
hello-2.1.1/m4/README
```

```
hello-2.1.1/m4/ChangeLog
hello-2.1.1/m4/Makefile.am
hello-2.1.1/m4/Makefile.in
hello-2.1.1/m4/codeset.m4
hello-2.1.1/m4/gettext.m4
hello-2.1.1/m4/glibc21.m4
hello-2.1.1/m4/iconv.m4
hello-2.1.1/m4/isc-posix.m4
hello-2.1.1/m4/lcmessage.m4
hello-2.1.1/m4/lib-ld.m4
hello-2.1.1/m4/lib-link.m4
hello-2.1.1/m4/lib-prefix.m4
hello-2.1.1/m4/progtest.m4
hello-2.1.1/tests/
hello-2.1.1/tests/ChangeLog
hello-2.1.1/tests/Makefile.am
hello-2.1.1/tests/Makefile.in
hello-2.1.1/tests/hello-1
hello-2.1.1/tests/world-1
hello-2.1.1/tests/nothing-1
```

Change directory:

```
[root@centos8 ~]# cd hello-2.1.1/
```

The first file we need to look at is the README file. This file tells us to look at the **INSTALL** file:

```
[root@centos8 hello-2.1.1]# more INSTALL
Copyright 1994, 1995, 1996, 1999, 2000, 2001 Free Software Foundation,
Inc.

   This file is free documentation; the Free Software Foundation gives
unlimited permission to copy, distribute and modify it.
```

```
Basic Installation
==================

   These are generic installation instructions.

   The `configure' shell script attempts to guess correct values for
various system-dependent variables used during compilation.  It uses
those values to create a `Makefile' in each directory of the package.
It may also create one or more `.h' files containing system-dependent
definitions.  Finally, it creates a shell script `config.status' that
you can run in the future to recreate the current configuration, and a
file `config.log' containing compiler output (useful mainly for
debugging `configure').

   It can also use an optional file (typically called `config.cache'
and enabled with `--cache-file=config.cache' or simply `-C') that saves
the results of its tests to speed up reconfiguring.  (Caching is
disabled by default to prevent problems with accidental use of stale
cache files.)
--Plus--(11%)
```

Reading this file tells us that we need to use four commands:

- ./configure,
- make,
- make check,
- make install.

1.1 - ./configure

⚠️ **Important** : **configure** is a script that creates *makefiles* for a specific architecture. *makefiles* are read by the **make** command.

```
[root@centos8 hello-2.1.1]# ./configure
checking for a BSD-compatible install... /bin/install -c
checking whether build environment is sane... yes
checking for gawk... gawk
checking whether make sets ${MAKE}... yes
checking for gcc... gcc
checking for C compiler default output... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for style of include used by make... GNU
checking dependency style of gcc... gcc3
checking for strerror in -lcposix... no
checking how to run the C preprocessor... gcc -E
checking for ANSI C header files... yes
checking for sys/types.h... yes
checking for sys/stat.h... yes
checking for stdlib.h... yes
checking for string.h... yes
checking for memory.h... yes
checking for strings.h... yes
checking for inttypes.h... yes
checking for stdint.h... yes
checking for unistd.h... yes
checking for string.h... (cached) yes
checking fcntl.h usability... yes
checking fcntl.h presence... yes
checking for fcntl.h... yes
checking sys/file.h usability... yes
checking sys/file.h presence... yes
checking for sys/file.h... yes
```

```
checking sys/param.h usability... yes
checking sys/param.h presence... yes
checking for sys/param.h... yes
checking for working alloca.h... yes
checking for alloca... yes
checking for struct stat.st_blksize... yes
checking for msgfmt... /bin/msgfmt
checking for gmsgfmt... /bin/msgfmt
checking for xgettext... /bin/xgettext
checking for msgmerge... /bin/msgmerge
checking build system type... x86_64-unknown-linux
checking host system type... x86_64-unknown-linux
checking for ranlib... ranlib
checking for gcc option to accept ANSI C... none needed
checking for an ANSI C-conforming const... yes
checking for inline... inline
checking for off_t... yes
checking for size_t... yes
checking for stdlib.h... (cached) yes
checking for unistd.h... (cached) yes
checking for getpagesize... yes
checking for working mmap... yes
checking whether we are using the GNU C Library 2.1 or newer... yes
checking for ld used by GCC... /bin/ld
checking if the linker (/bin/ld) is GNU ld... yes
checking for shared library run path origin... done
checking for iconv... yes
checking argz.h usability... yes
checking argz.h presence... yes
checking for argz.h... yes
checking limits.h usability... yes
checking limits.h presence... yes
checking for limits.h... yes
checking locale.h usability... yes
```

```
checking locale.h presence... yes
checking for locale.h... yes
checking nl_types.h usability... yes
checking nl_types.h presence... yes
checking for nl_types.h... yes
checking malloc.h usability... yes
checking malloc.h presence... yes
checking for malloc.h... yes
checking stddef.h usability... yes
checking stddef.h presence... yes
checking for stddef.h... yes
checking for stdlib.h... (cached) yes
checking for string.h... (cached) yes
checking for unistd.h... (cached) yes
checking for sys/param.h... (cached) yes
checking for feof_unlocked... yes
checking for fgets_unlocked... yes
checking for getc_unlocked... yes
checking for getcwd... yes
checking for getegid... yes
checking for geteuid... yes
checking for getgid... yes
checking for getuid... yes
checking for mempcpy... yes
checking for munmap... yes
checking for putenv... yes
checking for setenv... yes
checking for setlocale... yes
checking for stpcpy... yes
checking for strcasecmp... yes
checking for strdup... yes
checking for strtoul... yes
checking for tsearch... yes
checking for __argz_count... yes
```

```
checking for __argz_stringify... yes
checking for __argz_next... yes
checking for iconv declaration...
        extern size_t iconv (iconv_t cd, char * *inbuf, size_t *inbytesleft, char * *outbuf, size_t
*outbytesleft);
checking for nl_langinfo and CODESET... yes
checking for LC_MESSAGES... yes
checking for bison... no
checking whether NLS is requested... yes
checking whether included gettext is requested... no
checking for GNU gettext in libc... yes
checking for perl... perl
configure: creating ./config.status
config.status: creating Makefile
config.status: creating contrib/Makefile
config.status: creating doc/Makefile
config.status: creating intl/Makefile
config.status: creating man/Makefile
config.status: creating po/Makefile.in
config.status: creating m4/Makefile
config.status: creating src/Makefile
config.status: creating tests/Makefile
config.status: creating config.h
config.status: executing depfiles commands
config.status: executing default-1 commands
config.status: creating po/POTFILES
config.status: creating po/Makefile
config.status: executing default commands
```

1.2 - make

> ⚠ **Important** : **make** calls the different commands that are used to create all

> ⚠ the necessary files needed to install hello.

```
[root@centos8 hello-2.1.1]# make
make  all-recursive
make[1]: Entering directory `/root/hello-2.1.1'
Making all in contrib
make[2]: Entering directory `/root/hello-2.1.1/contrib'
make[2]: Nothing to be done for `all'.
make[2]: Leaving directory `/root/hello-2.1.1/contrib'
Making all in doc
make[2]: Entering directory `/root/hello-2.1.1/doc'
make[2]: Nothing to be done for `all'.
make[2]: Leaving directory `/root/hello-2.1.1/doc'
Making all in intl
make[2]: Entering directory `/root/hello-2.1.1/intl'
make[2]: Nothing to be done for `all'.
make[2]: Leaving directory `/root/hello-2.1.1/intl'
Making all in po
make[2]: Entering directory `/root/hello-2.1.1/po'
make[2]: Nothing to be done for `all'.
make[2]: Leaving directory `/root/hello-2.1.1/po'
Making all in src
make[2]: Entering directory `/root/hello-2.1.1/src'
source='hello.c' object='hello.o' libtool=no \
depfile='.deps/hello.Po' tmpdepfile='.deps/hello.TPo' \
depmode=gcc3 /bin/sh ../depcomp \
gcc -DLOCALEDIR=\"/usr/local/share/locale\" -DHAVE_CONFIG_H -I. -I. -I.. -I. -I. -I.. -I../intl -I../intl    -g -
O2 -c `test -f 'hello.c' || echo './'`hello.c
source='version.c' object='version.o' libtool=no \
depfile='.deps/version.Po' tmpdepfile='.deps/version.TPo' \
depmode=gcc3 /bin/sh ../depcomp \
gcc -DLOCALEDIR=\"/usr/local/share/locale\" -DHAVE_CONFIG_H -I. -I. -I.. -I. -I. -I.. -I../intl -I../intl    -g -
```

```
O2 -c `test -f 'version.c' || echo './'`version.c
source='getopt.c' object='getopt.o' libtool=no \
depfile='.deps/getopt.Po' tmpdepfile='.deps/getopt.TPo' \
depmode=gcc3 /bin/sh ../depcomp \
gcc -DLOCALEDIR=\"/usr/local/share/locale\" -DHAVE_CONFIG_H -I. -I. -I.. -I. -I. -I.. -I../intl -I../intl    -g -
O2 -c `test -f 'getopt.c' || echo './'`getopt.c
source='getopt1.c' object='getopt1.o' libtool=no \
depfile='.deps/getopt1.Po' tmpdepfile='.deps/getopt1.TPo' \
depmode=gcc3 /bin/sh ../depcomp \
gcc -DLOCALEDIR=\"/usr/local/share/locale\" -DHAVE_CONFIG_H -I. -I. -I.. -I. -I. -I.. -I../intl -I../intl    -g -
O2 -c `test -f 'getopt1.c' || echo './'`getopt1.c
gcc  -g -O2   -o hello  hello.o version.o getopt.o getopt1.o
make[2]: Leaving directory `/root/hello-2.1.1/src'
Making all in man
make[2]: Entering directory `/root/hello-2.1.1/man'
perl help2man --name="Friendly Greeting Program" ../src/hello >hello.1
make[2]: Leaving directory `/root/hello-2.1.1/man'
Making all in m4
make[2]: Entering directory `/root/hello-2.1.1/m4'
make[2]: Nothing to be done for `all'.
make[2]: Leaving directory `/root/hello-2.1.1/m4'
Making all in tests
make[2]: Entering directory `/root/hello-2.1.1/tests'
make[2]: Nothing to be done for `all'.
make[2]: Leaving directory `/root/hello-2.1.1/tests'
make[2]: Entering directory `/root/hello-2.1.1'
make[2]: Leaving directory `/root/hello-2.1.1'
make[1]: Leaving directory `/root/hello-2.1.1'
```

1.3 - make check

⚠️ **Important** : **make check** checks whether the previous command worked

⚠ correctly..

```
[root@centos8 hello-2.1.1]# make check
Making check in contrib
make[1]: Entering directory `/root/hello-2.1.1/contrib'
make[1]: Nothing to be done for `check'.
make[1]: Leaving directory `/root/hello-2.1.1/contrib'
Making check in doc
make[1]: Entering directory `/root/hello-2.1.1/doc'
make[1]: Nothing to be done for `check'.
make[1]: Leaving directory `/root/hello-2.1.1/doc'
Making check in intl
make[1]: Entering directory `/root/hello-2.1.1/intl'
make[1]: Nothing to be done for `check'.
make[1]: Leaving directory `/root/hello-2.1.1/intl'
Making check in po
make[1]: Entering directory `/root/hello-2.1.1/po'
make[1]: Nothing to be done for `check'.
make[1]: Leaving directory `/root/hello-2.1.1/po'
Making check in src
make[1]: Entering directory `/root/hello-2.1.1/src'
make[1]: Nothing to be done for `check'.
make[1]: Leaving directory `/root/hello-2.1.1/src'
Making check in man
make[1]: Entering directory `/root/hello-2.1.1/man'
make[1]: Nothing to be done for `check'.
make[1]: Leaving directory `/root/hello-2.1.1/man'
Making check in m4
make[1]: Entering directory `/root/hello-2.1.1/m4'
make[1]: Nothing to be done for `check'.
make[1]: Leaving directory `/root/hello-2.1.1/m4'
Making check in tests
```

```
make[1]: Entering directory `/root/hello-2.1.1/tests'
make  check-TESTS
make[2]: Entering directory `/root/hello-2.1.1/tests'
PASS: hello-1
PASS: world-1
PASS: nothing-1
=================
All 3 tests passed
=================
make[2]: Leaving directory `/root/hello-2.1.1/tests'
make[1]: Leaving directory `/root/hello-2.1.1/tests'
make[1]: Entering directory `/root/hello-2.1.1'
make[1]: Leaving directory `/root/hello-2.1.1'
```

1.4 - make install

> ⚠️ **Important** : **make install** installs the software.

```
[root@centos8 hello-2.1.1]# make install
Making install in contrib
make[1]: Entering directory `/root/hello-2.1.1/contrib'
make[2]: Entering directory `/root/hello-2.1.1/contrib'
make[2]: Nothing to be done for `install-exec-am'.
make[2]: Nothing to be done for `install-data-am'.
make[2]: Leaving directory `/root/hello-2.1.1/contrib'
make[1]: Leaving directory `/root/hello-2.1.1/contrib'
Making install in doc
make[1]: Entering directory `/root/hello-2.1.1/doc'
make[2]: Entering directory `/root/hello-2.1.1/doc'
make[2]: Nothing to be done for `install-exec-am'.
```

```
/bin/sh ../mkinstalldirs /usr/local/info
mkdir -p -- /usr/local/info
 /bin/install -c -m 644 ./hello.info /usr/local/info/hello.info
 install-info --info-dir=/usr/local/info /usr/local/info/hello.info
make[2]: Leaving directory `/root/hello-2.1.1/doc'
make[1]: Leaving directory `/root/hello-2.1.1/doc'
Making install in intl
make[1]: Entering directory `/root/hello-2.1.1/intl'
if test "hello" = "gettext" \
   && test '' = 'intl-compat.o'; then \
  /bin/sh `case "./mkinstalldirs" in /*) echo "./mkinstalldirs" ;; *) echo "../../mkinstalldirs" ;; esac`
/usr/local/lib /usr/local/include; \
  /bin/install -c -m 644 libintl.h /usr/local/include/libintl.h; \
  @LIBTOOL@ --mode=install \
    /bin/install -c -m 644 libintl.a /usr/local/lib/libintl.a; \
else \
  : ; \
fi
if test 'no' = yes; then \
  test yes != no || /bin/sh `case "./mkinstalldirs" in /*) echo "./mkinstalldirs" ;; *) echo "../../mkinstalldirs"
;; esac` /usr/local/lib; \
  temp=/usr/local/lib/t-charset.alias; \
  dest=/usr/local/lib/charset.alias; \
  if test -f /usr/local/lib/charset.alias; then \
    orig=/usr/local/lib/charset.alias; \
    sed -f ref-add.sed $orig > $temp; \
    /bin/install -c -m 644 $temp $dest; \
    rm -f $temp; \
  else \
    if test yes = no; then \
      orig=charset.alias; \
      sed -f ref-add.sed $orig > $temp; \
      /bin/install -c -m 644 $temp $dest; \
      rm -f $temp; \
```

```
    fi; \
  fi; \
  /bin/sh `case "./mkinstalldirs" in /*) echo "./mkinstalldirs" ;; *) echo "../.
/mkinstalldirs" ;; esac`
/usr/local/share/locale; \
  test -f /usr/local/share/locale/locale.alias \
    && orig=/usr/local/share/locale/locale.alias \
    || orig=./locale.alias; \
  temp=/usr/local/share/locale/t-locale.alias; \
  dest=/usr/local/share/locale/locale.alias; \
  sed -f ref-add.sed $orig > $temp; \
  /bin/install -c -m 644 $temp $dest; \
  rm -f $temp; \
else \
  : ; \
fi
if test "hello" = "gettext"; then \
  /bin/sh `case "./mkinstalldirs" in /*) echo "./mkinstalldirs" ;; *) echo "../.
/mkinstalldirs" ;; esac`
/usr/local/share/gettext/intl; \
  /bin/install -c -m 644 VERSION /usr/local/share/gettext/intl/VERSION; \
  /bin/install -c -m 644 ChangeLog.inst /usr/local/share/gettext/intl/ChangeLog; \
  dists="COPYING.LIB-2.0 COPYING.LIB-2.1 Makefile.in config.charset locale.alias ref-add.sin ref-del.sin gmo.h
gettextP.h hash-string.h plural-exp.h eval-plural.h os2compat.h libgnuintl.h loadinfo.h bindtextdom.c dcgettext.c
dgettext.c gettext.c finddomain.c loadmsgcat.c localealias.c textdomain.c l10nflist.c explodename.c dcigettext.c
dcngettext.c dngettext.c ngettext.c plural.y plural-exp.c localcharset.c localename.c osdep.c os2compat.c intl-
compat.c"; \
  for file in $dists; do \
    /bin/install -c -m 644 ./$file \
          /usr/local/share/gettext/intl/$file; \
  done; \
  chmod a+x /usr/local/share/gettext/intl/config.charset; \
  dists="plural.c"; \
  for file in $dists; do \
    if test -f $file; then dir=.; else dir=.; fi; \
    /bin/install -c -m 644 $dir/$file \
```

```
              /usr/local/share/gettext/intl/$file; \
  done; \
  dists="xopen-msg.sed linux-msg.sed po2tbl.sed.in cat-compat.c COPYING.LIB-2 gettext.h libgettext.h plural-
eval.c"; \
  for file in $dists; do \
    rm -f /usr/local/share/gettext/intl/$file; \
  done; \
else \
  : ; \
fi
make[1]: Leaving directory `/root/hello-2.1.1/intl'
Making install in po
make[1]: Entering directory `/root/hello-2.1.1/po'
/bin/sh `case "./mkinstalldirs" in /*) echo "./mkinstalldirs" ;; *) echo "../././mkinstalldirs" ;; esac`
/usr/local/share
mkdir -p -- /usr/local/share/locale/ca/LC_MESSAGES
installing ca.gmo as /usr/local/share/locale/ca/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/da/LC_MESSAGES
installing da.gmo as /usr/local/share/locale/da/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/de/LC_MESSAGES
installing de.gmo as /usr/local/share/locale/de/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/de_DE/LC_MESSAGES
installing de_DE.gmo as /usr/local/share/locale/de_DE/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/el/LC_MESSAGES
installing el.gmo as /usr/local/share/locale/el/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/eo/LC_MESSAGES
installing eo.gmo as /usr/local/share/locale/eo/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/es/LC_MESSAGES
installing es.gmo as /usr/local/share/locale/es/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/et/LC_MESSAGES
installing et.gmo as /usr/local/share/locale/et/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/fi/LC_MESSAGES
installing fi.gmo as /usr/local/share/locale/fi/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/fr/LC_MESSAGES
```

```
installing fr.gmo as /usr/local/share/locale/fr/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/gl/LC_MESSAGES
installing gl.gmo as /usr/local/share/locale/gl/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/he/LC_MESSAGES
installing he.gmo as /usr/local/share/locale/he/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/hr/LC_MESSAGES
installing hr.gmo as /usr/local/share/locale/hr/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/hu/LC_MESSAGES
installing hu.gmo as /usr/local/share/locale/hu/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/id/LC_MESSAGES
installing id.gmo as /usr/local/share/locale/id/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/it/LC_MESSAGES
installing it.gmo as /usr/local/share/locale/it/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/ja/LC_MESSAGES
installing ja.gmo as /usr/local/share/locale/ja/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/ko/LC_MESSAGES
installing ko.gmo as /usr/local/share/locale/ko/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/lv/LC_MESSAGES
installing lv.gmo as /usr/local/share/locale/lv/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/nb/LC_MESSAGES
installing nb.gmo as /usr/local/share/locale/nb/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/nl/LC_MESSAGES
installing nl.gmo as /usr/local/share/locale/nl/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/nn/LC_MESSAGES
installing nn.gmo as /usr/local/share/locale/nn/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/pl/LC_MESSAGES
installing pl.gmo as /usr/local/share/locale/pl/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/pt/LC_MESSAGES
installing pt.gmo as /usr/local/share/locale/pt/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/pt_BR/LC_MESSAGES
installing pt_BR.gmo as /usr/local/share/locale/pt_BR/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/ru/LC_MESSAGES
installing ru.gmo as /usr/local/share/locale/ru/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/sk/LC_MESSAGES
```

```
installing sk.gmo as /usr/local/share/locale/sk/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/sl/LC_MESSAGES
installing sl.gmo as /usr/local/share/locale/sl/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/sv/LC_MESSAGES
installing sv.gmo as /usr/local/share/locale/sv/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/tr/LC_MESSAGES
installing tr.gmo as /usr/local/share/locale/tr/LC_MESSAGES/hello.mo
mkdir -p -- /usr/local/share/locale/uk/LC_MESSAGES
installing uk.gmo as /usr/local/share/locale/uk/LC_MESSAGES/hello.mo
if test "hello" = "gettext"; then \
  /bin/sh `case "./mkinstalldirs" in /*) echo "./mkinstalldirs" ;; *) echo "../../mkinstalldirs" ;; esac`
/usr/local/share/gettext/po; \
  for file in Makefile.in.in Makevars remove-potcdate.sin quot.sed boldquot.sed en@quot.header en@boldquot.header
insert-header.sin Rules-quot  ; do \
    /bin/install -c -m 644 ./$file \
           /usr/local/share/gettext/po/$file; \
  done; \
else \
  : ; \
fi
make[1]: Leaving directory `/root/hello-2.1.1/po'
Making install in src
make[1]: Entering directory `/root/hello-2.1.1/src'
make[2]: Entering directory `/root/hello-2.1.1/src'
/bin/sh ../mkinstalldirs /usr/local/bin
  /bin/install -c hello /usr/local/bin/hello
make[2]: Nothing to be done for `install-data-am'.
make[2]: Leaving directory `/root/hello-2.1.1/src'
make[1]: Leaving directory `/root/hello-2.1.1/src'
Making install in man
make[1]: Entering directory `/root/hello-2.1.1/man'
make[2]: Entering directory `/root/hello-2.1.1/man'
make[2]: Nothing to be done for `install-exec-am'.
/bin/sh ../mkinstalldirs /usr/local/man/man1
```

```
mkdir -p -- /usr/local/man/man1
 /bin/install -c -m 644 ./hello.1 /usr/local/man/man1/hello.1
make[2]: Leaving directory `/root/hello-2.1.1/man'
make[1]: Leaving directory `/root/hello-2.1.1/man'
Making install in m4
make[1]: Entering directory `/root/hello-2.1.1/m4'
make[2]: Entering directory `/root/hello-2.1.1/m4'
make[2]: Nothing to be done for `install-exec-am'.
make[2]: Nothing to be done for `install-data-am'.
make[2]: Leaving directory `/root/hello-2.1.1/m4'
make[1]: Leaving directory `/root/hello-2.1.1/m4'
Making install in tests
make[1]: Entering directory `/root/hello-2.1.1/tests'
make[2]: Entering directory `/root/hello-2.1.1/tests'
make[2]: Nothing to be done for `install-exec-am'.
make[2]: Nothing to be done for `install-data-am'.
make[2]: Leaving directory `/root/hello-2.1.1/tests'
make[1]: Leaving directory `/root/hello-2.1.1/tests'
make[1]: Entering directory `/root/hello-2.1.1'
make[2]: Entering directory `/root/hello-2.1.1'
make[2]: Nothing to be done for `install-exec-am'.
make[2]: Nothing to be done for `install-data-am'.
make[2]: Leaving directory `/root/hello-2.1.1'
make[1]: Leaving directory `/root/hello-2.1.1'
```

Now we can test our newly install software:

```
[root@centos8 hello-2.1.1]# hello
Hello, world!
```

All that work for just one line!

LAB #2 - The rpm Command

In order to ease the burden of installing, uninstalling and managing software, called packages, CentOS and Red Hat use a special file format called rpm for **Redhat Package Manager**. The command used to manage packages is also called **rpm**.

The command line switches of the rpm command are as follows:

```
[root@centos8 hello-2.1.1]# cd ~
[root@centos8 ~]# rpm --help
Usage: rpm [OPTION...]

Query/Verify package selection options:
  -a, --all                             query/verify all packages
  -f, --file                            query/verify package(s) owning file
  -g, --group                           query/verify package(s) in group
  -p, --package                         query/verify a package file
      --pkgid                           query/verify package(s) with package identifier
      --hdrid                           query/verify package(s) with header identifier
      --triggeredby                     query the package(s) triggered by the package
      --whatconflicts                   query/verify the package(s) which require a dependency
      --whatrequires                    query/verify the package(s) which require a dependency
      --whatobsoletes                   query/verify the package(s) which obsolete a dependency
      --whatprovides                    query/verify the package(s) which provide a dependency
      --whatrecommends                  query/verify the package(s) which recommends a dependency
      --whatsuggests                    query/verify the package(s) which suggests a dependency
      --whatsupplements                 query/verify the package(s) which supplements a dependency
      --whatenhances                    query/verify the package(s) which enhances a dependency
      --nomanifest                      do not process non-package files as manifests

Query options (with -q or --query):
  -c, --configfiles                     list all configuration files
  -d, --docfiles                        list all documentation files
  -L, --licensefiles                    list all license files
```

```
    -A, --artifactfiles                list all artifact files
        --dump                         dump basic file information
    -l, --list                         list files in package
        --queryformat=QUERYFORMAT      use the following query format
    -s, --state                        display the states of the listed files


Verify options (with -V or --verify):
        --nofiledigest                 don't verify digest of files
        --nofiles                      don't verify files in package
        --nodeps                       don't verify package dependencies
        --noscript                     don't execute verify script(s)


Install/Upgrade/Erase options:
        --allfiles                     install all files, even configurations which might otherwise be skipped
        --allmatches                   remove all packages which match <package> (normally an error is generated if
<package> specified multiple packages)
        --badreloc                     relocate files in non-relocatable package
    -e, --erase=<package>+             erase (uninstall) package
        --excludedocs                  do not install documentation
        --excludepath=<path>           skip files with leading component <path>
        --force                        short hand for --replacepkgs --replacefiles
    -F, --freshen=<packagefile>+       upgrade package(s) if already installed
    -h, --hash                         print hash marks as package installs (good with -v)
        --ignorearch                   don't verify package architecture
        --ignoreos                     don't verify package operating system
        --ignoresize                   don't check disk space before installing
        --noverify                     short hand for --ignorepayload --ignoresignature
    -i, --install                      install package(s)
        --justdb                       update the database, but do not modify the filesystem
        --nodeps                       do not verify package dependencies
        --nofiledigest                 don't verify digest of files
        --nocontexts                   don't install file security contexts
        --nocaps                       don't install file capabilities
        --noorder                      do not reorder package installation to satisfy dependencies
```

```
      --noscripts                       do not execute package scriptlet(s)
      --notriggers                      do not execute any scriptlet(s) triggered by this package
      --oldpackage                      upgrade to an old version of the package (--force on upgrades does this
automatically)
      --percent                         print percentages as package installs
      --prefix=<dir>                    relocate the package to <dir>, if relocatable
      --relocate=<old>=<new>            relocate files from path <old> to <new>
      --replacefiles                    ignore file conflicts between packages
      --replacepkgs                     reinstall if the package is already present
      --test                            don't install, but tell if it would work or not
  -U, --upgrade=<packagefile>+          upgrade package(s)
      --reinstall=<packagefile>+        reinstall package(s)

Common options for all rpm modes and executables:
  -D, --define='MACRO EXPR'             define MACRO with value EXPR
      --undefine=MACRO                  undefine MACRO
  -E, --eval='EXPR'                     print macro expansion of EXPR
      --target=CPU-VENDOR-OS            Specify target platform
      --macros=<FILE:...>               read <FILE:...> instead of default file(s)
      --noplugins                       don't enable any plugins
      --nodigest                        don't verify package digest(s)
      --nosignature                     don't verify package signature(s)
      --rcfile=<FILE:...>               read <FILE:...> instead of default file(s)
  -r, --root=ROOT                       use ROOT as top level directory (default: "/")
      --dbpath=DIRECTORY                use database in DIRECTORY
      --querytags                       display known query tags
      --showrc                          display final rpmrc and macro configuration
      --quiet                           provide less detailed output
  -v, --verbose                         provide more detailed output
      --version                         print the version of rpm being used

Options implemented via popt alias/exec:
      --scripts                         list install/erase scriptlets from package(s)
      --setperms                        set permissions of files in a package
```

```
        --setugids                      set user/group ownership of files in a package
        --setcaps                       set capabilities of files in a package
        --restore                       restore file/directory permissions
        --conflicts                     list capabilities this package conflicts with
        --obsoletes                     list other packages removed by installing this package
        --provides                      list capabilities that this package provides
        --requires                      list capabilities required by package(s)
        --recommends                    list capabilities recommended by package(s)
        --suggests                      list capabilities suggested by package(s)
        --supplements                   list capabilities supplemented by package(s)
        --enhances                      list capabilities enhanced by package(s)
        --info                          list descriptive information from package(s)
        --changelog                     list change logs for this package
        --changes                       list changes for this package with full time stamps
        --xml                           list metadata in xml
        --triggers                      list trigger scriptlets from package(s)
        --filetriggers                  list filetrigger scriptlets from package(s)
        --last                          list package(s) by install time, most recent first
        --dupes                         list duplicated packages
        --filesbypkg                    list all files from each package
        --fileclass                     list file names with their classes
        --filecolor                     list file names with their colors
        --fileprovide                   list file names with their provides
        --filerequire                   list file names with requires
        --filecaps                      list file names with their POSIX1.e capabilities


Help options:
  -?, --help                            Show this help message
        --usage                         Display brief usage message
```

2.1 - Configuration

The file used to configure the construction of an rpm is **/usr/lib/rpm/rpmrc** :

_____

```
[root@centos8 ~]# more /usr/lib/rpm/rpmrc
#/*! \page config_rpmrc Default configuration: /usr/lib/rpm/rpmrc
# \verbatim
#
# This is a global RPM configuration file. All changes made here will
# be lost when the rpm package is upgraded. Any per-system configuration
# should be added to /etc/rpmrc, while per-user configuration should
# be added to ~/.rpmrc.
#
######################################################################
# Values for RPM_OPT_FLAGS for various platforms

# "fat" binary with both archs, for Darwin
optflags: fat -O2 -g -arch i386 -arch ppc

optflags: i386 -O2 -g -march=i386 -mtune=i686
optflags: i486 -O2 -g -march=i486
optflags: i586 -O2 -g -march=i586
optflags: i686 -O2 -g -march=i686
optflags: pentium3 -O2 -g -march=pentium3
optflags: pentium4 -O2 -g -march=pentium4
optflags: athlon -O2 -g -march=athlon
optflags: geode -Os -g -m32 -march=geode
optflags: ia64 -O2 -g
optflags: x86_64 -O2 -g
optflags: amd64 -O2 -g
optflags: ia32e -O2 -g

optflags: alpha -O2 -g -mieee
optflags: alphaev5 -O2 -g -mieee -mtune=ev5
optflags: alphaev56 -O2 -g -mieee -mtune=ev56
optflags: alphapca56 -O2 -g -mieee -mtune=pca56
optflags: alphaev6 -O2 -g -mieee -mtune=ev6
optflags: alphaev67 -O2 -g -mieee -mtune=ev67
```

```
optflags: sparc -O2 -g -m32 -mtune=ultrasparc
optflags: sparcv8 -O2 -g -m32 -mtune=ultrasparc -mv8
optflags: sparcv9 -O2 -g -m32 -mtune=ultrasparc
optflags: sparcv9v -O2 -g -m32 -mtune=niagara
optflags: sparc64 -O2 -g -m64 -mtune=ultrasparc
optflags: sparc64v -O2 -g -m64 -mtune=niagara

optflags: m68k -O2 -g -fomit-frame-pointer

optflags: ppc -O2 -g
optflags: ppc8260 -O2 -g
optflags: ppc8560 -O2 -g
optflags: ppc32dy4 -O2 -g
optflags: ppciseries -O2 -g
optflags: ppcpseries -O2 -g
optflags: ppc64 -O2 -g
optflags: ppc64le -O2 -g
optflags: ppc64p7 -O3 -mtune=power7 -mcpu=power7 -g

optflags: parisc -O2 -g -mpa-risc-1-0
optflags: hppa1.0 -O2 -g -mpa-risc-1-0
optflags: hppa1.1 -O2 -g -mpa-risc-1-0
optflags: hppa1.2 -O2 -g -mpa-risc-1-0
--More--(11%)
```

These directives indicate how to optimise the construction of an rpm based upon the architecture of the processor as returned by the **uname -p** command. For example, **buildarchtranslate: athlon: i386** means that the processus should use the **i386** optimisations when building a src.rpm for the **athlon** architecture. Any changes made to the configuration should be put into the **/etc/rpmrc** or **~/.rpmrc** files.

2.2 - Usage

To view a list of the packages installed on the machine, use the following command:

_____

```
[root@centos8 ~]# rpm -qa | more
dracut-squash-049-95.git20200804.el8_3.4.x86_64
gnutls-dane-3.6.14-8.el8_3.x86_64
mtr-0.92-3.el8.x86_64
fontpackages-filesystem-1.44-22.el8.noarch
dhcp-libs-4.3.6-41.el8.x86_64
alsa-lib-1.2.3.2-1.el8.x86_64
geolite2-city-20180605-1.el8.noarch
cockpit-ws-224.2-1.el8.x86_64
python3-dbus-1.2.4-15.el8.x86_64
libvirt-daemon-config-network-6.0.0-28.1.module_el8.3.0+755+88436ea4.x86_64
samba-client-libs-4.12.3-12.el8.3.x86_64
libICE-1.0.9-15.el8.x86_64
bind-license-9.11.20-5.el8_3.1.noarch
dnf-4.2.23-4.el8.noarch
at-spi2-core-2.28.0-1.el8.x86_64
libssh-config-0.9.4-2.el8.noarch
bzip2-libs-1.0.6-26.el8.x86_64
python3-syspurpose-1.27.16-1.el8.x86_64
perl-Unicode-Normalize-1.25-396.el8.x86_64
centos-linux-release-8.3-1.2011.el8.noarch
sssd-krb5-2.3.0-9.el8.x86_64
perl-MIME-Base64-3.15-396.el8.x86_64
glibc-langpack-en-2.28-127.el8.x86_64
libcollection-0.7.0-39.el8.x86_64
vim-filesystem-8.0.1763-15.el8.noarch
perl-Sys-Virt-6.0.0-1.module_el8.3.0+555+a55c8938.x86_64
elfutils-libelf-0.180-1.el8.x86_64
vim-enhanced-8.0.1763-15.el8.x86_64
kernel-modules-4.18.0-147.8.1.el8_1.x86_64
perl-Encode-2.97-3.el8.x86_64
audit-libs-3.0-0.17.20191104git1c2f876.el8.x86_64
grub2-pc-2.02-90.el8_3.1.x86_64
perl-libnet-3.11-3.el8.noarch
```

```
--More--
```

You can also use the rpm command to find out how many packages are installed:

```
[root@centos8 ~]# rpm -qa | wc -l
802
```

To search for a specific package, you need to pipe the result into grep:

```
[root@centos8 ~]# rpm -qa | grep setup
platform-python-setuptools-39.2.0-6.el8.noarch
python3-setuptools-wheel-39.2.0-6.el8.noarch
setup-2.12.2-6.el8.noarch
cryptsetup-libs-2.3.3-2.el8.x86_64
cryptsetup-2.3.3-2.el8.x86_64
```

You can find out the details of a specific package such as **setup-2.8.71-4.el7.noarch** by using the following command:

```
[root@centos8 ~]# rpm -qi setup
Name        : setup
Version     : 2.12.2
Release     : 6.el8
Architecture: noarch
Install Date: Mon 19 Apr 2021 11:50:02 AM EDT
Group       : System Environment/Base
Size        : 724837
License     : Public Domain
Signature   : RSA/SHA256, Fri 15 May 2020 01:23:16 AM EDT, Key ID 05b555b38483c65d
Source RPM  : setup-2.12.2-6.el8.src.rpm
Build Date  : Fri 15 May 2020 01:20:15 AM EDT
Build Host  : aarch64-02.mbox.centos.org
Relocations : (not relocatable)
Packager    : CentOS Buildsys <bugs@centos.org>
Vendor      : CentOS
```

```
URL          : https://pagure.io/setup/
Summary      : A set of system configuration and setup files
Description :
The setup package contains a set of important system configuration and
setup files, such as passwd, group, and profile.
```

Using the **l** switch with rpm gives a list of all the files installed by a specific package:

```
[root@centos8 ~]# rpm -ql setup
/etc/aliases
/etc/bashrc
/etc/csh.cshrc
/etc/csh.login
/etc/dnf/protected.d/setup.conf
/etc/environment
/etc/ethertypes
/etc/exports
/etc/filesystems
/etc/fstab
/etc/group
/etc/gshadow
/etc/host.conf
/etc/hosts
/etc/inputrc
/etc/motd
/etc/networks
/etc/passwd
/etc/printcap
/etc/profile
/etc/profile.d
/etc/profile.d/csh.local
/etc/profile.d/lang.csh
/etc/profile.d/lang.sh
/etc/profile.d/sh.local
```

```
/etc/protocols
/etc/services
/etc/shadow
/etc/shells
/etc/subgid
/etc/subuid
/usr/share/doc/setup
/usr/share/doc/setup/uidgid
/usr/share/licenses/setup
/usr/share/licenses/setup/COPYING
/var/log/lastlog
```

whilst using the **f** switch shows the package that installed a specific file:

```
[root@centos8 ~]# rpm -qf /etc/exports
setup-2.12.2-6.el8.noarch
```

Using the **V** switch you can check what has changed since a package was first installed:

```
[root@centos8 ~]# rpm -qV setup
.M....G..  g /var/log/lastlog
```

In the case where the command returns nothing, nothing has changed. If something has changed you would see a line per file with the following keywords:

Keyword	Description
5	MD5 Control
S	File size
L	Symbolic link
T	Modification date
D	Peripheral
U	Owner changed
G	Group changed

Keyword	Description
M	Permissions changed
?	Unreadable file
Missing	File removed

> ⚠️ **Important** : An rpm package is a modified cpio file. To extract the contents, use the following command **rpm2cpio package.src.rpm | cpio -i –make-directories**

LAB #3 - The dnf Command

3.1 - Presentation

dnf is an abbreviation of **Dandified YUM**. Previously, both RHEL and CentOS used **Y**ellow dog **U**pdater, **M**odified (Yum) for package management. In RHEL/CentOS 8, the yum command has been replaced by **dnf-3** :

```
[root@centos8 ~]# ls -l /usr/bin/dnf-3
-rwxr-xr-x. 1 root root 1954 Aug  4  2020 /usr/bin/dnf-3
[root@centos8 ~]# ls -l /usr/bin/yum
lrwxrwxrwx. 1 root root 5 Aug  4  2020 /usr/bin/yum -> dnf-3
[root@centos8 ~]# ls -l /usr/bin/dnf
lrwxrwxrwx. 1 root root 5 Aug  4  2020 /usr/bin/dnf -> dnf-3
```

The dnf command improves the yum command by adding:

- a faster dependency résolution whilst using less memory,
- a compatibility with both Python 2 and Python 3.

Note that :

- dnf's usage is very similar to that of yum,
- both commands can co-exist on the same system.

The command takes the following form:

```
# dnf <options> <command> <package(s)> [Enter]
```

The switches and commands specific to dnf are shown below:

```
[root@centos8 ~]# dnf --help
usage: dnf [options] COMMAND

List of Main Commands:

alias                   List or create command aliases
autoremove              remove all unneeded packages that were originally installed as dependencies
check                   check for problems in the packagedb
check-update            check for available package upgrades
clean                   remove cached data
deplist                 List package's dependencies and what packages provide them
distro-sync             synchronize installed packages to the latest available versions
downgrade               Downgrade a package
group                   display, or use, the groups information
help                    display a helpful usage message
history                 display, or use, the transaction history
info                    display details about a package or group of packages
install                 install a package or packages on your system
list                    list a package or groups of packages
makecache               generate the metadata cache
mark                    mark or unmark installed packages as installed by user.
module                  Interact with Modules.
provides                find what package provides the given value
reinstall               reinstall a package
remove                  remove a package or packages from your system
```

```
repolist                    display the configured software repositories
repoquery                   search for packages matching keyword
repository-packages         run commands on top of all packages in given repository
search                      search package details for the given string
shell                       run an interactive DNF shell
swap                        run an interactive DNF mod for remove and install one spec
updateinfo                  display advisories about packages
upgrade                     upgrade a package or packages on your system
upgrade-minimal             upgrade, but only 'newest' package match which fixes a problem that affects your system

List of Plugin Commands:

builddep                    Install build dependencies for package or spec file
changelog                   Show changelog data of packages
config-manager              manage dnf configuration options and repositories
copr                        Interact with Copr repositories.
debug-dump                  dump information about installed rpm packages to file
debug-restore               restore packages recorded in debug-dump file
debuginfo-install           install debuginfo packages
download                    Download package to current directory
needs-restarting            determine updated binaries that need restarting
playground                  Interact with Playground repository.
repoclosure                 Display a list of unresolved dependencies for repositories
repodiff                    List differences between two sets of repositories
repograph                   Output a full package dependency graph in dot format
repomanage                  Manage a directory of rpm packages
reposync                    download all packages from remote repo

General DNF options:
  -c [config file], --config [config file]
                       config file location
  -q, --quiet          quiet operation
  -v, --verbose        verbose operation
  --version            show DNF version and exit
```

```
--installroot [path]  set install root
--nodocs              do not install documentations
--noplugins           disable all plugins
--enableplugin [plugin]
                      enable plugins by name
--disableplugin [plugin]
                      disable plugins by name
--releasever RELEASEVER
                      override the value of $releasever in config and repo
                      files
--setopt SETOPTS      set arbitrary config and repo options
--skip-broken         resolve depsolve problems by skipping packages
-h, --help, --help-cmd
                      show command help
--allowerasing        allow erasing of installed packages to resolve
                      dependencies
-b, --best            try the best available package versions in
                      transactions.
--nobest              do not limit the transaction to the best candidate
-C, --cacheonly       run entirely from system cache, don't update cache
-R [minutes], --randomwait [minutes]
                      maximum command wait time
-d [debug level], --debuglevel [debug level]
                      debugging output level
--debugsolver         dumps detailed solving results into files
--showduplicates      show duplicates, in repos, in list/search commands
-e ERRORLEVEL, --errorlevel ERRORLEVEL
                      error output level
--obsoletes           enables dnf's obsoletes processing logic for upgrade
                      or display capabilities that the package obsoletes for
                      info, list and repoquery
--rpmverbosity [debug level name]
                      debugging output level for rpm
-y, --assumeyes       automatically answer yes for all questions
```

```
--assumeno             automatically answer no for all questions
--enablerepo [repo]    Enable additional repositories. List option. Supports
                       globs, can be specified multiple times.
--disablerepo [repo]   Disable repositories. List option. Supports globs, can
                       be specified multiple times.
--repo [repo], --repoid [repo]
                       enable just specific repositories by an id or a glob,
                       can be specified multiple times
--enable               enable repos with config-manager command
                       (automatically saves)
--disable              disable repos with config-manager command
                       (automatically saves)
-x [package], --exclude [package], --excludepkgs [package]
                       exclude packages by name or glob
--disableexcludes [repo], --disableexcludepkgs [repo]
                       disable excludepkgs
--repofrompath [repo,path]
                       label and path to an additional repository to use
                       (same path as in a baseurl), can be specified multiple
                       times.
--noautoremove         disable removal of dependencies that are no longer
                       used
--nogpgcheck           disable gpg signature checking (if RPM policy allows)
--color COLOR          control whether color is used
--refresh              set metadata as expired before running the command
-4                     resolve to IPv4 addresses only
-6                     resolve to IPv6 addresses only
--destdir DESTDIR, --downloaddir DESTDIR
                       set directory to copy packages to
--downloadonly         only download packages
--comment COMMENT      add a comment to transaction
--bugfix               Include bugfix relevant packages, in updates
--enhancement          Include enhancement relevant packages, in updates
--newpackage           Include newpackage relevant packages, in updates
```

```
  --security           Include security relevant packages, in updates
  --advisory ADVISORY, --advisories ADVISORY
                       Include packages needed to fix the given advisory, in
                       updates
  --bz BUGZILLA, --bzs BUGZILLA
                       Include packages needed to fix the given BZ, in
                       updates
  --cve CVES, --cves CVES
                       Include packages needed to fix the given CVE, in
                       updates
  --sec-severity {Critical,Important,Moderate,Low}, --secseverity {Critical,Important,Moderate,Low}
                       Include security relevant packages matching the
                       severity, in updates
  --forcearch ARCH     Force the use of an architecture
```

3.2 - Configuration

dnf's principal configuration file is **/etc/dnf/dnf.conf** :

```
[root@centos8 ~]# cat /etc/dnf/dnf.conf
[main]
gpgcheck=1
installonly_limit=3
clean_requirements_on_remove=True
best=True
skip_if_unavailable=False
```

Further configuration files can be found in the **/etc/dnf** directory:

```
[root@centos8 ~]# ls -l  /etc/dnf
total 4
drwxr-xr-x. 2 root root   6 Aug  4  2020 aliases.d
-rw-r--r--. 1 root root 108 Jun  2  2020 dnf.conf
```

```
drwxr-xr-x. 2 root root 168 Apr 19 12:13 modules.d
drwxr-xr-x. 2 root root   6 Aug  4  2020 modules.defaults.d
drwxr-xr-x. 3 root root  89 Aug  4  2020 plugins
drwxr-xr-x. 2 root root  93 Apr 19 11:52 protected.d
drwxr-xr-x. 2 root root  37 Aug  4  2020 vars
```

3.3 - Repositories

⚠ **Important** : A repository is generally an Internet based database containing pre-compiled, installable packages.

Repositories are defined in files located in the **/etc/yum.repos.d** directory:

```
[root@centos8 ~]# ls /etc/yum.repos.d/
CentOS-Linux-AppStream.repo         CentOS-Linux-Plus.repo
CentOS-Linux-BaseOS.repo            CentOS-Linux-PowerTools.repo
CentOS-Linux-ContinuousRelease.repo  CentOS-Linux-Sources.repo
CentOS-Linux-Debuginfo.repo         epel-modular.repo
CentOS-Linux-Devel.repo             epel-playground.repo
CentOS-Linux-Extras.repo            epel.repo
CentOS-Linux-FastTrack.repo         epel-testing-modular.repo
CentOS-Linux-HighAvailability.repo  epel-testing.repo
CentOS-Linux-Media.repo
```

For example :

```
[root@centos8 ~]# cat /etc/yum.repos.d/CentOS-Linux-BaseOS.repo
# CentOS-Linux-BaseOS.repo
#
# The mirrorlist system uses the connecting IP address of the client and the
```

```
# update status of each mirror to pick current mirrors that are geographically
# close to the client.  You should use this for CentOS updates unless you are
# manually picking other mirrors.
#
# If the mirrorlist does not work for you, you can try the commented out
# baseurl line instead.

[baseos]
name=CentOS Linux $releasever - BaseOS
mirrorlist=http://mirrorlist.centos.org/?release=$releasever&arch=$basearch&repo=BaseOS&infra=$infra
#baseurl=http://mirror.centos.org/$contentdir/$releasever/BaseOS/$basearch/os/
gpgcheck=1
enabled=1
gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-centosofficial
```

To see a list of all the dnf repositories for a system including their status, use the dnf command **repolist all**:

```
[root@centos8 ~]# dnf repolist all
repo id                      repo name                                                        status
appstream                    CentOS Linux 8 - AppStream                                       enabled
appstream-source             CentOS Linux 8 - AppStream - Source                              disabled
baseos                       CentOS Linux 8 - BaseOS                                          enabled
baseos-source                CentOS Linux 8 - BaseOS - Source                                 disabled
cr                           CentOS Linux 8 - ContinuousRelease                               disabled
debuginfo                    CentOS Linux 8 - Debuginfo                                       disabled
devel                        CentOS Linux 8 - Devel WARNING! FOR BUILDROOT USE ONLY!          disabled
epel                         Extra Packages for Enterprise Linux 8 - x86_64                   enabled
epel-debuginfo               Extra Packages for Enterprise Linux 8 - x86_64 - Debug           disabled
epel-modular                 Extra Packages for Enterprise Linux Modular 8 - x86_64           enabled
epel-modular-debuginfo       Extra Packages for Enterprise Linux Modular 8 - x86_64 - Debug   disabled
epel-modular-source          Extra Packages for Enterprise Linux Modular 8 - x86_64 - Source  disabled
epel-playground              Extra Packages for Enterprise Linux 8 - Playground - x86_64      disabled
epel-playground-debuginfo    Extra Packages for Enterprise Linux 8 - Playground - x86_64 - Debug   disabled
epel-playground-source       Extra Packages for Enterprise Linux 8 - Playground - x86_64 - Source  disabled
```

```
epel-source                     Extra Packages for Enterprise Linux 8 - x86_64 - Source        disabled
epel-testing                    Extra Packages for Enterprise Linux 8 - Testing - x86_64       disabled
epel-testing-debuginfo          Extra Packages for Enterprise Linux 8 - Testing - x86_64 - Debug    disabled
epel-testing-modular            Extra Packages for Enterprise Linux Modular 8 - Testing - x86_64    disabled
epel-testing-modular-debuginfo Extra Packages for Enterprise Linux Modular 8 - Testing - x86_64 - De disabled
epel-testing-modular-source     Extra Packages for Enterprise Linux Modular 8 - Testing - x86_64 - So disabled
epel-testing-source             Extra Packages for Enterprise Linux 8 - Testing - x86_64 - Source    disabled
extras                          CentOS Linux 8 - Extras                                        enabled
extras-source                   CentOS Linux 8 - Extras - Source                               disabled
fasttrack                       CentOS Linux 8 - FastTrack                                     disabled
ha                              CentOS Linux 8 - HighAvailability                              disabled
media-appstream                 CentOS Linux 8 - Media - AppStream                             disabled
media-baseos                    CentOS Linux 8 - Media - BaseOS                                disabled
plus                            CentOS Linux 8 - Plus                                          disabled
plus-source                     CentOS Linux 8 - Plus - Source                                 disabled
powertools                      CentOS Linux 8 - PowerTools
```

To see a list of enabled dnf repositories for a system, use the dnf command **repolist**:

```
[root@centos8 ~]# dnf repolist
repo id                          repo name
appstream                        CentOS Linux 8 - AppStream
baseos                           CentOS Linux 8 - BaseOS
epel                             Extra Packages for Enterprise Linux 8 - x86_64
epel-modular                     Extra Packages for Enterprise Linux Modular 8 - x86_64
extras                           CentOS Linux 8 - Extras
```

3.4 - Searching for Packages

To list all installed and available packages, use the dnf command **list**:

```
[root@centos8 ~]# dnf list | more
Last metadata expiration check: 2:31:07 ago on Tue 20 Apr 2021 03:34:31 PM EDT.
```

```
Installed Packages
NetworkManager.x86_64                                            1:1.26.0-12.el8_3
        @BaseOS
NetworkManager-libnm.x86_64                                      1:1.26.0-12.el8_3
        @BaseOS
NetworkManager-team.x86_64                                       1:1.26.0-12.el8_3
        @BaseOS
NetworkManager-tui.x86_64                                        1:1.26.0-12.el8_3
        @BaseOS
PackageKit.x86_64                                                1.1.12-6.el8
        @AppStream
PackageKit-glib.x86_64                                           1.1.12-6.el8
        @AppStream
abattis-cantarell-fonts.noarch                                  0.0.25-4.el8
        @AppStream
acl.x86_64                                                       2.2.53-1.el8
        @BaseOS
adcli.x86_64                                                     0.8.2-7.el8
        @BaseOS
adwaita-cursor-theme.noarch                                     3.28.0-2.el8
        @appstream
adwaita-icon-theme.noarch                                       3.28.0-2.el8
        @appstream
alsa-lib.x86_64                                                  1.2.3.2-1.el8
        @appstream
at.x86_64                                                        3.1.20-11.el8
        @BaseOS
at-spi2-atk.x86_64                                               2.26.2-1.el8
        @appstream
at-spi2-core.x86_64                                              2.28.0-1.el8
        @appstream
atk.x86_64                                                       2.28.1-1.el8
--More--
```

To list only the installed packages, use the **installed** option:

```
[root@centos8 ~]# dnf list installed | more
Installed Packages
NetworkManager.x86_64                      1:1.26.0-12.el8_3
 @BaseOS
NetworkManager-libnm.x86_64                1:1.26.0-12.el8_3
 @BaseOS
NetworkManager-team.x86_64                 1:1.26.0-12.el8_3
 @BaseOS
NetworkManager-tui.x86_64                  1:1.26.0-12.el8_3
 @BaseOS
PackageKit.x86_64                          1.1.12-6.el8
 @AppStream
PackageKit-glib.x86_64                     1.1.12-6.el8
 @AppStream
abattis-cantarell-fonts.noarch             0.0.25-4.el8
 @AppStream
acl.x86_64                                 2.2.53-1.el8
 @BaseOS
adcli.x86_64                               0.8.2-7.el8
 @BaseOS
adwaita-cursor-theme.noarch                3.28.0-2.el8
 @appstream
adwaita-icon-theme.noarch                  3.28.0-2.el8
 @appstream
alsa-lib.x86_64                            1.2.3.2-1.el8
 @appstream
at.x86_64                                  3.1.20-11.el8
 @BaseOS
at-spi2-atk.x86_64                         2.26.2-1.el8
 @appstream
at-spi2-core.x86_64                        2.28.0-1.el8
 @appstream
```

```
atk.x86_64                                          2.28.1-1.el8
 @appstream
--More--
```

To list only the available packages, use the **available** option:

```
[root@centos8 ~]# dnf list available | more
Last metadata expiration check: 2:40:08 ago on Tue 20 Apr 2021 03:34:31 PM EDT.
Available Packages
3proxy.x86_64                                       0.8.13-1.el8
          epel
AusweisApp2.x86_64                                  1.20.2-10.el8
          epel
AusweisApp2-data.noarch                             1.20.2-10.el8
          epel
AusweisApp2-doc.noarch                              1.20.2-10.el8
          epel
BackupPC.x86_64                                     4.4.0-1.el8
          epel
BackupPC-XS.x86_64                                  0.62-1.el8
          epel
BibTool.x86_64                                      2.68-1.el8
          epel
CCfits.x86_64                                       2.5-14.el8
          epel
CCfits-devel.x86_64                                 2.5-14.el8
          epel
CCfits-doc.noarch                                   2.5-14.el8
          epel
CGSI-gSOAP.x86_64                                   1.3.11-7.el8
          epel
CGSI-gSOAP-devel.x86_64                             1.3.11-7.el8
          epel
CUnit.i686                                          2.1.3-17.el8
```

```
                appstream
CUnit.x86_64                                              2.1.3-17.el8
                appstream
CharLS.x86_64                                             2.0.0-6.el8
                epel
CharLS-devel.x86_64                                       2.0.0-6.el8
--More--
```

To search for a string in the name or the short description of a package, use the dnf command **search**:

```
[root@centos8 ~]# dnf search httpd
Last metadata expiration check: 2:41:18 ago on Tue 20 Apr 2021 03:34:31 PM EDT.
================================ Name Exactly Matched: httpd ================================
httpd.x86_64 : Apache HTTP Server
================================ Name & Summary Matched: httpd ================================
centos-logos-httpd.noarch : CentOS-related icons and pictures used by httpd
keycloak-httpd-client-install.noarch : Tools to configure Apache HTTPD as Keycloak client
lighttpd-fastcgi.x86_64 : FastCGI module and spawning helper for lighttpd and PHP configuration
lighttpd-filesystem.noarch : The basic directory layout for lighttpd
lighttpd-mod_authn_gssapi.x86_64 : Authentication module for lighttpd that uses GSSAPI
lighttpd-mod_authn_mysql.x86_64 : Authentication module for lighttpd that uses a MySQL database
lighttpd-mod_authn_pam.x86_64 : Authentication module for lighttpd that uses PAM
lighttpd-mod_mysql_vhost.x86_64 : Virtual host module for lighttpd that uses a MySQL database
pagure-web-apache-httpd.noarch : Apache HTTPD configuration for Pagure
python3-keycloak-httpd-client-install.noarch : Tools to configure Apache HTTPD as Keycloak
                                             : client
radicale3-httpd.noarch : httpd config for Radicale
================================ Name Matched: httpd ================================
httpd-devel.x86_64 : Development interfaces for the Apache HTTP server
httpd-filesystem.noarch : The basic directory layout for the Apache HTTP server
httpd-manual.noarch : Documentation for the Apache HTTP server
httpd-tools.x86_64 : Tools for use with the Apache HTTP Server
libmicrohttpd.i686 : Lightweight library for embedding a webserver in applications
libmicrohttpd.x86_64 : Lightweight library for embedding a webserver in applications
```

```
lighttpd.x86_64 : Lightning fast webserver with light system requirements
perl-Test-Fake-HTTPD.noarch : Fake HTTP server module for testing
sysusage-httpd.noarch : Apache configuration for sysusage
================================= Summary Matched: httpd ===================================
mod_auth_mellon.x86_64 : A SAML 2.0 authentication module for the Apache Httpd Server
mod_dav_svn.x86_64 : Apache httpd module for Subversion server
```

To search for a string only in the name of a package, use the dnf command **list**:

```
root@centos8 ~]# dnf list httpd
Last metadata expiration check: 0:08:16 ago on Wed 21 Apr 2021 12:54:45 AM EDT.
Available Packages
httpd.x86_64                         2.4.37-30.module_el8.3.0+561+97fdbbcc                         appstream
```

dnf also allows you to search for a specific binary by using the dnf **provides** command:

```
[root@centos8 ~]# dnf provides httpd
Last metadata expiration check: 0:03:35 ago on Wed 21 Apr 2021 12:54:45 AM EDT.
httpd-2.4.37-30.module_el8.3.0+561+97fdbbcc.x86_64 : Apache HTTP Server
Repo        : appstream
Matched from:
Provide     : httpd = 2.4.37-30.module_el8.3.0+561+97fdbbcc
```

You can also search using the * wildcard:

```
[root@centos8 ~]# dnf list kerne\*
Last metadata expiration check: 0:00:24 ago on Wed 21 Apr 2021 12:54:45 AM EDT.
Installed Packages
kernel.x86_64                         4.18.0-147.8.1.el8_1                         @BaseOS
kernel.x86_64                         4.18.0-240.22.1.el8_3                        @BaseOS
kernel-core.x86_64                    4.18.0-147.8.1.el8_1                         @BaseOS
kernel-core.x86_64                    4.18.0-240.22.1.el8_3                        @BaseOS
kernel-modules.x86_64                 4.18.0-147.8.1.el8_1                         @BaseOS
kernel-modules.x86_64                 4.18.0-240.22.1.el8_3                        @BaseOS
```

```
kernel-tools.x86_64                         4.18.0-240.22.1.el8_3            @BaseOS
kernel-tools-libs.x86_64                     4.18.0-240.22.1.el8_3            @BaseOS
Available Packages
kernel-abi-whitelists.noarch                 4.18.0-240.22.1.el8_3            baseos
kernel-cross-headers.x86_64                   4.18.0-240.22.1.el8_3            baseos
kernel-debug.x86_64                          4.18.0-240.22.1.el8_3            baseos
kernel-debug-core.x86_64                      4.18.0-240.22.1.el8_3            baseos
kernel-debug-devel.x86_64                     4.18.0-240.22.1.el8_3            baseos
kernel-debug-modules.x86_64                   4.18.0-240.22.1.el8_3            baseos
kernel-debug-modules-extra.x86_64             4.18.0-240.22.1.el8_3            baseos
kernel-devel.x86_64                          4.18.0-240.22.1.el8_3            baseos
kernel-doc.noarch                            4.18.0-240.22.1.el8_3            baseos
kernel-headers.x86_64                        4.18.0-240.22.1.el8_3            baseos
kernel-modules-extra.x86_64                   4.18.0-240.22.1.el8_3            baseos
kernel-rpm-macros.noarch                     123-1.el8                       appstream
kernelshark.x86_64                           2.7-8.el8                       appstream
```

To see a list of package groups, use the **grouplist** dnf command:

```
[root@centos8 ~]# dnf grouplist
Last metadata expiration check: 1:49:11 ago on Tue 20 Apr 2021 09:37:31 PM EDT.
Available Environment Groups:
   Server with GUI
   Server
   Workstation
   KDE Plasma Workspaces
   Virtualization Host
   Custom Operating System
Installed Environment Groups:
   Minimal Install
Available Groups:
   Container Management
   .NET Core Development
   RPM Development Tools
```

```
   Development Tools
   Graphical Administration Tools
   Headless Management
   Legacy UNIX Compatibility
   Network Servers
   Scientific Support
   Security Tools
   Smart Card Support
   System Tools
   Fedora Packager
   Xfce
```

3.5 - Viewing Information on and Downloading a Package

To view information on a particular package, use the **info** dnf command:

```
[root@centos8 ~]# dnf info httpd
Last metadata expiration check: 2:43:14 ago on Tue 20 Apr 2021 03:34:31 PM EDT.
Available Packages
Name         : httpd
Version      : 2.4.37
Release      : 30.module_el8.3.0+561+97fdbbcc
Architecture : x86_64
Size         : 1.7 M
Source       : httpd-2.4.37-30.module_el8.3.0+561+97fdbbcc.src.rpm
Repository   : appstream
Summary      : Apache HTTP Server
URL          : https://httpd.apache.org/
License      : ASL 2.0
Description  : The Apache HTTP Server is a powerful, efficient, and extensible
             : web server.
```

To download a package without installing it, the old **yumdownloader** command is replaced by the dnf command **download** :

```
[root@centos8 ~]# dnf download httpd
Last metadata expiration check: 2:46:56 ago on Tue 20 Apr 2021 03:34:31 PM EDT.
httpd-2.4.37-30.module_el8.3.0+561+97fdbbcc.x86_64.rpm          4.0 MB/s | 1.7 MB     00:00
```

The package is downloaded to the current working directory:

```
[root@centos8 ~]# updatedb
[root@centos8 ~]# locate httpd-2.4.37-30.
/root/httpd-2.4.37-30.module_el8.3.0+561+97fdbbcc.x86_64.rpm
```

3.6 - Installing a Package

To install a package, dnf provides the **install** command:

```
[root@centos8 ~]# dnf install httpd
Last metadata expiration check: 2:58:37 ago on Tue 20 Apr 2021 03:34:31 PM EDT.
Dependencies resolved.
================================================================================
 Package            Arch       Version                                Repository   Size
================================================================================
Installing:
 httpd              x86_64     2.4.37-30.module_el8.3.0+561+97fdbbcc   appstream    1.7 M
Installing dependencies:
 apr                x86_64     1.6.3-11.el8                            appstream    125 k
 apr-util           x86_64     1.6.1-6.el8                             appstream    105 k
 centos-logos-httpd noarch     80.5-2.el8                              baseos        24 k
 httpd-filesystem   noarch     2.4.37-30.module_el8.3.0+561+97fdbbcc   appstream     37 k
 httpd-tools        x86_64     2.4.37-30.module_el8.3.0+561+97fdbbcc   appstream    104 k
 mod_http2          x86_64     1.15.7-2.module_el8.3.0+477+498bb568    appstream    154 k
Installing weak dependencies:
 apr-util-bdb       x86_64     1.6.1-6.el8                             appstream     25 k
 apr-util-openssl   x86_64     1.6.1-6.el8                             appstream     27 k
```

```
Enabling module streams:
 httpd                             2.4

Transaction Summary
================================================================================
Install  9 Packages

Total download size: 2.3 M
Installed size: 6.0 M
Is this ok [y/N]: n
Operation aborted.
```

The **-y** switch of the dnf command automatically answers yes to dnf's questions:

```
[root@centos8 ~]# dnf install httpd -y
...
Installed:
  apr-1.6.3-11.el8.x86_64
  apr-util-1.6.1-6.el8.x86_64
  apr-util-bdb-1.6.1-6.el8.x86_64
  apr-util-openssl-1.6.1-6.el8.x86_64
  centos-logos-httpd-80.5-2.el8.noarch
  httpd-2.4.37-30.module_el8.3.0+561+97fdbbcc.x86_64
  httpd-filesystem-2.4.37-30.module_el8.3.0+561+97fdbbcc.noarch
  httpd-tools-2.4.37-30.module_el8.3.0+561+97fdbbcc.x86_64
  mod_http2-1.15.7-2.module_el8.3.0+477+498bb568.x86_64

Complete!
```

You can re-install a package using dnf's **reinstall** command:

```
[root@centos8 ~]# dnf reinstall httpd
Last metadata expiration check: 0:02:31 ago on Tue 20 Apr 2021 06:35:25 PM EDT.
Dependencies resolved.
```

```
==========================================================================
 Package        Architecture Version                                 Repository       Size
==========================================================================
Reinstalling:
 httpd          x86_64       2.4.37-30.module_el8.3.0+561+97fdbbcc   appstream      1.7 M

Transaction Summary
==========================================================================


Total download size: 1.7 M
Installed size: 4.9 M
Is this ok [y/N]: y
```

To installa package group, use dnf's **groupinstall** command:

```
[root@centos8 ~]# dnf groupinstall 'System Tools'
Last metadata expiration check: 1:51:28 ago on Tue 20 Apr 2021 09:37:31 PM EDT.
Dependencies resolved.
==========================================================================
 Package                    Architecture      Version              Repository         Size
==========================================================================
Installing group/module packages:
 NetworkManager-libreswan   x86_64            1.2.10-4.el8         appstream         120 k
 cifs-utils                 x86_64            6.8-3.el8            baseos             96 k
 libreswan                  x86_64            3.32-7.el8_3         appstream         1.4 M
 nmap                       x86_64            2:7.70-5.el8         appstream         5.8 M
 openldap-clients           x86_64            2.4.46-15.el8        baseos            202 k
 samba-client               x86_64            4.12.3-12.el8.3      baseos            692 k
 setserial                  x86_64            2.17-45.el8          baseos             32 k
 tigervnc                   x86_64            1.10.1-9.el8_3       appstream         290 k
 tmux                       x86_64            2.7-1.el8            baseos            317 k
 xdelta                     x86_64            3.1.0-4.el8          baseos             96 k
 zsh                        x86_64            5.5.1-6.el8_1.2      baseos            2.9 M
Installing dependencies:
```

```
 fltk                              x86_64              1.3.4-5.el8                appstream              590 k
 ldns                              x86_64              1.7.0-21.el8               appstream              166 k
 mesa-libGLU                       x86_64              9.0.0-15.el8               appstream              185 k
 nss-tools                         x86_64              3.53.1-17.el8_3            appstream              560 k
 tigervnc-icons                    noarch              1.10.1-9.el8_3             appstream               47 k
 tigervnc-license                  noarch              1.10.1-9.el8_3             appstream               38 k
Installing Groups:
 System Tools


Transaction Summary
================================================================================================
Install  17 Packages

Total download size: 13 M
Installed size: 47 M
Is this ok [y/N]: y
```

3.7 - Updating Packages

To check for package updates, use dnf's **check-update** command:

```
[root@centos8 ~]# dnf check-update
Last metadata expiration check: 1:38:50 ago on Tue 20 Apr 2021 09:37:31 PM EDT.

epel-release.noarch                      8-10.el8                      epel
procps-ng.x86_64                         3.3.15-3.el8_3.1              baseos
selinux-policy.noarch                    3.14.3-54.el8_3.4            baseos
selinux-policy-targeted.noarch           3.14.3-54.el8_3.4            baseos
```

To update packages, dnf has two commands **update** and **upgrade**. You can also specify a single package or a list of packages:

```
[root@centos8 ~]# dnf update epel-release.noarch
Last metadata expiration check: 1:43:33 ago on Tue 20 Apr 2021 09:37:31 PM EDT.
```

```
Dependencies resolved.
================================================================================
 Package                    Architecture        Version              Repository              Size
================================================================================
Upgrading:
 epel-release               noarch              8-10.el8             epel                    22 k

Transaction Summary
================================================================================
Upgrade  1 Package

Total download size: 22 k
Is this ok [y/N]: y
```

To update a package group, use dnf's **groupupdate** command:

```
[root@centos8 ~]# dnf groupupdate 'System Tools'
Last metadata expiration check: 1:55:43 ago on Tue 20 Apr 2021 09:37:31 PM EDT.
Dependencies resolved.
================================================================================
 Package                    Architecture        Version              Repository              Size
================================================================================
Installing Groups:
 System Tools

Transaction Summary
================================================================================

Is this ok [y/N]: y
Complete!
```

3.8 - Deleting Packages

To delete a package, use dnf's **remove** command:

```
[root@centos8 ~]# dnf remove httpd
Dependencies resolved.
================================================================================
 Package                 Architecture Version                                  Repository       Size
================================================================================
Removing:
 httpd                   x86_64       2.4.37-30.module_el8.3.0+561+97fdbbcc     @appstream       4.9 M
Removing unused dependencies:
 apr                     x86_64       1.6.3-11.el8                              @appstream       260 k
 apr-util                x86_64       1.6.1-6.el8                               @appstream       231 k
 apr-util-bdb            x86_64       1.6.1-6.el8                               @appstream        12 k
 apr-util-openssl        x86_64       1.6.1-6.el8                               @appstream        20 k
 centos-logos-httpd      noarch       80.5-2.el8                                @baseos          1.9 k
 httpd-filesystem        noarch       2.4.37-30.module_el8.3.0+561+97fdbbcc     @appstream       400
 httpd-tools             x86_64       2.4.37-30.module_el8.3.0+561+97fdbbcc     @appstream       195 k
 mod_http2               x86_64       1.15.7-2.module_el8.3.0+477+498bb568      @appstream       393 k

Transaction Summary
================================================================================
Remove  9 Packages

Freed space: 6.0 M
Is this ok [y/N]: y
```

To delete a package group, use dnf's **groupremove** command:

```
[root@centos8 ~]# dnf groupremove 'System Tools'
Dependencies resolved.
================================================================================
```

```
 Package                         Architecture     Version                  Repository          Size
 ================================================================================================
 Removing:
  NetworkManager-libreswan       x86_64           1.2.10-4.el8             @appstream          420 k
  cifs-utils                     x86_64           6.8-3.el8                @baseos             192 k
  libreswan                      x86_64           3.32-7.el8_3             @appstream          4.7 M
  nmap                           x86_64           2:7.70-5.el8             @appstream           24 M
  openldap-clients               x86_64           2.4.46-15.el8            @baseos             612 k
  samba-client                   x86_64           4.12.3-12.el8.3          @baseos             2.3 M
  setserial                      x86_64           2.17-45.el8              @baseos              37 k
  tigervnc                       x86_64           1.10.1-9.el8_3           @appstream          849 k
  tmux                           x86_64           2.7-1.el8                @baseos             781 k
  xdelta                         x86_64           3.1.0-4.el8              @baseos             184 k
  zsh                            x86_64           5.5.1-6.el8_1.2          @baseos             7.2 M
 Removing unused dependencies:
  fltk                           x86_64           1.3.4-5.el8              @appstream          2.8 M
  ldns                           x86_64           1.7.0-21.el8             @appstream          536 k
  mesa-libGLU                    x86_64           9.0.0-15.el8             @appstream          490 k
  nss-tools                      x86_64           3.53.1-17.el8_3          @appstream          2.2 M
  tigervnc-icons                 noarch           1.10.1-9.el8_3           @appstream           33 k
  tigervnc-license               noarch           1.10.1-9.el8_3           @appstream           18 k
 Removing Groups:
  System Tools


 Transaction Summary
 ================================================================================================
 Remove   17 Packages

 Freed space: 47 M
 Is this ok [y/N]: y
```

To delete unused dependencies left over from previous deletions, use dnf's **autoremove** command:

```
[root@centos8 ~]# dnf autoremove
```

```
Last metadata expiration check: 0:08:52 ago on Wed 21 Apr 2021 12:39:54 AM EDT.
Dependencies resolved.
================================================================================
 Package                  Architecture       Version                Repository            Size
================================================================================
Removing:
 fipscheck                x86_64             1.5.0-4.el8            @BaseOS               47 k
 fipscheck-lib            x86_64             1.5.0-4.el8            @BaseOS               12 k
 grub2-tools-efi          x86_64             1:2.02-90.el8_3.1      @BaseOS              2.0 M

Transaction Summary
================================================================================
Remove  3 Packages

Freed space: 2.1 M
Is this ok [y/N]: y
```

To empty the installed package cache, use dnf's **clean all** command:

```
[root@centos8 ~]# dnf clean all
58 files removed
```

Shared Libraries

Presentation

Introduction

Shared Libraries are bits of common code used by several programs in the same **domain** (sound, databases, video e.t.c.). The functions porposed by one or several shared libraries are refered to as an **API** (*Application Programming Interface*). Under Linux, shared libraries are refered to as ***Shared Objects*** and have a **.so** suffix.

Shared Object Locations

Shared Objects are stored in **lib** directories, for example:

Directory	Contents
/lib	System Shared Objects
/usr/lib	User Shared Objects
/usr/local/lib	Local Shared Objects
/usr/X11R6/lib	Graphical System Shared Objects
/opt/kde4/lib	Shared Objects for KDE

> ⚠ **Important** : The most important Shared Object is **libc**. Without libc, Linux will not function.

ld-linux.so.2

The Shared Object **ld-linux.so.2** is used to create a link between a Shared Object and an executable when the latter starts. For this reason, **ld-linux.so.2** is often refered to as the **Link Loader**. **ld-linux.so.2** looks for Shared Objects in the following places and in the order shown:

- in the paths specified by the **LD_LIBRARY_PATH** system variable,
- in the paths specified by the **/etc/ld.so.cache** cache file,
- in **/lib** and **/usr/lib**.

The contents of the cache file are built from the information contained within the **/etc/ld.so.conf** file.

In order to study the impact of a missing Shared Object, install **mc**:

```
[root@centos8 ~]# dnf install mc
Last metadata expiration check: 0:20:35 ago on Wed 21 Apr 2021 12:54:45 AM EDT.
Dependencies resolved.
```

```
=========================================================================
 Package              Architecture         Version                     Repository                  Size
=========================================================================
Installing:
 mc                   x86_64               1:4.8.19-9.el8               appstream                   1.9 M

Transaction Summary
=========================================================================
Install  1 Package

Total download size: 1.9 M
Installed size: 6.8 M
Is this ok [y/N]: y
```

The ldd Command

To determine which Shared Objects are linked to a binary, use the **ldd** command:

```
[root@centos8 ~]# ldd /usr/bin/mc
    linux-vdso.so.1 (0x00007fff39386000)
    libslang.so.2 => /lib64/libslang.so.2 (0x00007f0a74152000)
    libgpm.so.2 => /lib64/libgpm.so.2 (0x00007f0a73f4b000)
    libgmodule-2.0.so.0 => /lib64/libgmodule-2.0.so.0 (0x00007f0a73d47000)
    libglib-2.0.so.0 => /lib64/libglib-2.0.so.0 (0x00007f0a73a2e000)
    libpthread.so.0 => /lib64/libpthread.so.0 (0x00007f0a7380e000)
    libc.so.6 => /lib64/libc.so.6 (0x00007f0a7344b000)
    libdl.so.2 => /lib64/libdl.so.2 (0x00007f0a73247000)
    libm.so.6 => /lib64/libm.so.6 (0x00007f0a72ec5000)
    libncurses.so.6 => /lib64/libncurses.so.6 (0x00007f0a72c9a000)
    libtinfo.so.6 => /lib64/libtinfo.so.6 (0x00007f0a72a6d000)
    libgnutls.so.30 => /lib64/libgnutls.so.30 (0x00007f0a7267c000)
    libpcre.so.1 => /lib64/libpcre.so.1 (0x00007f0a7240b000)
    /lib64/ld-linux-x86-64.so.2 (0x00007f0a74994000)
```

```
    libp11-kit.so.0 => /lib64/libp11-kit.so.0 (0x00007f0a720d8000)
    libidn2.so.0 => /lib64/libidn2.so.0 (0x00007f0a71eba000)
    libunistring.so.2 => /lib64/libunistring.so.2 (0x00007f0a71b39000)
    libtasn1.so.6 => /lib64/libtasn1.so.6 (0x00007f0a71926000)
    libnettle.so.6 => /lib64/libnettle.so.6 (0x00007f0a716ec000)
    libhogweed.so.4 => /lib64/libhogweed.so.4 (0x00007f0a714bb000)
    libgmp.so.10 => /lib64/libgmp.so.10 (0x00007f0a71223000)
    libffi.so.6 => /lib64/libffi.so.6 (0x00007f0a7101a000)
```

Now let us see what happens when a Shared Object is missing. Rename the **/usr/lib/libslang.so.2** to **/usr/lib/libslang.so.2.old**:

```
[root@centos8 ~]# mv /lib64/libslang.so.2 /lib64/libslang.so.2.old
```

Run the ldd command again:

```
[root@centos8 ~]# ldd /usr/bin/mc
    linux-vdso.so.1 (0x00007fff669a6000)
    libslang.so.2 => not found
    libgpm.so.2 => /lib64/libgpm.so.2 (0x00007fc6ccba0000)
    libgmodule-2.0.so.0 => /lib64/libgmodule-2.0.so.0 (0x00007fc6cc99c000)
    libglib-2.0.so.0 => /lib64/libglib-2.0.so.0 (0x00007fc6cc683000)
    libpthread.so.0 => /lib64/libpthread.so.0 (0x00007fc6cc463000)
    libc.so.6 => /lib64/libc.so.6 (0x00007fc6cc0a0000)
    libncurses.so.6 => /lib64/libncurses.so.6 (0x00007fc6cbe75000)
    libtinfo.so.6 => /lib64/libtinfo.so.6 (0x00007fc6cbc48000)
    libdl.so.2 => /lib64/libdl.so.2 (0x00007fc6cba44000)
    libgnutls.so.30 => /lib64/libgnutls.so.30 (0x00007fc6cb653000)
    libpcre.so.1 => /lib64/libpcre.so.1 (0x00007fc6cb3e2000)
    /lib64/ld-linux-x86-64.so.2 (0x00007fc6cd112000)
    libp11-kit.so.0 => /lib64/libp11-kit.so.0 (0x00007fc6cb0af000)
    libidn2.so.0 => /lib64/libidn2.so.0 (0x00007fc6cae91000)
    libunistring.so.2 => /lib64/libunistring.so.2 (0x00007fc6cab10000)
    libtasn1.so.6 => /lib64/libtasn1.so.6 (0x00007fc6ca8fd000)
    libnettle.so.6 => /lib64/libnettle.so.6 (0x00007fc6ca6c3000)
```

```
    libhogweed.so.4 => /lib64/libhogweed.so.4 (0x00007fc6ca492000)
    libgmp.so.10 => /lib64/libgmp.so.10 (0x00007fc6ca1fa000)
    libffi.so.6 => /lib64/libffi.so.6 (0x00007fc6c9ff1000)
```

Note the presence of the line **libslang.so.2 ⇒ not found**. In such a scenario **mc** will not launch:

```
[root@centos8 ~]# mc
mc: error while loading shared libraries: libslang.so.2: cannot open shared object file: No such file or
directory
```

Correct the previous error and check that all is OK:

```
[root@centos8 ~]# mv /lib64/libslang.so.2.old /lib64/libslang.so.2
[root@centos8 ~]# ldd /usr/bin/mc
    linux-vdso.so.1 (0x00007fff4b8de000)
    libslang.so.2 => /lib64/libslang.so.2 (0x00007f670a991000)
    libgpm.so.2 => /lib64/libgpm.so.2 (0x00007f670a78a000)
    libgmodule-2.0.so.0 => /lib64/libgmodule-2.0.so.0 (0x00007f670a586000)
    libglib-2.0.so.0 => /lib64/libglib-2.0.so.0 (0x00007f670a26d000)
    libpthread.so.0 => /lib64/libpthread.so.0 (0x00007f670a04d000)
    libc.so.6 => /lib64/libc.so.6 (0x00007f6709c8a000)
    libdl.so.2 => /lib64/libdl.so.2 (0x00007f6709a86000)
    libm.so.6 => /lib64/libm.so.6 (0x00007f6709704000)
    libncurses.so.6 => /lib64/libncurses.so.6 (0x00007f67094d9000)
    libtinfo.so.6 => /lib64/libtinfo.so.6 (0x00007f67092ac000)
    libgnutls.so.30 => /lib64/libgnutls.so.30 (0x00007f6708ebb000)
    libpcre.so.1 => /lib64/libpcre.so.1 (0x00007f6708c4a000)
    /lib64/ld-linux-x86-64.so.2 (0x00007f670b1d3000)
    libp11-kit.so.0 => /lib64/libp11-kit.so.0 (0x00007f6708917000)
    libidn2.so.0 => /lib64/libidn2.so.0 (0x00007f67086f9000)
    libunistring.so.2 => /lib64/libunistring.so.2 (0x00007f6708378000)
    libtasn1.so.6 => /lib64/libtasn1.so.6 (0x00007f6708165000)
    libnettle.so.6 => /lib64/libnettle.so.6 (0x00007f6707f2b000)
    libhogweed.so.4 => /lib64/libhogweed.so.4 (0x00007f6707cfa000)
```

```
    libgmp.so.10 => /lib64/libgmp.so.10 (0x00007f6707a62000)
    libffi.so.6 => /lib64/libffi.so.6 (0x00007f6707859000)
```

The /etc/ld.so.conf File

The **/etc/ld.so.conf** file is used to configure the cache: **/etc/ld.so.cache** :

```
[root@centos8 ~]# cat /etc/ld.so.conf
include ld.so.conf.d/*.conf
```

As you can see, this file contains just one **include** directive that points to the **/etc/ld.so.conf.d/** directory:

```
[root@centos8 ~]# ls -l /etc/ld.so.conf.d/
total 16
-rw-r--r--. 1 root root 26 Mar  1 10:21 bind-export-x86_64.conf
-r--r--r--. 1 root root 67 Apr  9  2020 kernel-4.18.0-147.8.1.el8_1.x86_64.conf
-r--r--r--. 1 root root 67 Apr  8 15:09 kernel-4.18.0-240.22.1.el8_3.x86_64.conf
-rw-r--r--. 1 root root 17 Nov  3 19:38 libiscsi-x86_64.conf
```

For example, the **bind-export-x86_64.conf** file contains one line:

```
[root@centos8 ~]# cat /etc/ld.so.conf.d/bind-export-x86_64.conf
/usr/lib64//bind9-export/
```

The ldconfig Command

The **ldconfig** command is used to:

- to update the cache with the shared objects found in the paths in the **/etc/ld.so.conf** file together with those in **/lib** and **/usr/lib**,
- to update the symbolic links on the shared objects. The symbolic links are used to manage Shared Object version changes.

When used with the **-p** switch, the ldconfig command shows the cntents of the cache:

```
[root@centos8 ~]# ldconfig -p | more
546 libs found in cache `/etc/ld.so.cache'
    p11-kit-trust.so (libc6,x86-64) => /lib64/p11-kit-trust.so
    libzstd.so.1 (libc6,x86-64) => /lib64/libzstd.so.1
    libz.so.1 (libc6,x86-64) => /lib64/libz.so.1
    libyaml-0.so.2 (libc6,x86-64) => /lib64/libyaml-0.so.2
    libyajl.so.2 (libc6,x86-64) => /lib64/libyajl.so.2
    libxtables.so.12 (libc6,x86-64) => /lib64/libxtables.so.12
    libxslt.so.1 (libc6,x86-64) => /lib64/libxslt.so.1
    libxshmfence.so.1 (libc6,x86-64) => /lib64/libxshmfence.so.1
    libxml2.so.2 (libc6,x86-64) => /lib64/libxml2.so.2
    libxkbcommon.so.0 (libc6,x86-64) => /lib64/libxkbcommon.so.0
    libxcb.so.1 (libc6,x86-64) => /lib64/libxcb.so.1
    libxcb-xvmc.so.0 (libc6,x86-64) => /lib64/libxcb-xvmc.so.0
    libxcb-xv.so.0 (libc6,x86-64) => /lib64/libxcb-xv.so.0
    libxcb-xtest.so.0 (libc6,x86-64) => /lib64/libxcb-xtest.so.0
    libxcb-xselinux.so.0 (libc6,x86-64) => /lib64/libxcb-xselinux.so.0
    libxcb-xkb.so.1 (libc6,x86-64) => /lib64/libxcb-xkb.so.1
    libxcb-xinput.so.0 (libc6,x86-64) => /lib64/libxcb-xinput.so.0
    libxcb-xinerama.so.0 (libc6,x86-64) => /lib64/libxcb-xinerama.so.0
    libxcb-xf86dri.so.0 (libc6,x86-64) => /lib64/libxcb-xf86dri.so.0
    libxcb-xfixes.so.0 (libc6,x86-64) => /lib64/libxcb-xfixes.so.0
    libxcb-sync.so.1 (libc6,x86-64) => /lib64/libxcb-sync.so.1
    libxcb-shm.so.0 (libc6,x86-64) => /lib64/libxcb-shm.so.0
--More--
```

To add your own Shared Objects to the system:

- create a file in **/etc/ld.so.conf.d/** containing the paths where the Shared Objects can be found,
- execute **ldconfig -v** to re-build the cache.