How SteamOS is contributing to the Linux ecosystem

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About me

- Igalian since 2001
- Debian developer
- Working on SteamOS
- Previous projects: QEMU, Maemo, ...

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The Steam Deck

- Handheld gaming computer released by Valve in 2022
- Custom operating system: SteamOS 3
  - Versions 1 and 2 have been discontinued
- Successful consumer device with standard Linux components

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The power of open source software

- How has SteamOS contributed to the Linux ecosystem?
- Disclaimer:
  - The list of examples in this presentation is by no means complete
  - Contributions by different developers, companies, and regular users

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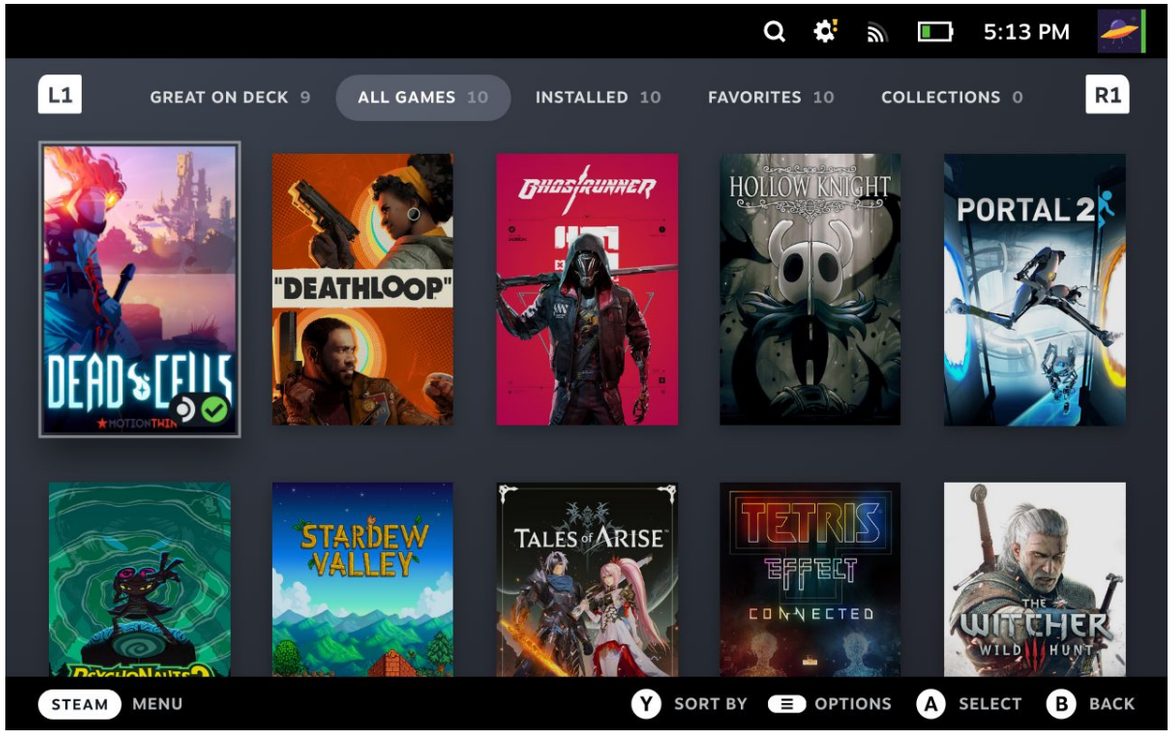
A closer look at the Steam Deck

User interface



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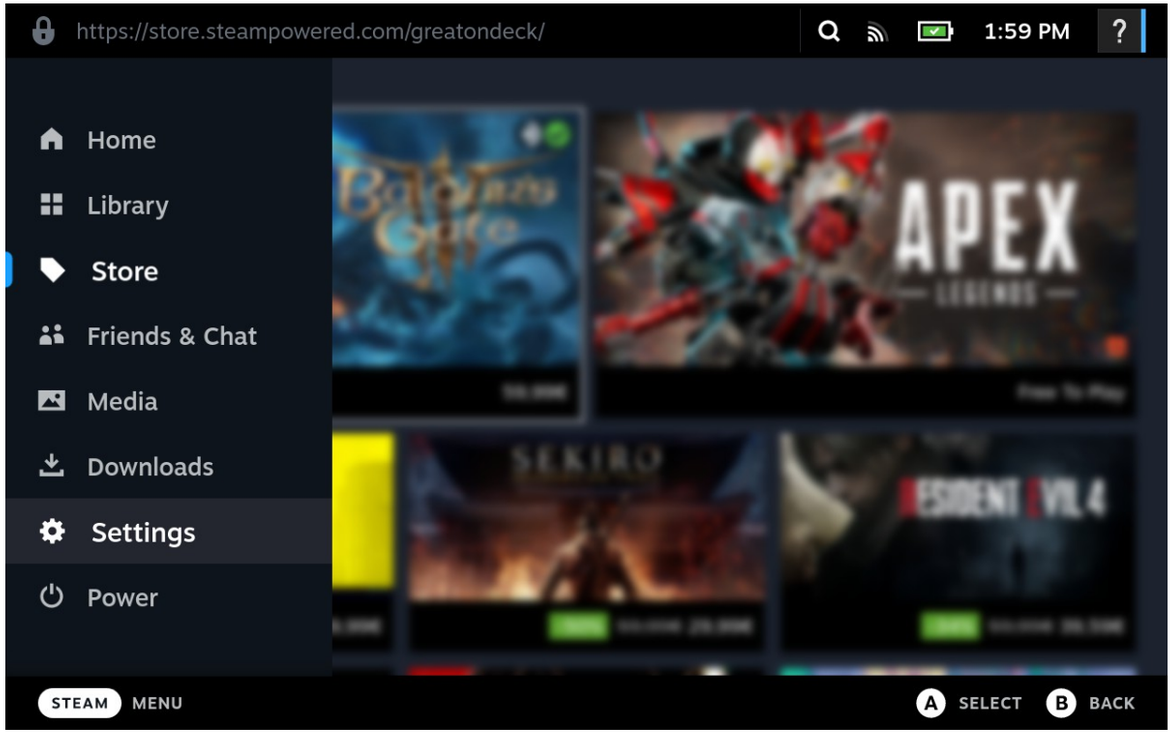
SteamOS under the hood

- Linux distribution, based on Arch Linux
- Standard components with some customizations
- FHS-based layout, GNU userspace, systemd, dbus
- Unlocked by default, full access to the OS

Gaming mode



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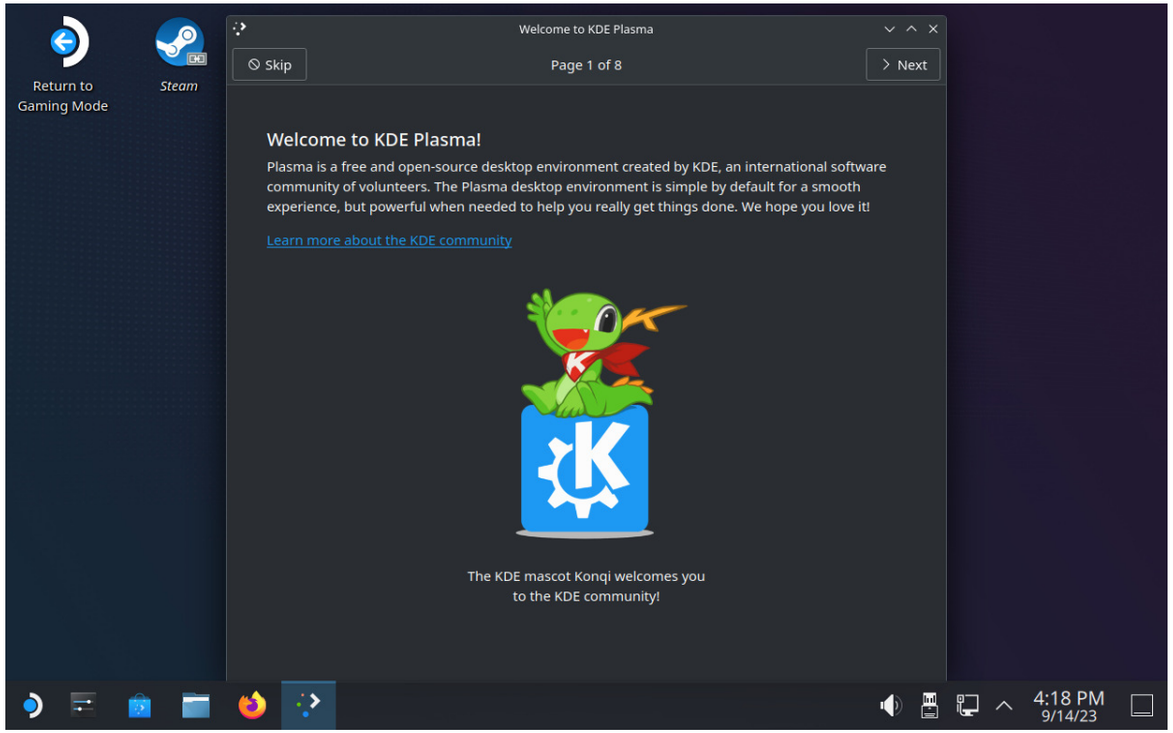
Desktop mode



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Desktop mode

- Regular KDE Plasma desktop
- You can install anything:
  - Web browser
  - Tools
  - Non-Steam games
- Usable like a regular desktop computer

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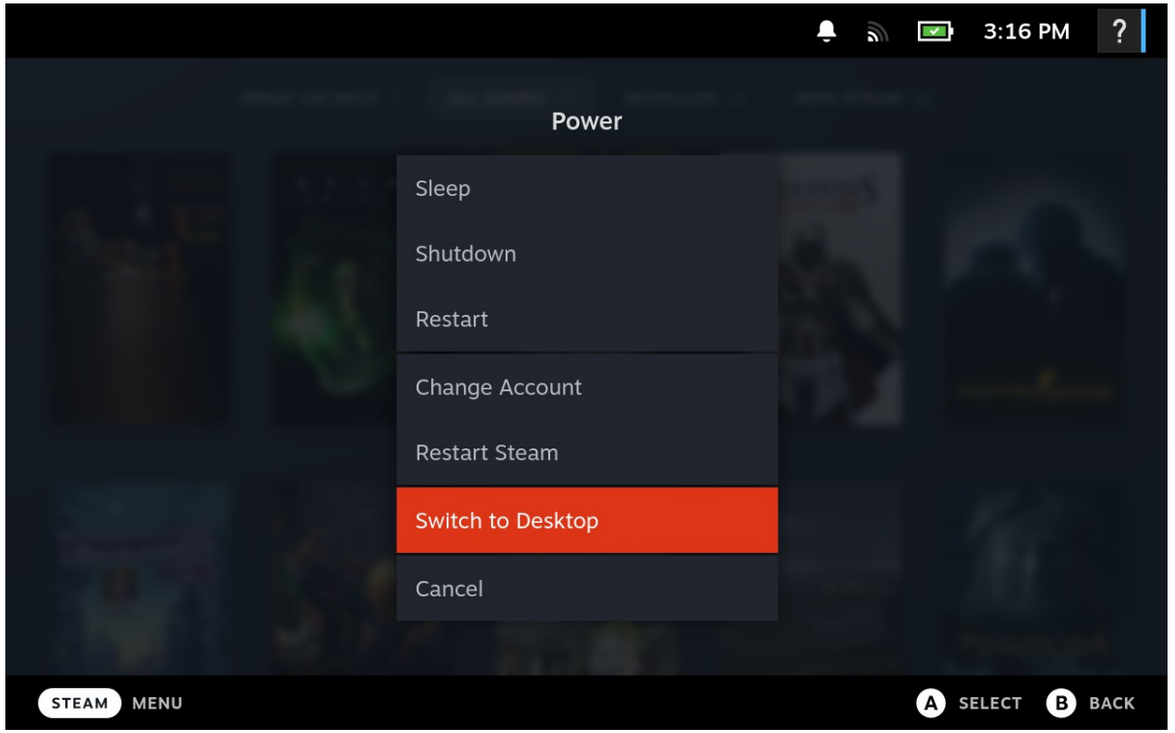
Easily accessible



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Gaming on Linux

Linux OS, Windows games

- SteamOS is a Linux-based OS
- Most Steam games are for Windows
- Most will never get a Linux version
- Solution: Proton

Proton

- Tool to run Windows games on Linux
- Collection of different open source packages, notably:
  - **Wine**: Compatibility layer for Windows APIs
  - **DXVK**: Translates Direct3D 9-11 into Vulkan
  - **VKD3D-Proton**: Translates Direct3D 12 into Vulkan
  - Also GStreamer and other libraries
- Published by Valve in 2018
- Very actively developed

https://github.com/ValveSoftware/Proton

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Wine

- Run Windows apps on Linux
- Not an emulator, the code runs directly on the CPU
- Windows APIs implemented using Linux APIs and other standards
- Developed by CodeWeavers in partnership with Valve

https://source.winehq.org/git/wine.git/
https://github.com/ValveSoftware/wine

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Implementing Windows APIs

- If the APIs are similar ⇨ no problem
- Otherwise Wine needs to implemented the missing parts
  - This can result in overhead
  - Not always easily solvable in userspace
  - Solution: new Linux features to fill in the missing gaps

Windows synchronization functions

- `WaitForMultipleObjects()`: used by many Windows games
- No direct equivalent in Linux: implemented using `futex()`
- Inefficient: restricted to a single object
- Performance problems in heavily multithreaded games
- Solution: new futex API

New futex API

- futex: fast user-space locking
  - Can only wait on a single object
  - Only 32-bit futexes
  - Hard to use and hard to extend
- New API (Linux 5.16): `futex_waitv()`
  - Similar to `WaitForMultipleObjects()`
- New API (wip): futex2
- Work by André Almeida

https://lwn.net/Articles/866112/

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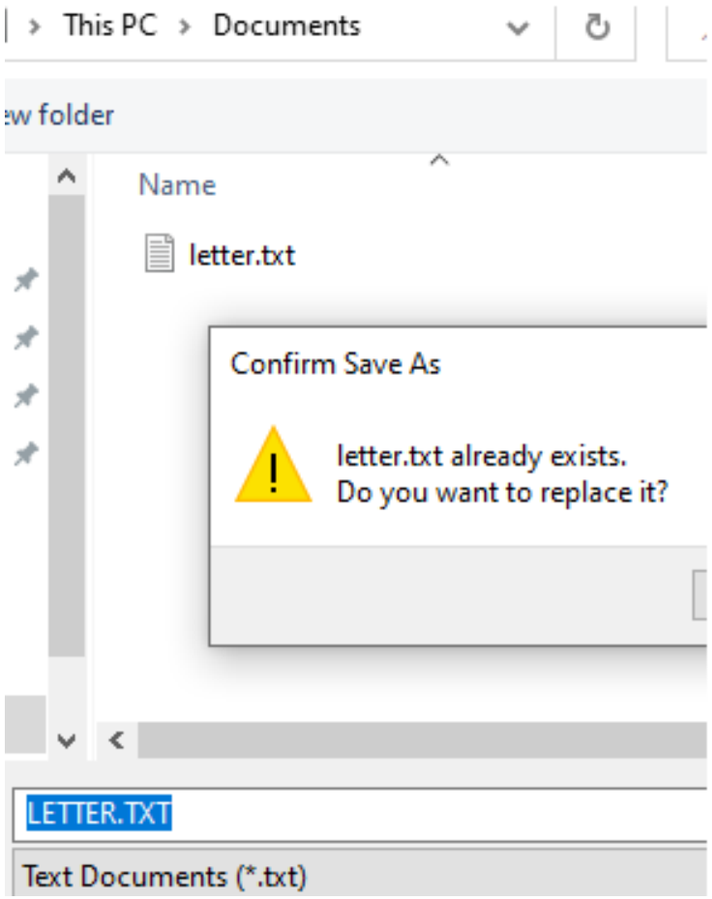
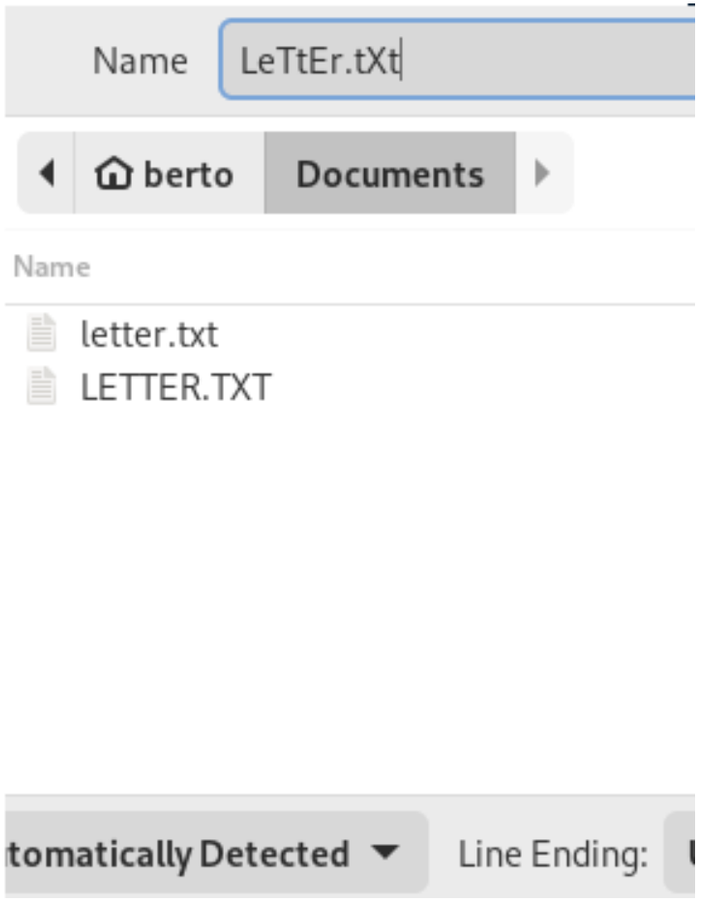

This PC
Documents
ew folder
Name
letter.txt
Confirm Save As
letter.txt already exists.
Do you want to replace it?
LETTER.TXT
Text Documents (*.txt)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letter.txt
LETTER.TXT
tomatically Detected
Line Ending:

Case insensitive filesystem

- Windows filesystems are traditionally case insensitive
- Apps expect that `data.bin` and `DATA.BIN` are the same file
- Linux filesystems are case sensitive
  - Slow solution: implement this in Wine
  - Fast solution: make ext4 case insensitive
  - Work by Gabriel Krisman
- Later added to F2FS by Daniel Rosenberg

https://lwn.net/Articles/784041/
https://lore.kernel.org/all/20190719000322.106163-3-drosen@google.com/

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Other contributions to the Linux kernel

Reliable userspace spinlocks

- Spinlock: efficient synchronization mechanism
- Used extensively in the kernel
- Hard to implement reliably in user space
- Work by André Almeida, Mathieu Desnoyers
- Presented at the OSS EU this week

https://lwn.net/Articles/931789/

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btrfs same-fsid feature

- btrfs identifies a filesystem by its fsid
- You cannot mount two filesystems with the same id
- Problem: this can happen in systems with A/B partitioning
- Solution: add mechamism to support this scenario
- Work by Guilherme Piccoli

https://lore.kernel.org/linux-btrfs/20230504170708.787361-1-gpiccoli@igalia.com/

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Split-lock detector handling

- Atomic operations on non-aligned memory can cause a denial of service
- The kernel slows them down to prevent this
- Problem: many games use them
- Solution: add a way to control this behavior
- Work by Guilherme Piccoli

https://lwn.net/Articles/911219/

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More kernel features

- panic notifiers refactor
- kdumpst: tool for collecting data on a kernel crash
  - Arch Linux pstore and kdump tool, supports GRUB and both initcpio/dracut as init systems
- Work by Guilherme Piccoli

https://kernel-recipes.org/en/2023/schedule/panic-attack/
https://gitlab.freedesktop.org/gpiccoli/kdumpst

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And many other improvements and bug fixes...

Graphics

RADV

- Mesa Vulkan driver for AMD GPUs
  - Developed by Valve and other contributors
  - Alternative to AMD's official drivers
  - Most popular driver, shipped by most distros
- ACO: a shader compiler for AMD graphics
  - Reduces stuttering, increases FPS
  - Developed by Valve, announced in 2019

https://steamcommunity.com/games/221410/announcements/detail/1602634609636894200

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Advanced color in Linux: HDR

- Linux DRM exposes a small set of color properties
  - Proposals to extend the DRM color API have stalled
- AMD GPUs have additional color capabilities
- New work: driver-specific color API for AMD drivers
- Allows displaying content with High Dynamic Range (HDR)
  - Supported in userspace by the Gamescope compositor
- Available in the upcoming SteamOS 3.5
- Melissa Wen (Igalia), Joshua Ashton (Valve), Harry Wentland (AMD)

https://melissawen.github.io/blog/2023/08/21/amd-steamdeck-colors

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Better handling of GPU resets

- GPUs are complex and can crash
- No standard API to report the problem to userspace
- Roadmap:
  - Standarize how DRM reports GPU hangs to userspace
  - Standarize how userspace drivers deal with a hang
  - Standarize what compositors do after a reset
- Work (in progress) by André Almeida
- Presented at the North American OSS

https://www.youtube.com/watch?v=qpBLju1l9_w

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Asynchronous page flip in atomic API

- Improve the atomic DRM API to add asynchronous page flipping
  - Work by André Almeida
  - Presented at the XDC 2022

https://www.youtube.com/watch?v=qayPPIfrqtE

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Gamescope

- A micro-compositor for games, developed by Valve
- Allows:
  - Spoofing resolutions
  - Upscaling
  - Frame rate limiting
- Runs the Steam Deck's game UI
- Available in your favorite Linux distro

https://github.com/ValveSoftware/gamescope

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General OS work

SteamOS 3

- Arch Linux with a customization layer on top
- Almost all packages come directly from Arch, unmodified
- Policy: upstream everything
  - Original developer
  - Arch (when appropriate)

Immutable OS

- SteamOS has an immutable, read-only root filesystem
- A/B partitioning scheme
- Users are not expected to use the package manager or do anything that touches the root filesystem
- How to install new software then?

Adding software to an immutable OS

- Steam games: Steam store
- Desktop apps: Flatpak
  - Also used in other distros like Silverblue or Endless OS

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Flatpak

- A sandboxed app framework for the Linux desktop
- Apps are
  - Handled directly by their developers
  - Distro-independent
  - Isolated from the OS
- Flathub: the Linux app store
  - More than 2000 apps available
  - Primary distribution channel for some apps (e.g. Bottles)

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https://mastodon.blaede.family/@cassidy/111031129234702967

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XDG Portals

- A way for apps to interact with the host
  - Used by Flatpak, but also by others
- Portals define D-Bus interfaces for things like:
  - Access to files
  - Opening URIs
  - Screenshots
  - Settings

Selecting the right portals

- Portal APIs are implemented by desktop-specific backends (GTK, KDE, ...)
- Not all backends work on all desktop environments
  - Developers cannot test all posible desktops
  - This can cause crashes, timeouts and other issues
- Many backends can be installed at the same time
- Problem: limited way to select which portal to use
- Affects the Steam Deck: two graphical sessions

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New mechanism to configure portals

- Desktops can select which portals to use
- Feature added to xdg-desktop-portal 1.18.0
- Soon in all major distros
- Work by Emmanuele Bassi

https://github.com/flatpak/xdg-desktop-portal/issues/906

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Bugfixes and new features: KDE

- Discover: handle updates with large numbers of packages
  - Work by Harald Sitter
- Improve detection of new icons when an app is installed
  - Work by David Redondo
- Better handling of udev events from external drives
  - Work by Alberto García and David Edmundson

https://invent.kde.org/plasma/discover/-/merge_requests/630
https://invent.kde.org/frameworks/kded/-/merge_requests/21
https://bugs.kde.org/show_bug.cgi?id=467751

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Bugfixes and new features: UDisks

- Pass arbitrary options to mkfs
- Mount a filesystem on behalf of a different user
- Handle filesystem labels with non-printable characters
- Work by Alberto García

https://github.com/storaged-project/udisks/issues/583
https://github.com/storaged-project/udisks/issues/1065
https://github.com/storaged-project/udisks/issues/1056

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And many more

- Network Manager
- ALSA
- Pipewire
- SDL
- ...

Conclusion

- SteamOS is a fairly standard Linux system
- Policy: upstream everything
- Contributions to the Linux kernel, graphics, desktop, ...
- Brings new users and app developers closer to Linux

Thanks!

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