The Future of Linux Application Distribution

OSTree, Flatpak & GNOME Software

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Samsung Research UK. Staines, 2017 March 16th

About Mario

- Computer Science Engineer by the *University of Coruña*
- Open Source developer, *GNOME* Foundation member
- Previously worked at *Igalia* and *Samsung Research UK*
- Currently at *Endless Computers*, working in the *Desktop* team focused on the development of the core platform
- Your neighbour in Staines-upon-Thames since 2013

OSTree

What is OSTree?

- Git-like system for complete & bootable filesystems
- Disk efficient: de-duplication via SHA256SUM hashes, check outs files from the object store via hard links
- Network efficient: static deltas, summary file
- Reliable updates & rollback: atomicity, no inconsistencies
- Safe: GPG verification for commits and summary file
- Introspectable library and command line tools

Multiple use cases: OS deployment, efficient OTA updates, continuous integration & QA, bundled applications...

Atomic & incremental upgrades

- Git-like fetching via HTTP: simple setup
- Incremental downloads of objects, using pre-generated static deltas when available
- Automatic verification of fecthed objects and deltas
- Automatic creation of new deployments (+ 3-way merge)
- Atomic swapping of boot configurations via symlinks

```
$ ls -l /ostree/
total 12K
lrwxrwxrwx 1 root root    8 Oct  4 16:55 boot.0 -> boot.0.1
drwxr-xr-x 3 root root 4.0K Oct  4 16:55 boot.0.1
drwxr-xr-x 3 root root 4.0K Oct  4 16:55 deploy
drwxr-xr-x 7 root root 4.0K Mar 12 12:59 repo
```

Some internal details

Anatomy of an OSTree repository:

- Types of repositories: bare, bare-user, archive-z2
- Objects (commits, dirtree, dirmeta, content) + refs
- The summary file

OSTree deployments:

- Multiple deployments per OS, parallel installable
- Shared stateful data among deployments (/etc, /var)

Comparison with other systems

OSTree vs APT/RPM

- Deploying full filesystem VS partial ones
- Truly atomic VS potentially broken intermediate stages
- No dependencies hell, no postinst/postrm hooks...

OSTree vs image replication (flashing)

- Predictable like flashing, but much more efficient
- Only 2 persistent directories supported: /etc & /var
- Works on top of any filesystems supporting hard links
- Supports installing different versions of the OS in parallel

Who is using OSTree?

- Atomic project (Fedora, CentOS)
- GNOME Continuous
- Qt OTA updates
- Automotive Grade Linux (AGL)
- Endless OS
- Flatpak

Flatpak

What is Flatpak?

- A new way of distributing applications in Linux
- Sits on top of OSTree and *bubblewrap* (chroot on steroids)
- Allows having both user and system-wide installations
- Cross-platform by design: **runtimes** and **applications**
- Reliable and secure: GPG signatures, sanboxing, portals...
- Open Source project. Started by Red Hat, contributions from Endless, Collabora, Codethink, Intel, Kinvolk, Solus...

Similar in some ways to Docker, but with the focus on end user applications instead of for containerized system-wide services.

A brief note on bubblewrap

- Allows running sandboxed applications in chroot-like environments as an **unprivileged user**
- Creates a mount namespace with `/` on a `tmpfs`
- Uses `PR_SET_NO_NEW_PRIVS` when cloning the process to limit what the binary can do after dropping privileges
- Implements a subset of the Kernel's user namespaces feature to isolate processes
- More namespaces: `CLONE_NEWUSER`, `CLONE_NEWIPC`, `CLONE_NEWPID`, `CLONE_NEWNET`, `CLONE_NEWUTS`
- Allows passing a list of *seccomp* filters to limit *syscalls*

Bubblewrap example

```
[fedoravm ~]$ bwrap --ro-bind /usr /usr --ro-bind /etc/resolv.conf /etc/resolv.conf \
      --symlink usr/lib /lib --symlink usr/lib64 /lib64 --symlink usr/bin /bin \
      --dir /tmp --proc /proc --dev /dev \
      --unshare-pid --unshare-net \
      --chdir / \
      /bin/sh

sh-4.3$ ls /
bin  dev  etc  lib  lib64  proc  tmp  usr

sh-4.3$ ls /dev/
console  full  null  ptmx  pts random shm  stderr  stdin  stdout  tty  urandom  zero

sh-4.3$ ls -l /etc/
total 4
-rw-r--r-- 1 65534 65534 53 Mar 14 00:46 resolv.conf

sh-4.3$ ifconfig
lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

sh-4.3$ ps aux
USER       PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
1000         1  0.0  0.0  15472   160 ?        S    01:28   0:00 bwrap --ro-bind /usr /usr --
1000         2  0.0  0.1 122136  3608 ?        S    01:28   0:00 /bin/sh
1000         8  0.0  0.1 150020  3544 ?        R+   01:29   0:00 ps aux
```

Anatomy of a Flatpak Runtime

```
$ tree -L 3 /var/lib/flatpak/runtime/org.gnome.Platform/x86_64/3.22/active/
|-- deploy
|-- files
|  |-- bin
|  |  |-- [...]
|  |  |-- basename
|  |  |-- bash
|  |  |-- [...]
|  |-- etc
|  |  |-- [...]
|  |  |-- ca-certificates.conf
|  |  |-- dbus-1
|  |  |-- [...]
|  |-- lib
|  |  |-- [...]
|  |  |-- libglib-2.0.so.0.5000.2
|  |  |-- libGL.so -> libGL.so.1.0.0
|  |  |-- [...]
|  |-- lib64
|  |  `-- ld-linux-x86-64.so.2 -> /usr/lib/ld-linux-x86-64.so.2
|  |-- [...]
|  |-- manifest-base-1.json
|  |-- manifest.json
|  |-- sbin -> bin
|  |-- share
|  |  |-- [...]
|  |  |-- applications
|  |  |-- [...]
|  `-- var
|      |-- cache
|      |-- lib
|      `-- run
`-- metadata
```

Anatomy of a Flatpak Application

```
$ tree -L 3 /var/lib/flatpak/app/org.gnome.Todo/current/active/
/var/lib/flatpak/app/org.gnome.Todo/current/active/
|-- deploy
|-- export
|   `-- share
|       |-- applications
|       |-- dbus-1
|       `-- icons
|-- files
|   |-- bin
|   |   `-- gnome-todo
|   |-- lib
|   |   |-- debug
|   |   |-- evolution-data-server
|   |   |-- girepository-1.0
|   |   |-- gnome-todo
|   |   |-- goa-1.0
|   |   |-- libcamel-1.2.so -> libcamel-1.2.so.59.0.0
|   |   |-- [...]
|   |   `-- systemd
|   |-- manifest.json
|   `-- share
|       |-- appdata
|       |-- applications
|       |-- dbus-1
|       |-- GConf
|       |-- gir-1.0
|       |-- glib-2.0
|       |-- icons
|       |-- locale
|       |-- pixmaps
|       `-- runtime
`-- metadata
```

Putting all together: running a flatpak app

```
/.flatpak-info
/app
    /app/bin
    /app/lib
    /app/share
    [...]
/bin
/dev
    /dev/console
    /dev/full
    /dev/null
    [...]
/etc
[...]
/home/mario
    /home/mario/.config
    /home/mario/.local/share/flatpak
    /home/mario/.var/app/org.gnome.Todo
/lib
/lib64
/local
/proc
    /proc/1
    /proc/1/attr
    [...]
/run
    /run/build
    /run/build-runtime
    /run/host
    /run/systemd
    /run/user/1000
    [...]
    [...]
    /run/user/1000
    /run/user/1000/Xauthority
    /run/user/1000/app
    /run/user/1000/app/org.gnome.Todo
    /run/user/1000/bus
    /run/user/1000/dconf
    /run/user/1000/dconf/user
    /run/user/1000/doc
    /run/user/1000/flatpak-info
    [...]
/sbin
/sys
    /sys/block
    [...]
/tmp
    /tmp/.X11-unix
    /tmp/.X11-unix/X99
    [...]
/usr
    /usr/bin
    /usr/share
    /usr/share/applications
    [...]
/var
    /var/cache
    /var/config
    /var/config/user-dirs.dirs
    [...]
    /var/data
    /var/run
    /var/tmp
```

Platform and SDK Runtimes

Currently **two main standard runtimes** available:

- Freedesktop runtime: containes a set of essential libraries and services: D-Bus, GLib, PulseAudio, X11, Wayland
- GNOME runtime: based on the Freedesktop runtime, adds libraries like GTK+, GStreamer or GVFS on top.

  A KDE runtime is currently under development too:
  `https://github.com/KDE/flatpak-kde-runtime`

Two **types of runtimes**:

- Platform runtime: just the bits needed to **run** apps
- SDK runtime: platform + the necessary tools and files for development purposes (e.g. headers, debug symbols...)

The Sandbox

Limited access to the host system by default:

- No access to processes outside the sandbox (*namespaces*)
- No access to the network, session bus and devices
- Controlled execution of certain *syscalls* (*seccomp* filters)
- Read-only access to the runtime and app (*bind mounts*)
- Read-write access to `$HOME/.var/app/$APPID`
- Controlled access to resources (*cgroups*)
- No access to host services (e.g. X/Wayland, system bus...)

Flatpak's sandbox is very limiting by default, but there are ways of dealing with that to run real-word applications...

Escaping the Sandbox: fine-grained permissions

Easiest way to work with the sandbox is to open "holes" in it:

- Grant access to UNIX domain sockets: X.org, Wayland, PulseAudio, System and Sesssion D-Bus...
- Grant access to specific devices: dri, kvm
- Grant access to see, use and/or own specific D-Bus names
- Share specific subsystems with the host (network, IPC)
- Fine-grained permissions for filesystem access
- Define extensions for runtimes or applications (e.g. l10n)

Combining all this enables makes it possible to run apps in a more controlled way, but it's not very secure.

The manifest file

A Flatpak manifest file (`metadata`):

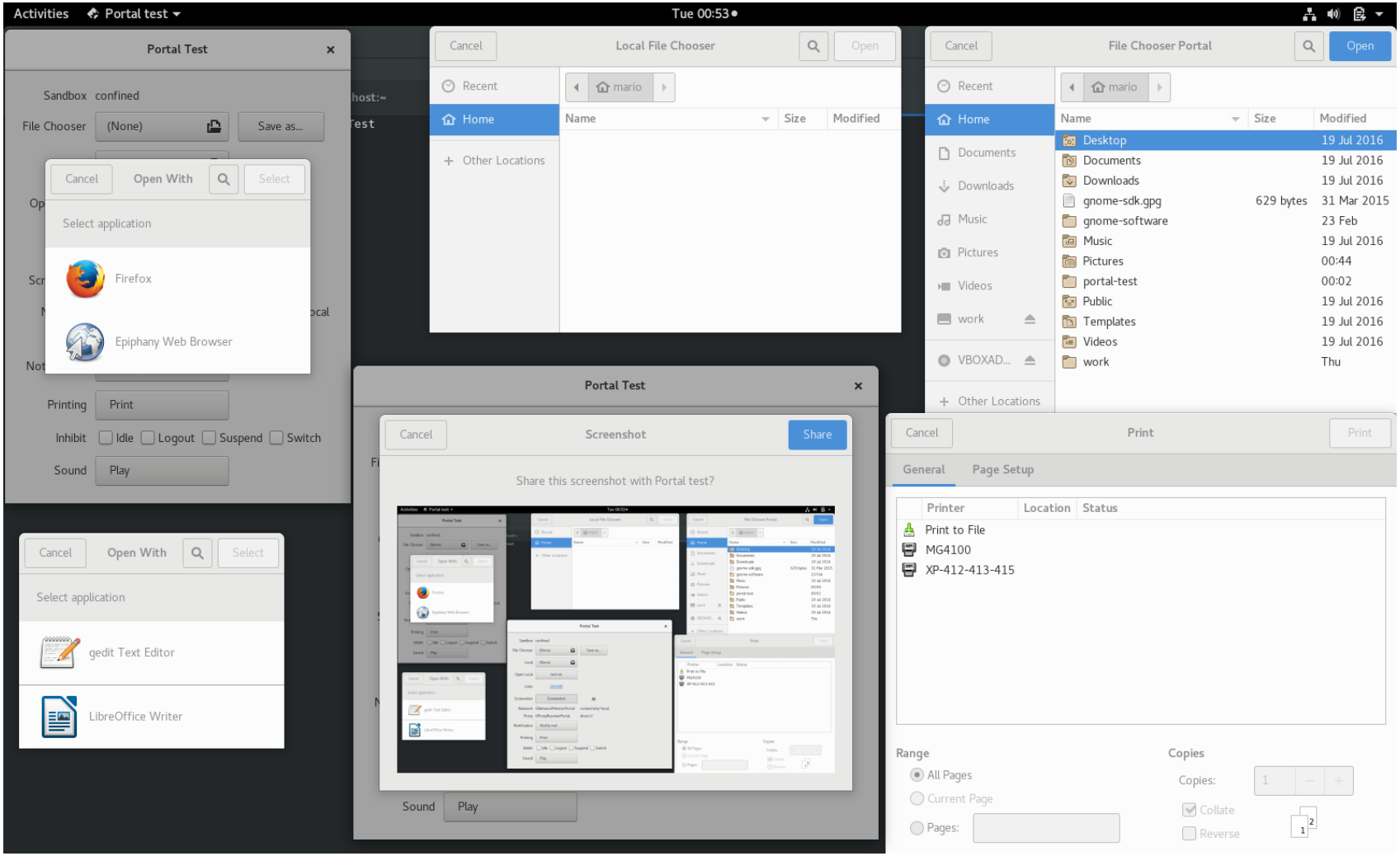
```
[Application]
name=org.gnome.Calculator
runtime=org.gnome.Platform/x86_64/3.20
sdk=org.gnome.Sdk/x86_64/3.20
command=gnome-calculator

[Context]
shared=network;ipc;
sockets=x11;wayland;
filesystems=xdg-run/dconf;~/.config/dconf:ro;

[Session Bus Policy]
ca.desrt.dconf=talk

[Environment]
DCONF_USER_CONFIG_DIR=.config/dconf

[Extension org.gnome.Calculator.Locale]
directory=share/runtime/locale
subdirectories=true

[Extension org.gnome.Calculator.Debug]
directory=lib/debug
```

Escaping the sandbox: Portals

- High-level APIs to allow sandboxed apps request access
- Out-of-process services, run in the host system
- Sandboxed apps communicate via D-Bus
- Different types of portals for different needs:
  - NetworkMonitor, OpenURI, Filechooser, Documents, Printing, Geolocation, Screenshots, Notifications, Proxy...
- Using portals is **safe**:
  - They don't expose sensible information from the host
  - Portal-initiated operations are **interactive** an **cancellable**
- Split in UI-less frontend + desktop-specific backends:
  - Currently backends for GTK+, with KDE work-in-progress.
  - GLib & GTK+ include support for several portals since 3.22

An example of Portals

```
$ flatpak run org.gnome.PortalTest
```



Building a flatpak apps

```
{
  "id" : "org.gnome.Todo",
  "branch" : "stable",
  "runtime" : "org.gnome.Platform",
  "runtime-version" : "3.22",
  "sdk" : "org.gnome.Sdk",
  "build-options" : {
    "cflags" : "-O2 -g",
    "cxxflags" : "-O2 -g",
    "env" : {
      "V" : "1"
    }
  },
  "command" : "gnome-todo",
  "modules" : [
    {
      "name" : "gnome-online-accounts",
      "config-opts" : [
        "--disable-telepathy",
        "--disable-documentation",
        "--disable-backend"
      ],
      "sources" : [
        {
          "url" : "https://download.gnome.org/sources/gnome-online-accounts/3.22/gnome-online
          "sha256" : "aacce93a71bf5e687a45ae0d00f31ea0625ddd8143235d6d8c64c4ec21bbfa33",
          "type" : "archive"
        }
      ]
    },
    [...] ---> More depedencies here
```

Building a flatpak apps (II)

```
    [...]
    {
      "name" : "gnome-todo",
      "sources" : [
        {
          "url" : "https://download.gnome.org/sources/gnome-todo/3.22/gnome-todo-3.22.1.tar.x
          "sha256" : "cb80f64f5edeeac7b221146d2203bd1bebc49d275b7a41e7a5418f409d9c74af",
          "type" : "archive"
        }
      ]
    }
  ],
  "cleanup" : [
    "/include", "/lib/pkgconfig", "/share/pkgconfig", "/share/aclocal", "/man",
    "/share/man", "/share/gtk-doc", "/share/vala", "*.la", "*.a"
  ],
  "finish-args" : [
    "--share=ipc",
    "--socket=x11",
    "--socket=wayland",
    "--share=network",
    "--talk-name=org.gnome.OnlineAccounts",
    "--talk-name=org.gnome.evolution.dataserver.AddressBook9",
    "--talk-name=org.gnome.evolution.dataserver.Calendar7",
    "--talk-name=org.gnome.evolution.dataserver.Sources5",
    "--talk-name=org.gnome.evolution.dataserver.Subprocess.Backend.*",
    "--filesystem=xdg-run/dconf",
    "--filesystem=~/.config/dconf:ro",
    "--talk-name=ca.desrt.dconf",
    "--env=DCONF_USER_CONFIG_DIR=.config/dconf"
  ]
}
```

Application distribution

- Publish your local repository: `build-export`
  - Export your app to an OSTree (archive-z2) repository
  - You could publish this repository now over HTTP
- Sign everything: `build-sign`, `build-update-repo`
  - Important to GPG-sign the commits and the summary file
  - Allows using unencrypted HTTP (faster downloads)
  - Recommended to create a dedicated GPG key
- Push to a production public repository: e.g. `rsync`
  - Simple requirements: static files served over HTTP!
  - Push it to your public server once you're happy
  - Order your commands wisely (avoid race conditions)

Application distribution (II)

- Configure your public repository appropriately:
  - `build-update-repo --title=<title>`
  - `build-update-repo --default-branch=<branch>`
- Provide efficient updates:
  - Enable HTTP keep-alive in the server (lots of files)
  - Use OSTree's static-deltas feature (good for big files)
  - Run `build-update-repo` everytime an app changes
- Generate application metadata for software centers:
  - Generate AppStream data for each application in your repo: `build-update-repo` will put it an `appstream` branch
  - Make sure your apps must export an AppData XML file!

Flatpak filetypes: .flatpakrepo and .flatpakref

Configuring flatpak "repositories": `gnome.flatpakrepo`

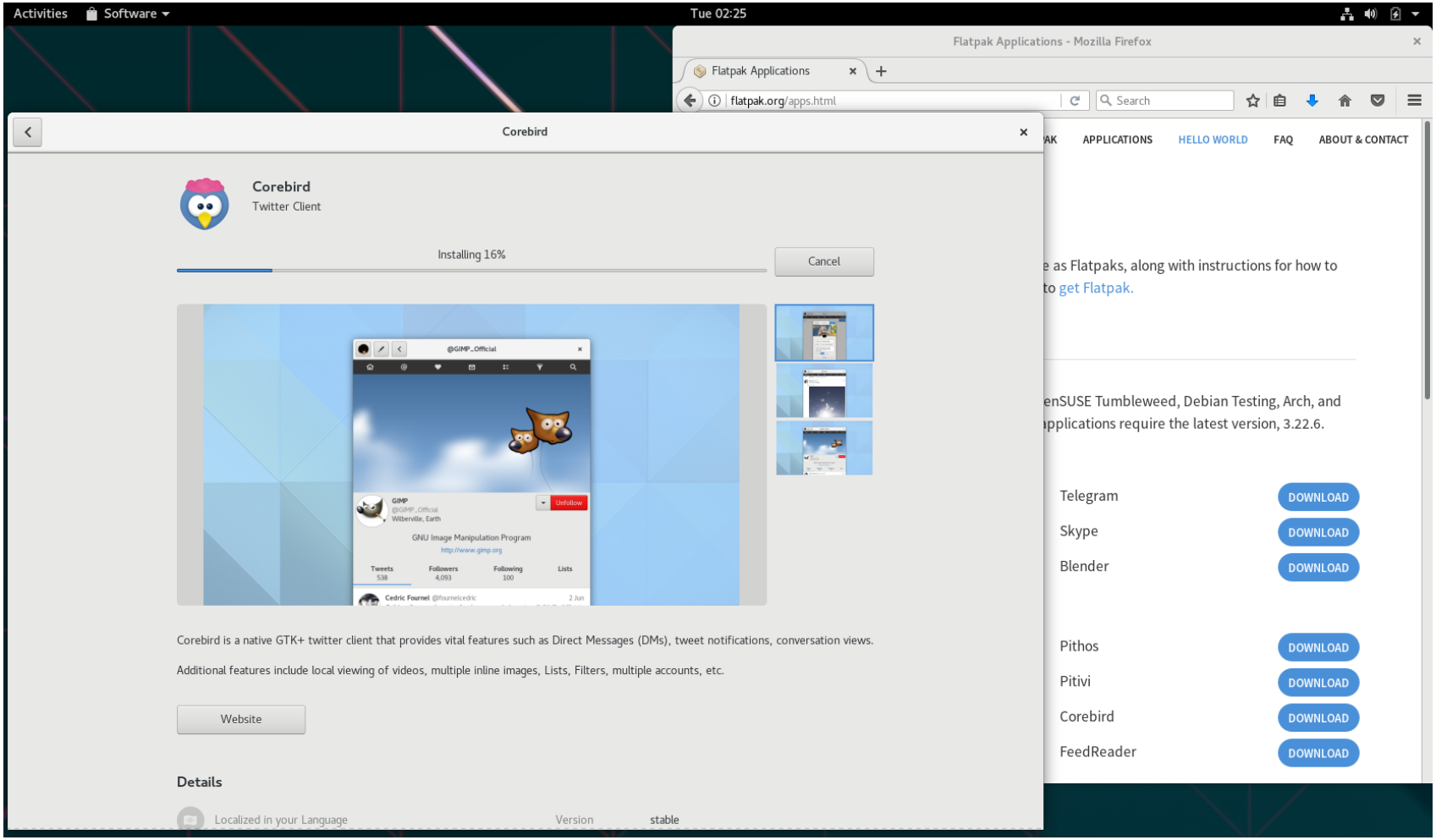
```
[Flatpak Repo]
Title=Gnome Stable Runtimes
Url=http://sdk.gnome.org/repo/
Homepage=https://www.gnome.org/get-involved/
Comment=The standard Gnome runtime used by most gnome apps
Description=GNOME runtimes are released with each major release and contain the main GNOME
platform libraries. At the moment they only receive minor bug fixing and security updates,
but should be considered ABI stable and frozen.
Icon=https://www.gnome.org/wp-content/themes/gnome-grass/images/gnome-logo.png
GPGKey=mQENBFUU[...]15w8jmY=
```

Installing an application: `gnome-recipes.flatpakref`

```
[Flatpak Ref]
Title=GNOME Recipes
Name=org.gnome.Recipes
Branch=master
Url=https://matthiasclasen.github.io/recipes-releases/repo
IsRuntime=False
GPGKey=mQENBFis[...]Kpp5G2YW
RuntimeRepo=https://sdk.gnome.org/gnome.flatpakrepo
Comment=GNOME loves to cook
```

Installing a flatpak application in one click

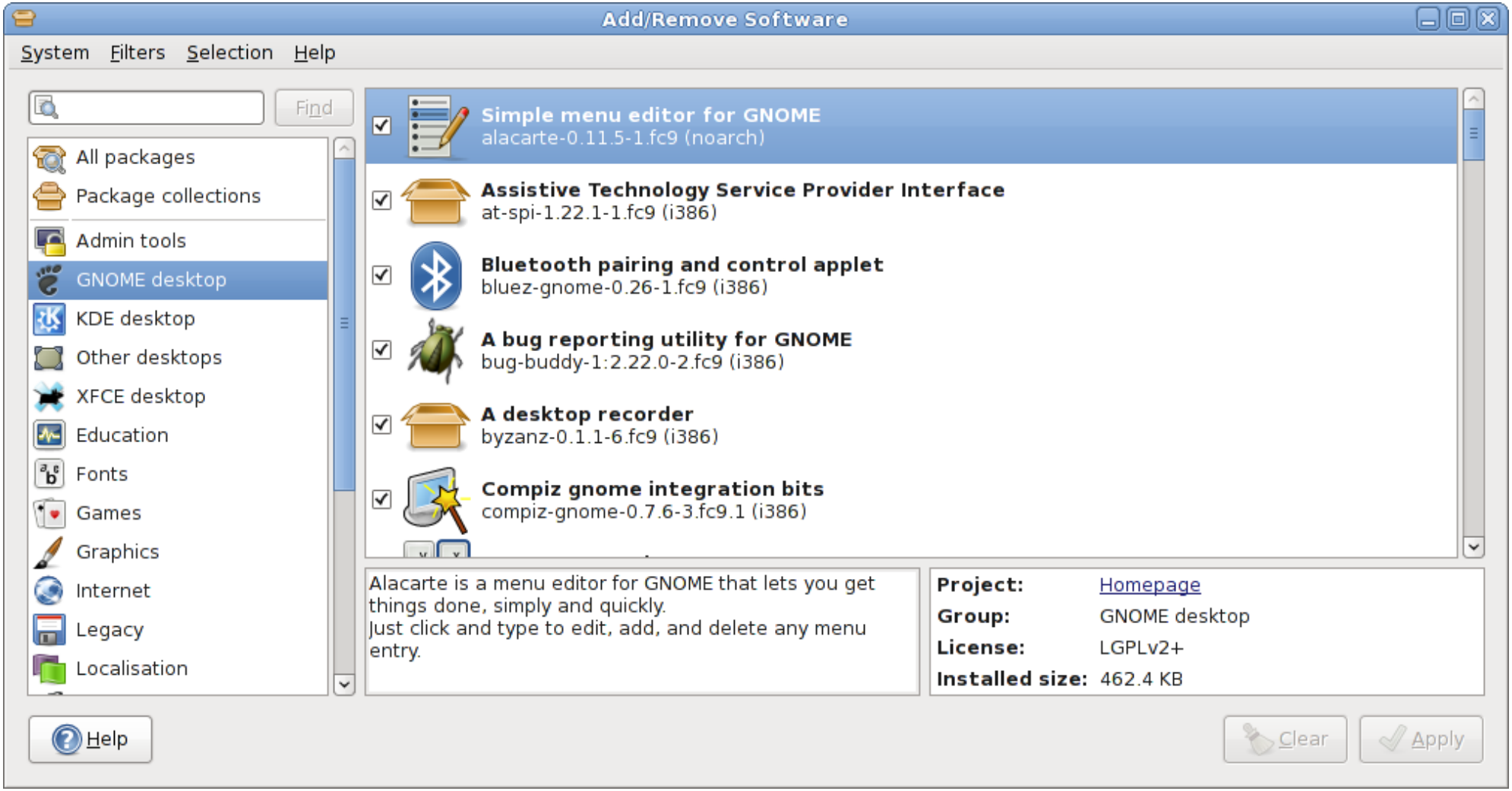
GNOME Software, flatpak and `.flatpakref` files in action:

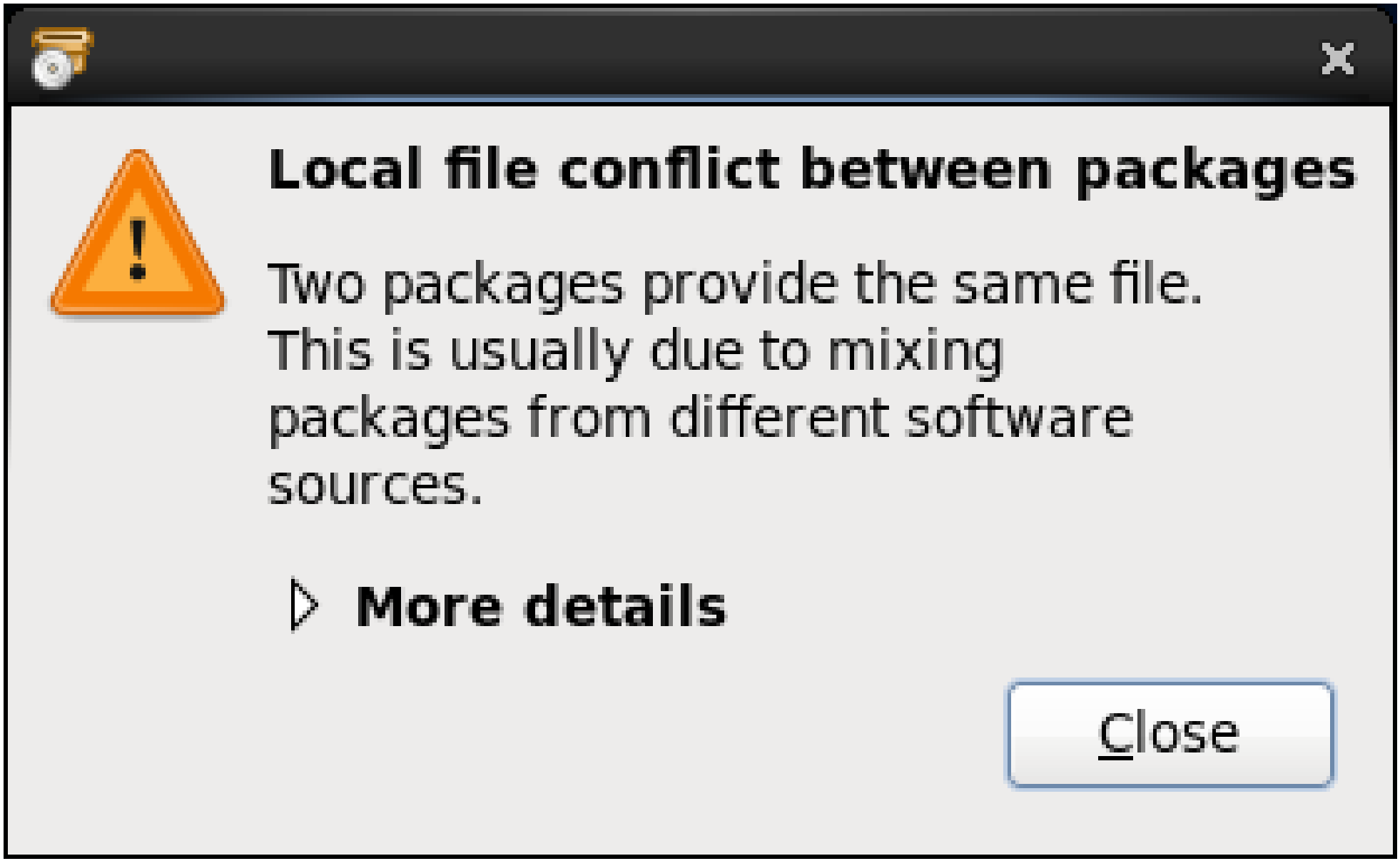


References:

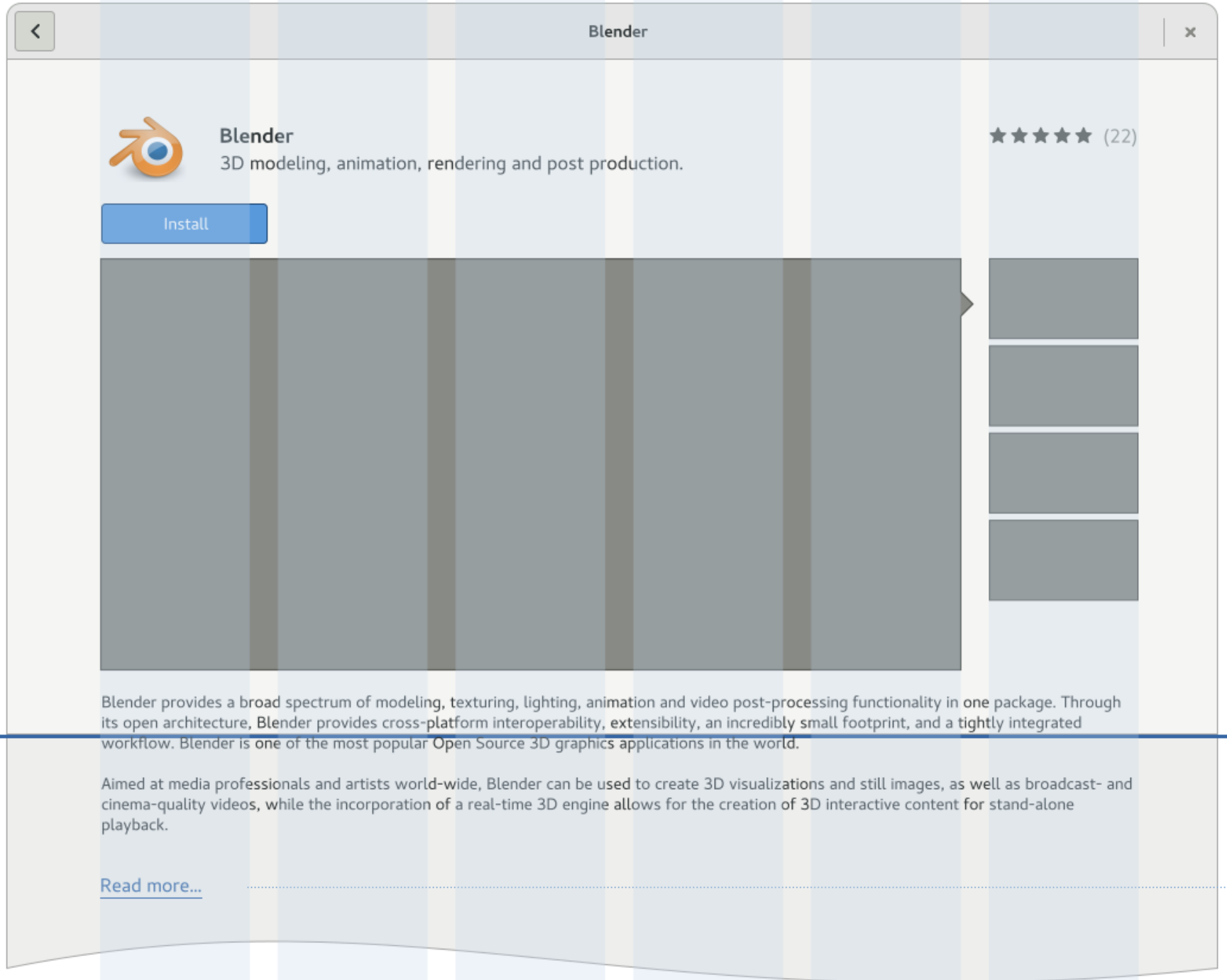
- *OSTree documentation:* `https://ostree.readthedocs.io/en/latest`
- *Project Atomic:* `https://www.projectatomic.io`
- *GNOME Continuous:* `https://wiki.gnome.org/Projects/GnomeContinuous`
- *Qt OTA updates:* `https://doc.qt.io/QtOTA`
- *Automotive Linux:* `https://automotivelinux.org`
- *Endless OS:* `https://endlessos.com`
- *Bubblewrap:* `https://github.com/projectatomic/bubblewrap`
- *Flatpak documentation:* `https://docs.flatpak.org/en/latest`
- *Flatpak portals:* `https://github.com/flatpak/xdg-desktop-portal`
- *Flatpak portals (GTK):* `https://github.com/flatpak/xdg-desktop-portal-gtk`
- *Alex Larsson's blog:* `https://blogs.gnome.org/alexl`
- *Christian Hergert's talk on Scale15x:* `https://hergert.me/talks/Flatpak-Scale-15x.pdf`

GNOME Software

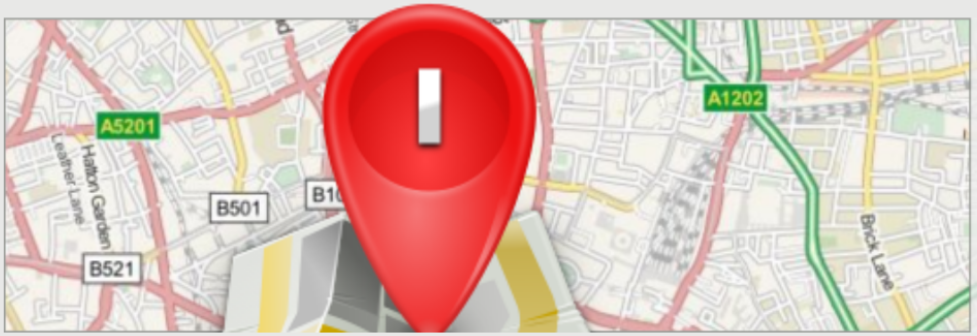

Add/Remove Software
System Filters Selection Help
Find
All packages
Package collections
Admin tools
GNOME desktop
KDE desktop
Other desktops
XFCE desktop
Education
Fonts
Games
Graphics
Internet
Legacy
Localisation
Simple menu editor for GNOME
alacarte-0.11.5-1.fc9 (noarch)
Assistive Technology Service Provider Interface
at-spi-1.22.1-1.fc9 (i386)
Bluetooth pairing and control applet
bluez-gnome-0.26-1.fc9 (i386)
A bug reporting utility for GNOME
bug-buddy-1:2.22.0-2.fc9 (i386)
A desktop recorder
byzanz-0.1.1-6.fc9 (i386)
Compiz gnome integration bits
compiz-gnome-0.7.6-3.fc9.1 (i386)
Alacarte is a menu editor for GNOME that lets you get things done, simply and quickly.
Just click and type to edit, add, and delete any menu entry.
Project: Homepage
Group: GNOME desktop
License: LGPLv2+
Installed size: 462.4 KB
Help
Clear
Apply


Local file conflict between packages
Two packages provide the same file.
This is usually due to mixing
packages from different software
sources.
More details
Close


together with another
common purpose 2 to
produce an effect 3
nomic cooperation Als
co·op′era′·tor n. or co-
co·opera·tion or co-o
tio‖ 1 the act of cooper
ciation of a number of
or profits 3 Ecol. an in
beneficial to all those


Blender
Blender
3D modeling, animation, rendering and post production.
(22)
Install
Blender provides a broad spectrum of modeling, texturing, lighting, animation and video post-processing functionality in one package. Through its open architecture, Blender provides cross-platform interoperability, extensibility, an incredibly small footprint, and a tightly integrated workflow. Blender is one of the most popular Open Source 3D graphics applications in the world.
Aimed at media professionals and artists world-wide, Blender can be used to create 3D visualizations and still images, as well as broadcast- and cinema-quality videos, while the incorporation of a real-time 3D engine allows for the creation of 3D interactive content for stand-alone playback.
Read more...

All | Installed | Updates 4



Maps

A simple maps application

Categories

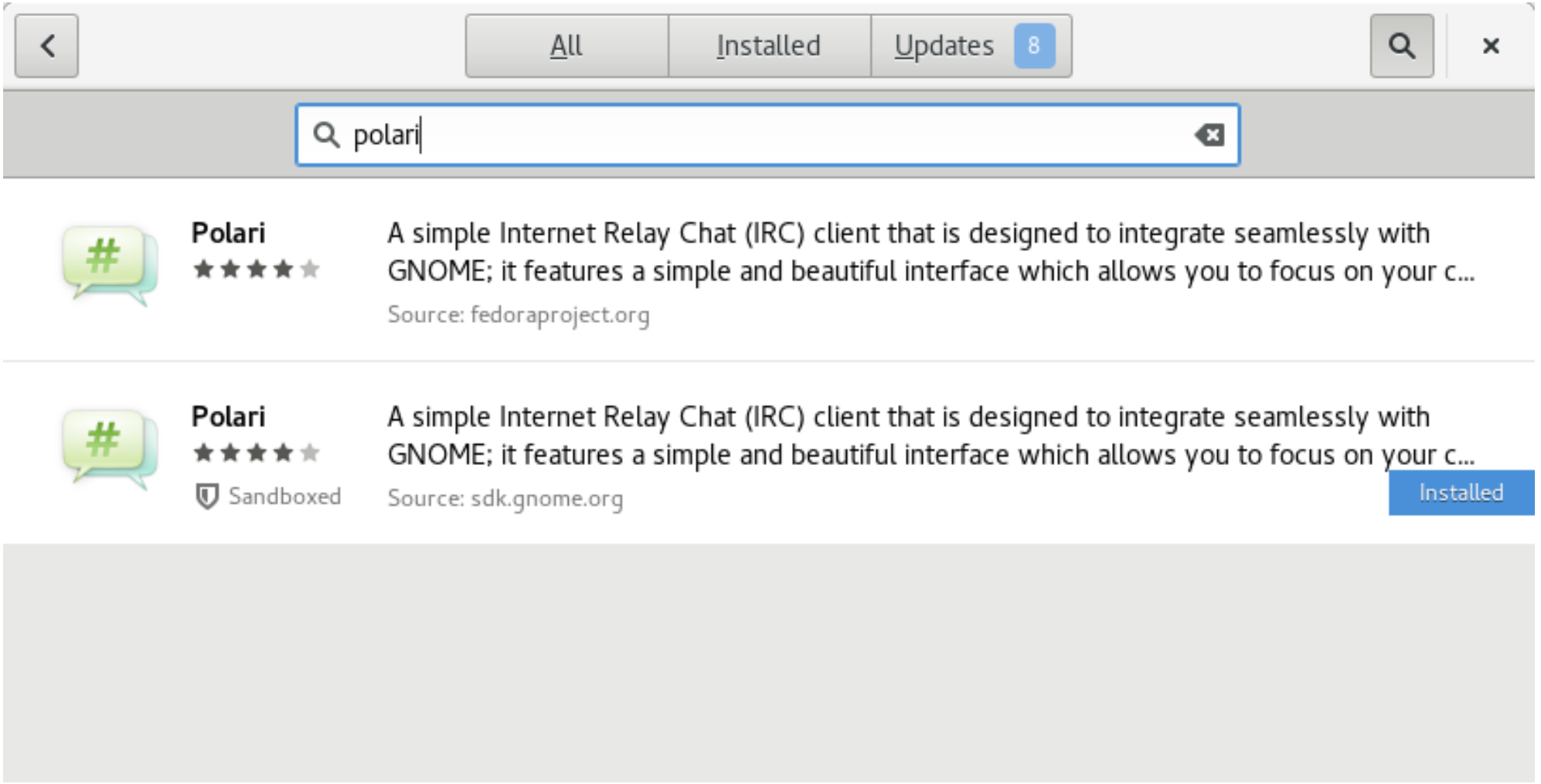
- Audio & Video
- Communication & News
- Games
- Graphics & Photography
- Productivity
- Add-ons

Editor's Picks

Installed

Installed

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Copyright 2013 Richard Hughes <richard@hughsie.com> -->
<component type="desktop">
  <id>org.gnome.Software.desktop</id>
  <metadata_license>CC0-1.0</metadata_license>
  <project_license>GPL-2.0+</project_license>
  <_name>GNOME Software</_name>
  <_summary>Application manager for GNOME</_summary>
  <description>
    <_p>
      Software allows you to find and install new applications
      extensions and remove existing installed applications.
    </_p>
```


All
Installed
Updates 8
polari
Polari
A simple Internet Relay Chat (IRC) client that is designed to integrate seamlessly with GNOME; it features a simple and beautiful interface which allows you to focus on your c...
Source: fedoraproject.org
Polari
A simple Internet Relay Chat (IRC) client that is designed to integrate seamlessly with GNOME; it features a simple and beautiful interface which allows you to focus on your c...
Sandboxed
Source: sdk.gnome.org
Installed

GNOME Software Plugin API

Table of Contents

★★★★★ **It just works...** 22 April 2016

usr01

Hands down, the easiest to use and most reliable scanner software I've encountered - on any platform.

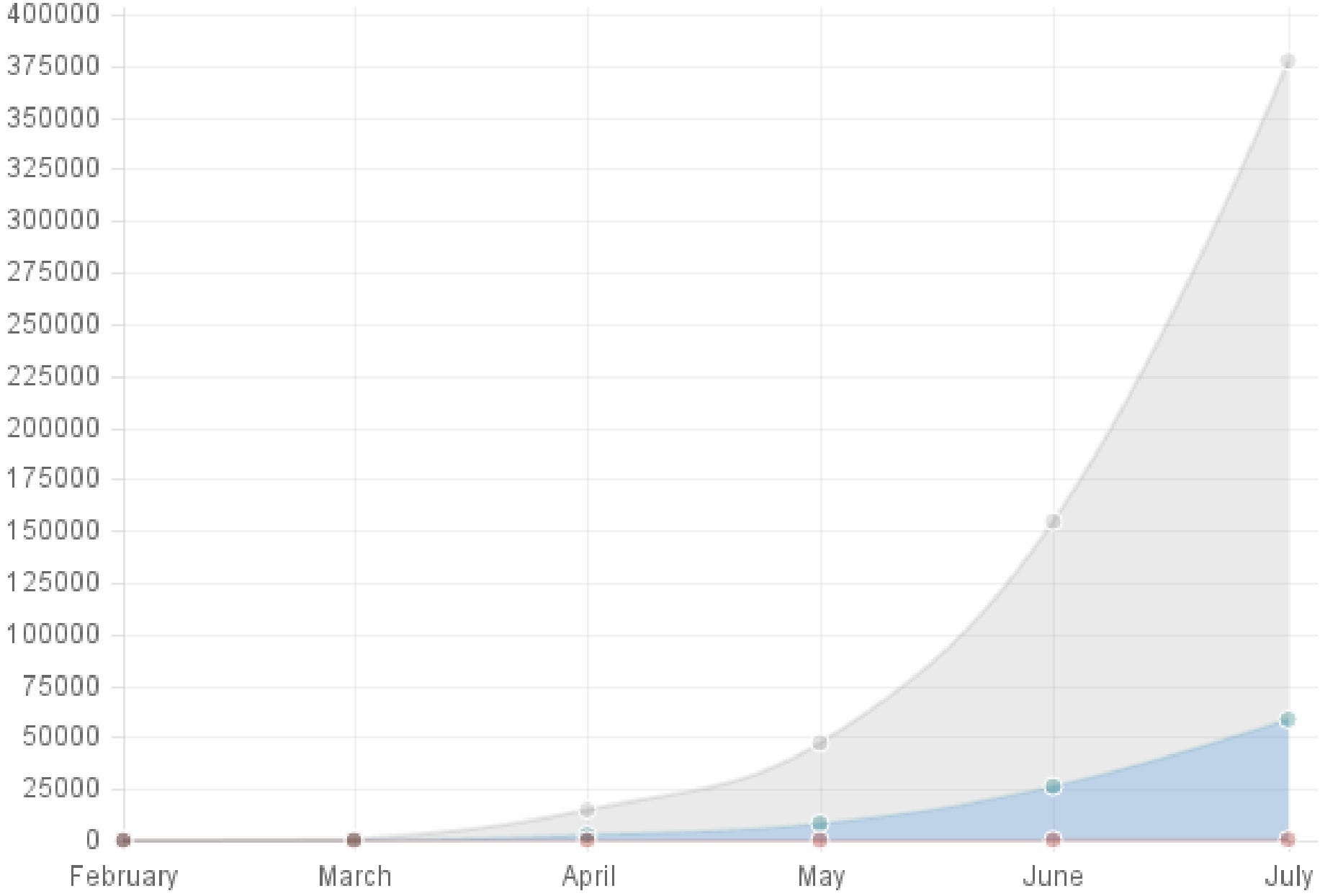
Was this review useful to you? Yes | No Report...

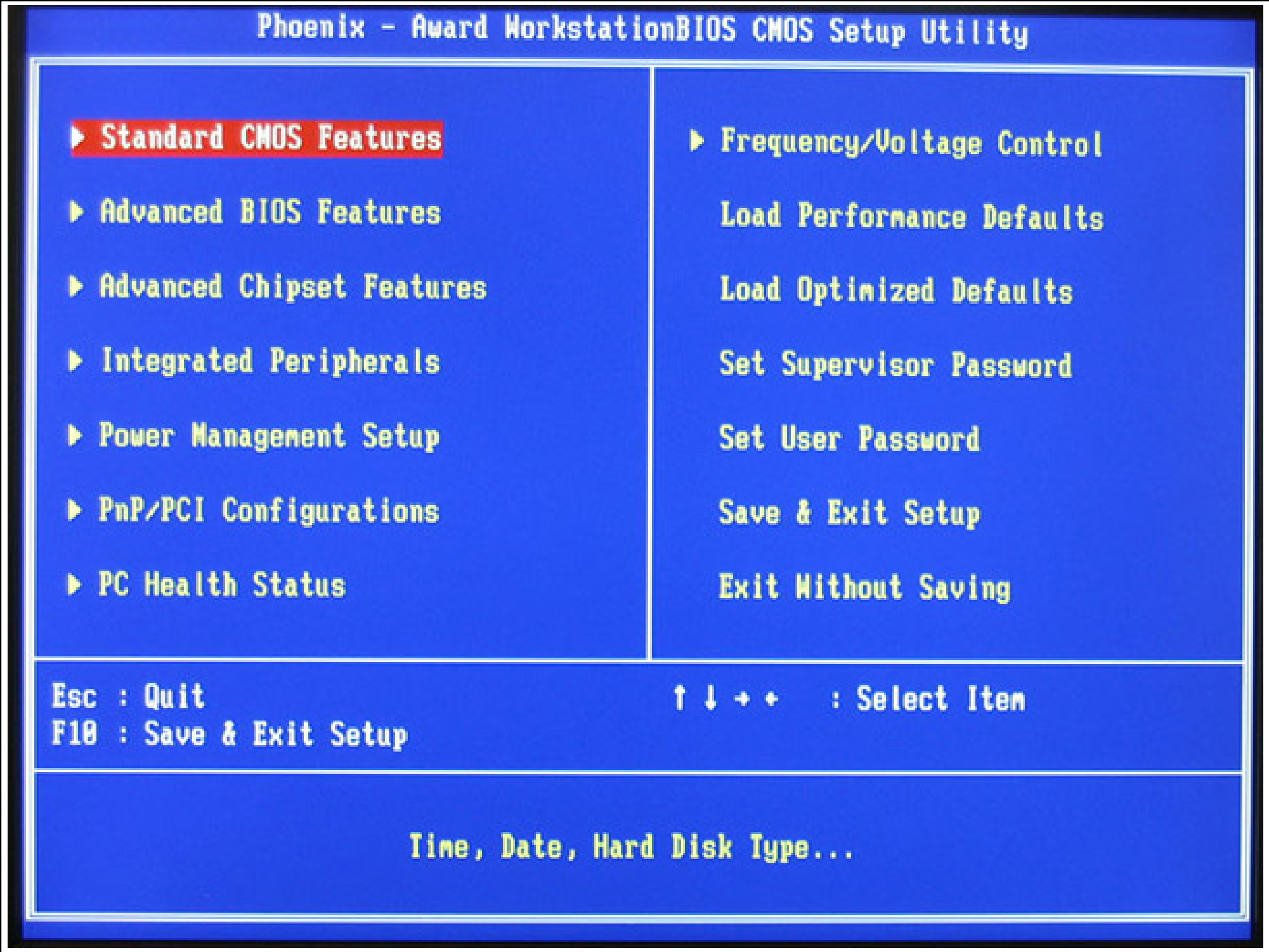
★★★★★ **Works great with my CanoScan** 10 February 2016

Richard Hughes

This is easy to use and works realy well with my scanner. The saved PDF file is clear and easy to read.

Was this review useful to you? Yes | No Report...


400000
375000
350000
325000
300000
275000
250000
225000
200000
175000
150000
125000
100000
75000
50000
25000
0
February
March
April
May
June
July


Phoenix - Award WorkstationBIOS CMOS Setup Utility
Standard CMOS Features
Advanced BIOS Features
Advanced Chipset Features
Integrated Peripherals
Power Management Setup
PnP/PCI Configurations
PC Health Status
Frequency/Voltage Control
Load Performance Defaults
Load Optimized Defaults
Set Supervisor Password
Set User Password
Save & Exit Setup
Exit Without Saving
Esc : Quit
F10 : Save & Exit Setup
↑ ↓ → ← : Select Item
Time, Date, Hard Disk Type...

LibreOffice

LibreOffice is a powerful office suite. Its clean interface and feature-rich tools help you unleash your creativity and enha...

Update

Freedesktop.org Application Platform version 1.4

Shared libraries provided by freedesktop.org

Update

GNOME Application Platform version 3.22

Shared libraries used by GNOME applications

Update

GNOME Software Development Kit version master (Nightl...

Tools and headers for developing applications using the GNOME application platform

Update

Device Firmware

ColorHugALS

3.0.2 ▸ 4.0.3

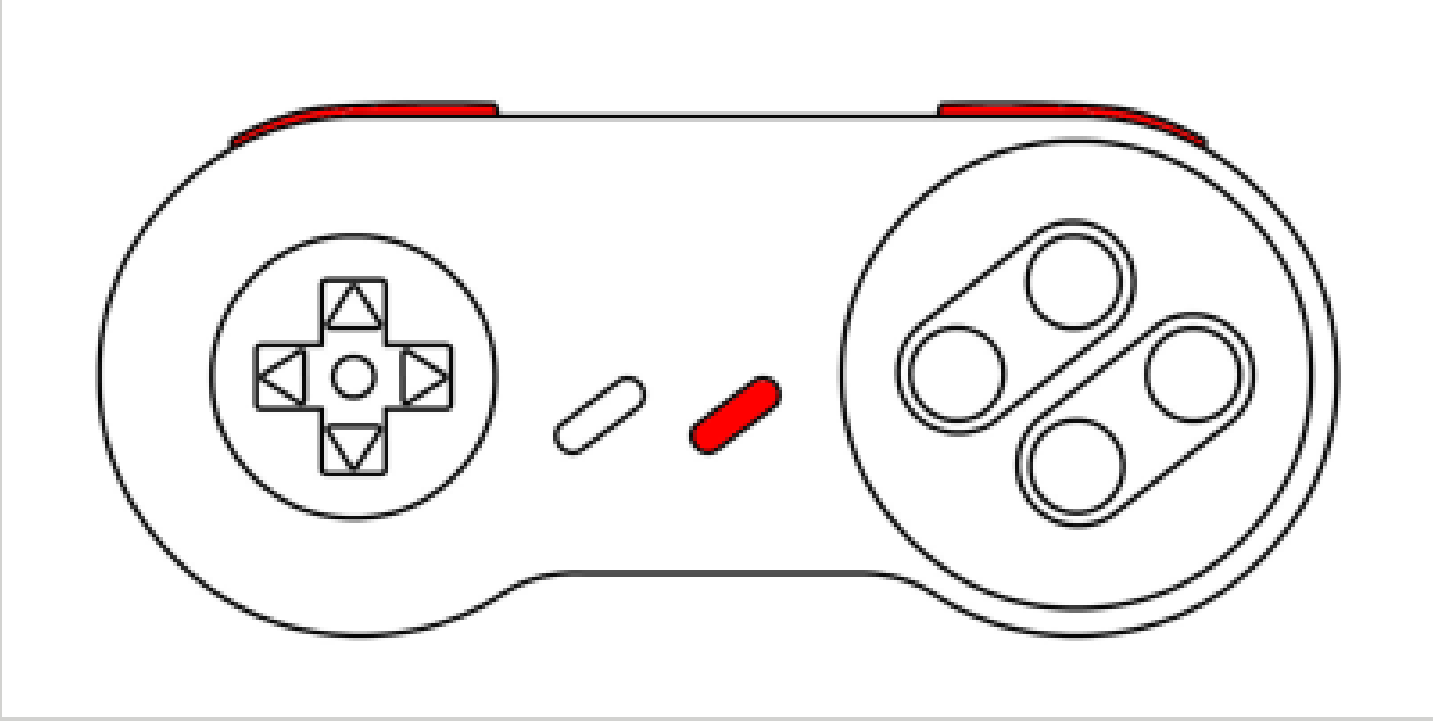
Version 4.0.3: Remove the invalid .inf file from the release tarball. No code or behaviour changes. Version 4.0.2: We n...

Device cannot be used during update.

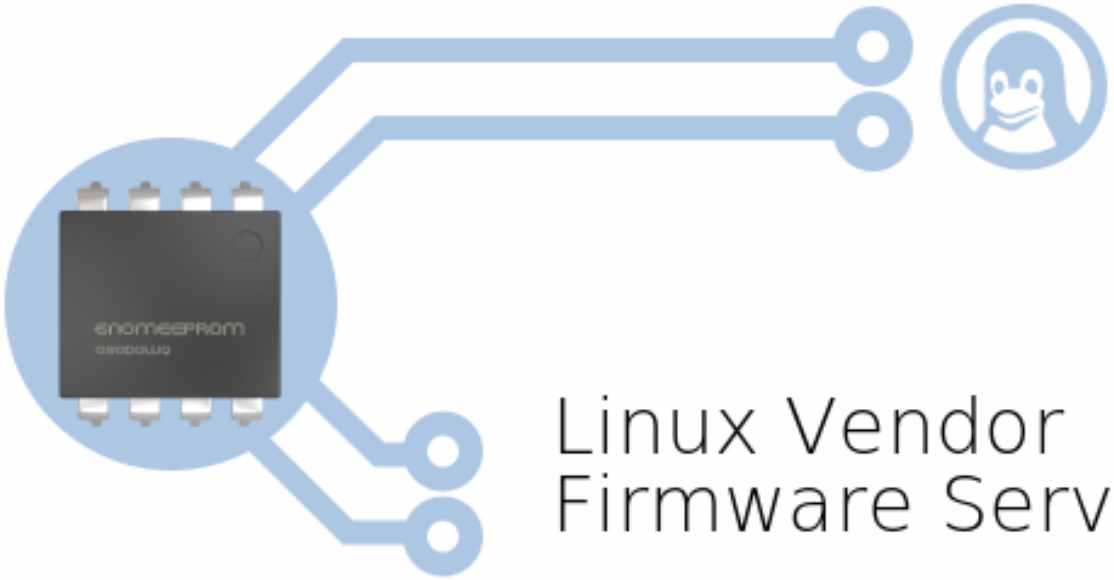
Update

Prepare 8Bitdo SFC30

Unplug the controller, hold down L+R+START for 3 seconds until both LEDs are flashing then reconnect the controller.



Cancel | Install



Linux Vendor Firmware Service

Please Login

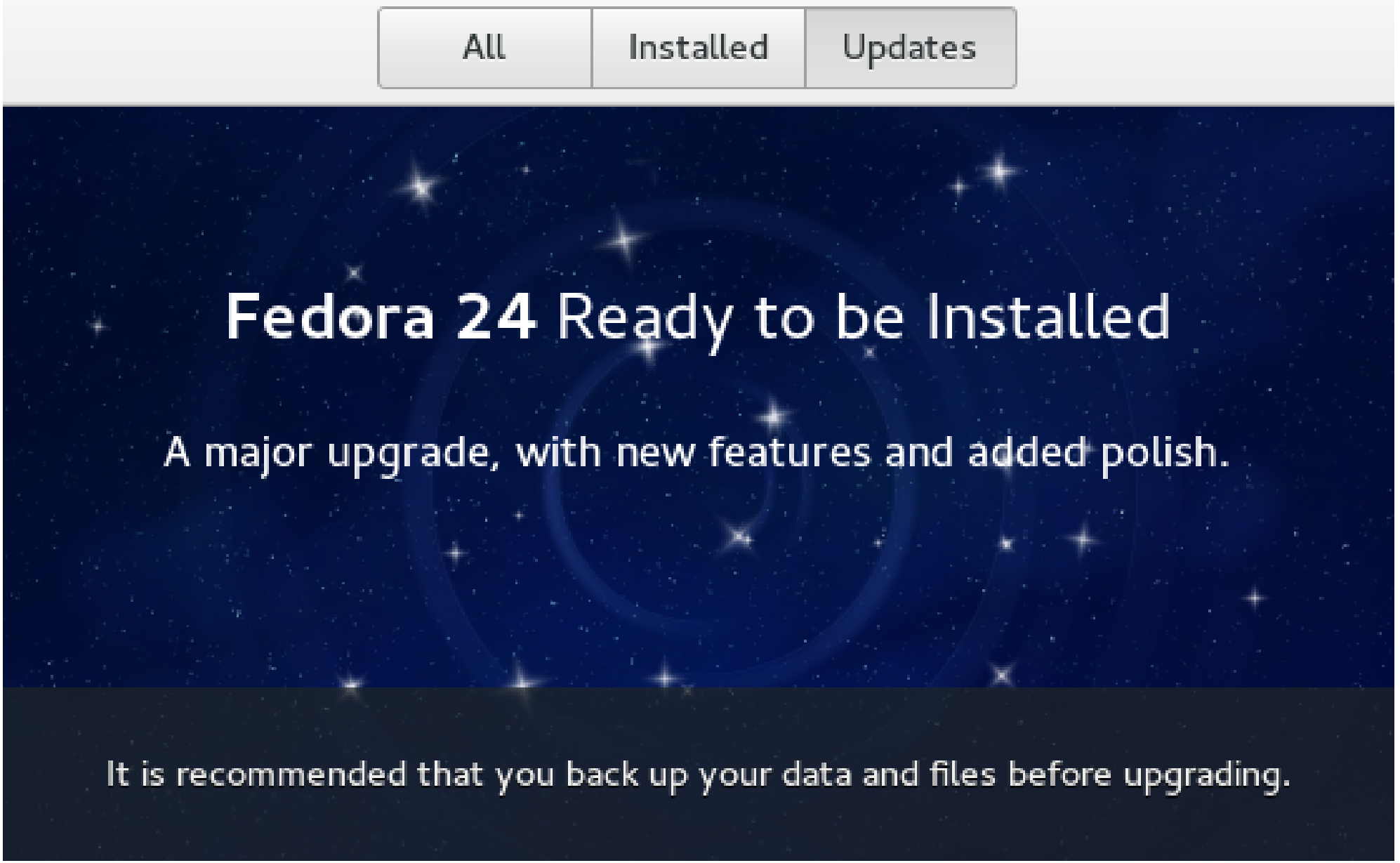
The Linux Vendor Firmware Service is a secure portal which allows hardware vendors to upload firmware updates. Files can be uploaded privately and optionally embargoed until a specific date.

This site is used by all major Linux distributions to provide metadata for clients such as fwupdmgr and GNOME Software. To upload firmware please login, or request a new account.

Username:

Password:

Login


All
Installed
Updates
Fedora 24 Ready to be Installed
A major upgrade, with new features and added polish.
It is recommended that you back up your data and files before upgrading.


CASE

Replace Installed Version of Blender?

A version of Blender is already installed. You can choose to replace the existing version, or install the new version alongside.

Installed Version

Blender

Version	2.76-2.23
Source	<distribution>

New Version

Blender

Version	2.76
Source	Blender Foundation

Cancel | Parallel Install | Replace


QUESTION
EVERYTHING

Thank you!