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LINUX MAGAZINE

ISSUE 292 – MARCH 2025

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Investigate the Linux engine beneath the Steam Deck's glossy chassis

Explore!

The Steam Deck game console runs on SteamOS, a variant of Arch Linux. While you typically use the Steam Deck like any other dedicated game machine, you can freely drop into a Linux Desktop mode of surprising and powerful potential.

BY JASON MCINTOSH

The Steam Deck, the versatile game console that Valve began selling in 2022, is hardly the first consumer-oriented technology that runs Linux under the hood. Readers of this magazine might have fond memories of the original TiVo boxes, for example, or have noticed a full copy of the GPL lurking in the deepest recesses of their cars' dashboard UI.

However, the Steam Deck stands apart in the level of transparency it offers regarding its Linux underpinnings. While its primary user interface is optimized for non-windowed displays and game-controller navigation, the Steam Deck explicitly invites users to alternatively use the device as a self-contained Linux machine running a KDE Plasma desktop. Bolder Steam Deck owners can use the power of its underlying operating system to extend and enhance their gaming experience.

This article presents an introductory guide through the user-explorable parts of SteamOS. I aim to empower you to playfully investigate this less obvious Steam Deck mode while still maintaining the core intent of the device: playing video games on a healthy and up-to-date SteamOS. More radical hacks of the Steam Deck hardware are certainly possible – as with any PC, you can wipe it and install your own Linux on it, if you want – but that is beyond the scope of this article.

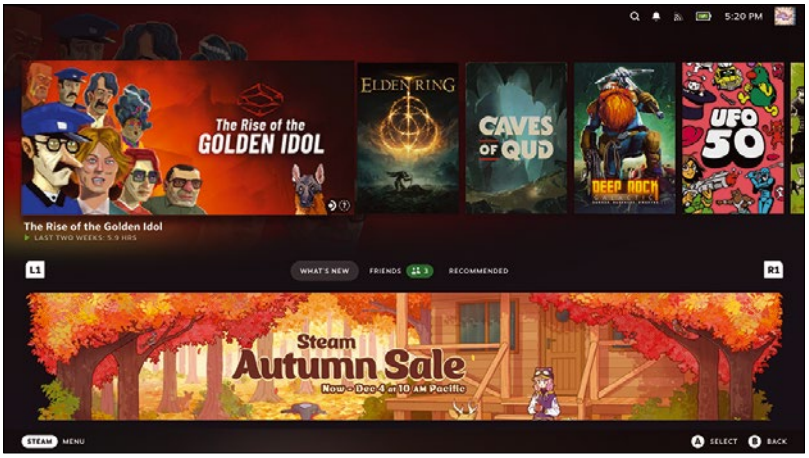

Figure 1: A typical view of the Steam Deck Gaming mode, right after turning on the console.

SteamOS in a Nutshell

The Steam Deck runs SteamOS 3, a derivative of Arch Linux. (Versions 1 and 2 of SteamOS were based on Debian and developed for Valve's previous experiments with commercial gaming hardware in the 2010s.) SteamOS 3 adds a handful of other Valve-developed technologies specific to the Steam Deck, such as the Proton compatibility layer that lets the machine efficiently run games and other software designed for Windows.

SteamOS divides its user interface into two major modes called *Gaming mode* and *Desktop mode*.

Gaming mode presents a user experience that resembles that of any other modern, Internet-connected game console, such as a Nintendo Switch or a Sony PlayStation. Gaming mode is designed to be operated entirely through the game-controller hardware built into the Steam Deck itself, or through a separate, Bluetooth-connected game controller that you provide. The Gaming mode UI is optimized for a single, non-windowed display, such as the Steam Deck's built-in screen or a connected TV. This is the default operation mode for the Steam Deck.

Figure 1 shows my Steam Deck in Gaming mode with big, colorful panels representing a handful of games I have installed – as well as an enticement to buy more.

Desktop mode is, very literally, a stock KDE Plasma desktop environment. It ships with a bit of Steam Deck branding and shortcuts to help you get your bearings, but you are otherwise free to treat it like any other Linux desktop. You can install non-Steam software using the command line or the KDE Discover application. You can even fire up Python and write your own software or stick something weird in your gaming machine's systemd timers!

Figure 2 shows my Steam Deck in Desktop mode, running the Steam desktop application, as well as a terminal window and a web browser.

Alongside this flexibility, the Steam Deck is designed to operate like a remotely managed device, much like other modern game consoles.

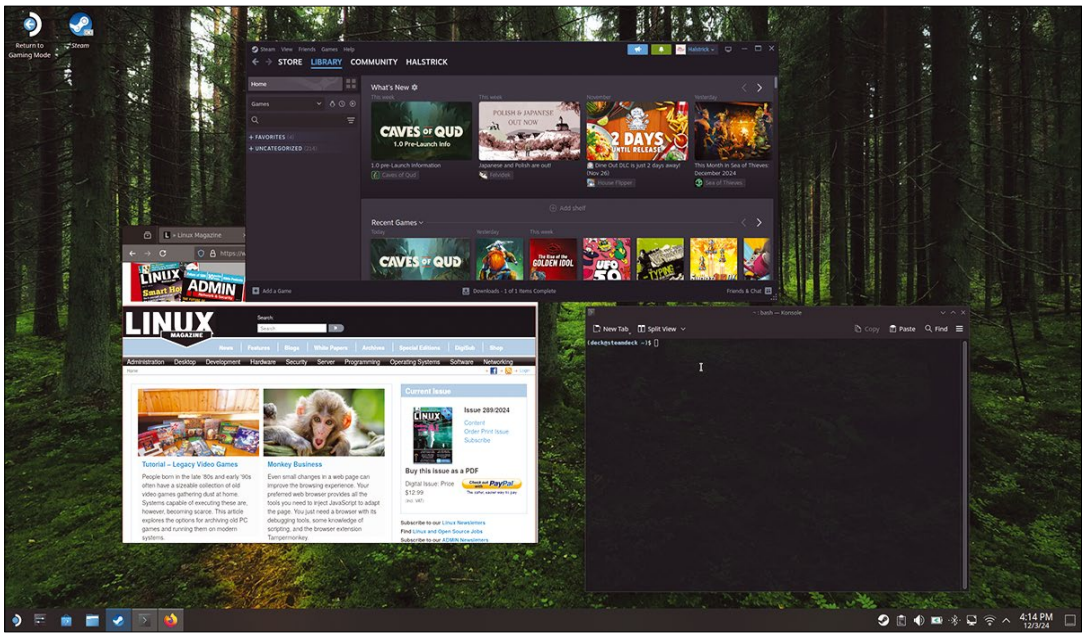

Figure 2: The same Steam Deck seen in Figure 1, only now running in Desktop mode.

While you can explore and modify the default user directory and a few other filesystem locations, SteamOS locks significant portions of the filesystem behind a read-only wall that not even `sudo` can breach. This prevents you from making changes that might get unexpectedly overwritten the next time Valve pushes an OS update to your device or which might prevent that update from running at all. Still, particularly risk-tolerant Steam Deck users can disable this safety feature if desired, as described later in this article.

Reasons to Pop the Hood

Even if you intend to use the Steam Deck only for playing games, bringing your familiarity with Linux to the device can significantly expand its potential to help you find fun and creativity.

Install and Manage Mods

A primary advantage that the world of PC gaming has over most consoles is the rich culture of game mods, player-developed modifications for game behaviors. The effects of mods can span the gamut from minor rules tweaks to entirely new fan-made works built from existing games' engines.

The combination of a user-accessibile filesystem and the Proton compatibility layer gives Steam Deck players access to game mods, even ones designed for Windows. The way that you install and manage mods varies among games. Some more polished games feature built-in mod-management libraries, while scrappier titles might require you to get far more manual, firing up a terminal window to make painstaking changes to data files or directories. In the latter case, the Desktop mode gives you all the power you need.

Install Games from Other Sources

Gaming mode is optimized to let you install, play, and – let's be honest – purchase games distributed through Steam. However, you can make almost any Linux or Windows executable installed on your Steam Deck available through Gaming mode. These can include manually installed applications, platform emulators like RetroDECK [1] or EmuDeck [2], or entire alternate games ecosystems such as Heroic Launcher [3]. In any case, doing this requires a side trip through Desktop mode.

As a simple example, you can use the KDE Discover application in Desktop mode to find and install SuperTux 2, an open source game similar to Super Mario Bros. You can then play it right away in Desktop mode, using a connected game controller. If you want faster access to the game in the future, then you can use the Steam desktop application to add SuperTux 2 to your Steam library, which lets you run the game from Gaming mode.

Tinker with Your Game Files

Because all of your games install their files in the user-writeable part of the filesystem, you are free to explore and modify these files however you like, using tools and techniques you're already well familiar with. Want to use `cp -av` to back up a game's data file and then see what happens to the game if you open the original in `vi` and change a thing or two? Nothing's stopping you!

Necessity can also be a motivator, beyond curiosity. Recently, I used my Steam Deck to play The Invincible, an excellent video game adaptation of the Stanisław Lem novel. My enjoyment of the game was briefly threatened by a disaster probably familiar to anyone with more than a little Linux experience. An update to the game collided with my

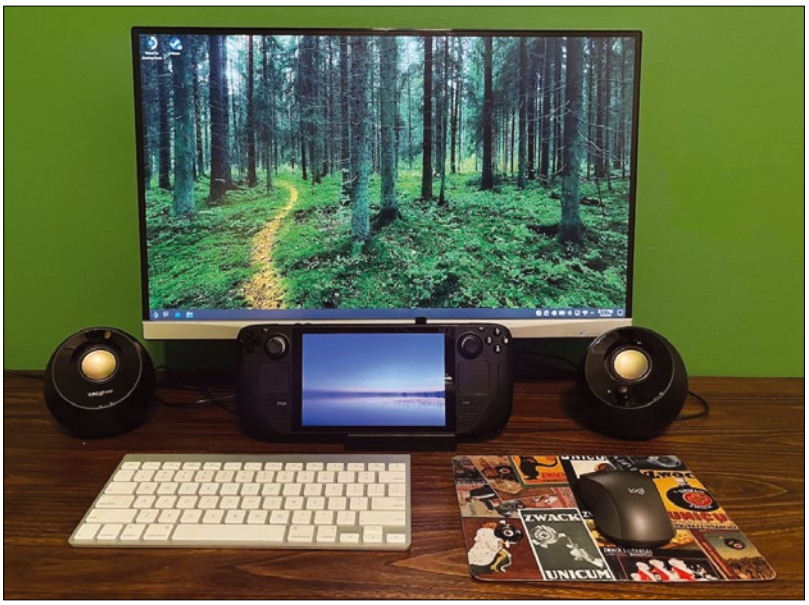

Figure 3: The author's preferred arrangement for using the Steam Deck in Desktop mode: docked, acting as a secondary screen to an external display, and with a keyboard and mouse connected over Bluetooth.

overstuffed Steam Deck running out of storage, resulting in my saved-game file being corrupted.

But, thanks to my Linux knowledge – and my experience at tiptoeing through much more serious disasters over a long engineering career – I was able to recover my saves through research, exploration, and careful experimentation. In the end, I used `touch` to create an empty file that the game's logs told me it expected to find in a certain location, and I was able to resume my perilous mission on the planet Regis III, curled comfortably on my couch wearing headphones.

This adventure, while uninvited, still left me feeling pretty good about my own diagnostic skills – as well as the power and flexibility of the Steam Deck. I dare say I wouldn't have been able to accomplish this sort of rescue on my PlayStation 5.

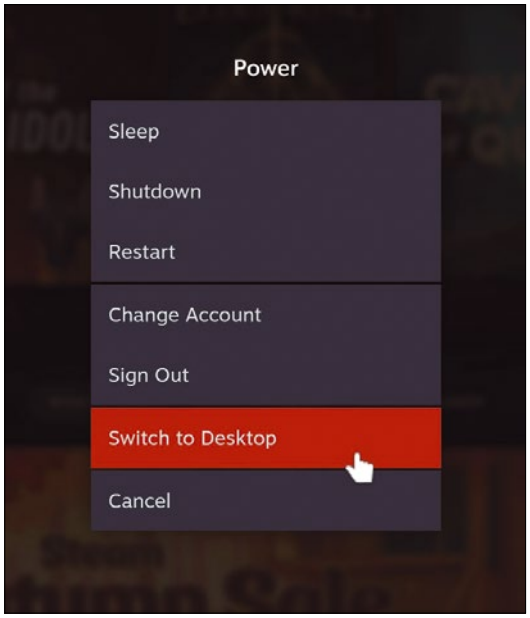

Figure 4: It's not the most obvious menu option, but it's not hidden, either.

Setting Up Desktop Peripherals

You can use Desktop mode without connecting external input devices or displays to your Steam Deck. Its built-in display can fit the whole KDE desktop, albeit at a tiny scale that might require some squinting. You can control the mouse pointer though the Steam Deck's on-board joysticks, trackpads, and triggers – or even the built-in touch screen, with a bit of patience. A virtual keyboard allows you to type using that same touch screen, similarly to how you enter text on a modern smartphone.

If you're in a pinch, being able to fall back to some or all of these measures can be helpful. However, if you want to explore the Linux side of your Steam Deck with comfort, efficiency, and minimum eye strain, then you need to connect it to a proper keyboard, video, and mouse setup.

The Steam Deck hardware includes both Bluetooth support and one USB-C port. This is enough to let you connect a wireless keyboard and mouse, for example, and then plug in a display using an HDMI-to-USB cable. However, this setup relies on battery power, because it takes up the sole USB-C port leaving you with no way to charge the device. This makes it inappropriate for anything other than very short-term use.

To let your Steam Deck really shine as a part-time Linux PC, use a peripheral that expands its USB-C port into a variety of other ports, including a route to power. While many solutions exist, I prefer Valve's own Steam Deck Docking Station. This little bit of custom-molded plastic and rubber includes three USB-A ports, HDMI and DisplayPort outputs, and a power pass-through. It also holds your Steam Deck in a propped-up, screen-forward manner, allowing you to position it relative to an external display so that you can use Desktop mode with both the machine's built-in screen as well as the external display.

Figure 3 shows my own preferred Steam Deck desktop arrangement. The mix of a commodity Acer display, an ancient Apple Bluetooth keyboard, and a much newer Logitech Bluetooth mouse demonstrates how the Steam Deck is happy to work with a variety of standards-capable devices.

Because the Steam Deck is designed to let you pair almost any Bluetooth-using game controller – even ones associated with other game consoles – the system offers rich Bluetooth configuration UIs in both Gaming mode and Desktop mode.

Of the two options, Gaming mode offers a simpler UI for Bluetooth pairing – and one that's much more legible on the small Steam Deck screen, if you haven't set up an external display yet. While intended to let you connect game controllers, this UI lets you pair any Bluetooth devices in range, including keyboards and mice. For more information, see the Bluetooth section of the "Steam Deck – Basic Use & Troubleshooting Guide" [4].

Having traditional input devices ready to use with your Steam Deck can have beneficial side effects, beyond making Desktop mode easier to use. Hardware mice or keyboards that work in Desktop mode also work in Gaming mode. Some games, such as traditional "point-and-click" adventures, present situations where grabbing a physical mouse can provide a much more comfortable experience than pushing a pointer around with a gamepad.

Even if you don't plan on using the Linux desktop with your Steam Deck very often, the modest investment in pairing up a mouse and keyboard with it can prove worthwhile.

Launch Desktop Mode

The SteamOS Gaming mode hides the doorway to Desktop mode in plain sight as the next-to-last option on the Power menu. To enter Desktop mode from the default Gaming mode, follow these steps:

1. Press the *STEAM* button on the Steam Deck, or the home button on your Bluetooth-connected game controller. (The home button varies depending upon your controller. For example, on a PlayStation controller, it is the button with the PlayStation logo on it.)
2. Select *Power* from the SteamOS menu panel that appears to open the Power menu (Figure 4).
3. Select *Switch to Desktop*.

After a few moments, a KDE Plasma desktop appears. If you have already plugged in an external display, the desktop appears on both the Steam Deck screen and the external display – it probably looks a bit backwards from what you expected. The next section addresses a one-time fix you can apply to your display setup before you start exploring the desktop.

Make Your External Display Primary

The first time you use an external display with your Steam Deck in Desktop mode, the device probably treats the Steam Deck's built-in screen as the main display, with the other one as secondary. If this happens, then the KDE panel, desktop shortcut icons, and other main-display features all appear in tiny form on the Steam Deck screen, while the external display shows a much larger, entirely empty desktop background. Even if you have sharper eyes than mine, this is probably not what you want.

To permanently assign the external display as the primary desktop screen, follow these steps:

1. On the Steam Deck screen, in the KDE panel, click the Application Launcher. Its icon resembles a Steam Deck logo, located in the bottom-left corner of the screen.
2. In the Application Launcher panel, select *Settings* to open the System Settings window.
3. Select *Display and Monitor*.
4. From the Device menu, select the name of your external display. Generally speaking, this will be the device *not* named *Built-in Screen*, which is the identifier of the Steam Deck screen.
5. Select the *Primary* radio button.
6. Click *Apply*. The KDE panel and other desktop elements move from the Steam Deck screen to the external display.

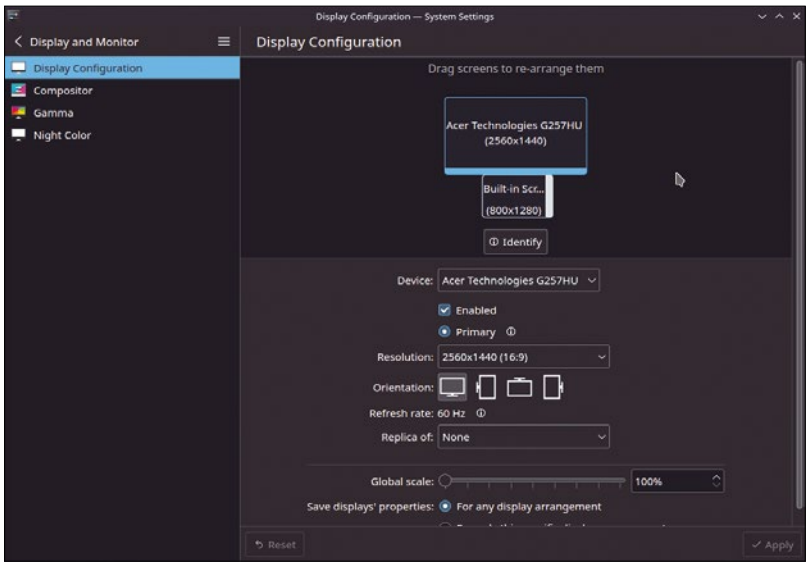

Figure 5: The author's preferred Display and Monitor settings for Desktop mode.

Your next step depends on whether you want to continue using your Steam Deck screen as a secondary display while in Desktop mode, as shown in Figure 3, or whether you want to keep Desktop mode contained entirely on the external display while it's connected.

To use your Steam Deck screen as a secondary display:

1. Reposition the two boxes in the display diagram so they reflect how you have positioned your Steam Deck and your external display relative to one another. Figure 5 shows what my Display and Monitor settings looks like, enabling the setup shown in Figure 3.
2. Click *Apply*.

To deactivate your Steam Deck screen while your external display is connected:

1. From the Device menu, select *Built-in Screen*.
2. Clear the *Enabled* checkbox.
3. Click *Apply*.

You can re-enable your Steam Deck screen at any time by following the previous instructions again, selecting the *Enabled* checkbox instead of clearing it.

SteamOS remembers your settings with this display so you don't need to repeat these steps the next time that you connect your Steam Deck to it. If you connect the Steam Deck to a different display, then you'll probably need to repeat this procedure.

Explore Desktop Mode

SteamOS Desktop mode logs you in as a non-privileged Linux user named `deck`. Its home directory is `/home/deck`, and you are free to use all the tools that KDE Plasma makes available – including the

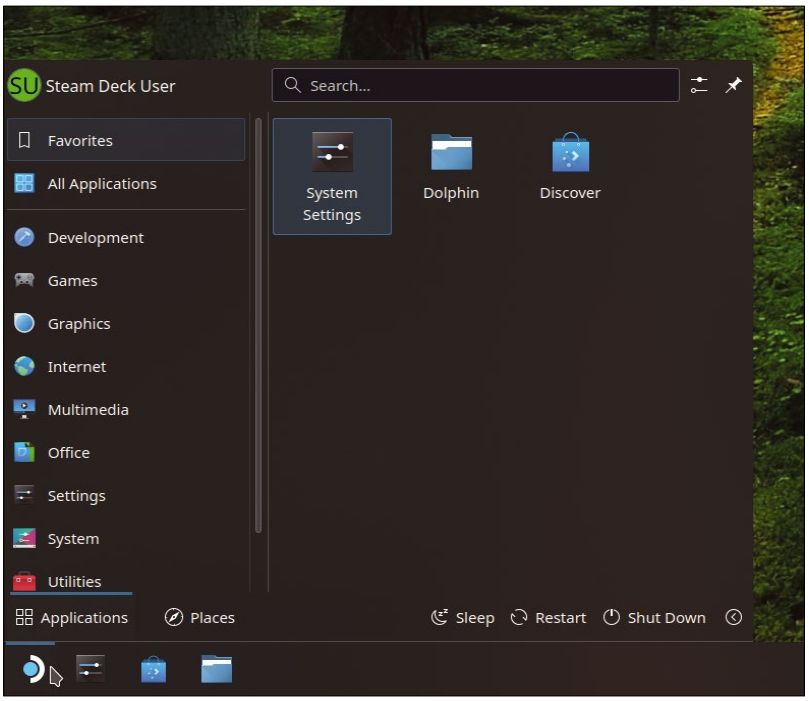

Figure 6: Clicking the Application Launcher, shaped like a Steam Deck logo.

Dolphin filesystem browser and Konsole terminal windows – to explore the system.

In normal use, all user-level operations you perform on Steam Deck are performed as the `deck` user, regardless of which Steam user accounts you have registered with Gaming mode.

For the sake of simplicity, I recommend using `deck` for all your Steam Deck exploration and experimentation. As noted later in this article, SteamOS does give you tools to grant `deck` more privileges when needed.

The first Desktop mode UI element to get familiar with is the KDE panel, which runs across the bottom of the primary display by default. The first icon on it is the Application Launcher, which in SteamOS is shaped like a Steam Deck logo (Figure 6). (Don't confuse it with the *Return to Gaming Mode* desktop shortcut, which is *also* shaped like a Steam Deck logo. I cover that later in this article.)

Treat the Application Launcher as your home base while you become familiar with Desktop mode. You can use it to find and run every tool and application mentioned in this article.

Aside from the filesystem locks described earlier, this really is a fully functional desktop Linux environment. You can use it with the same expectation of safety that you would find on any other Linux machine, when logged in as an unprivileged user. That is: As long as you understand what you're doing, you're unlikely to catastrophically delete your data or otherwise mess up the operation of your Steam Deck by accident.

When you feel bold enough to deactivate some of these safety measures, see the Advanced Use section later in this article. Until then, you should feel free to explore! Desktop mode gives you a great opportunity to get familiar with KDE Plasma.

To launch the Dolphin file browser, click the Application Launcher and select *System* | *Dolphin*. This opens a window focusing on part of the `deck` user's home directory.

When you are ready for a Linux command line, click the Application Launcher and select *System* | *Konsole*, as shown in Figure 7. And there you have it: a Linux command line on your video game console, with minimal resistance on the console's part.

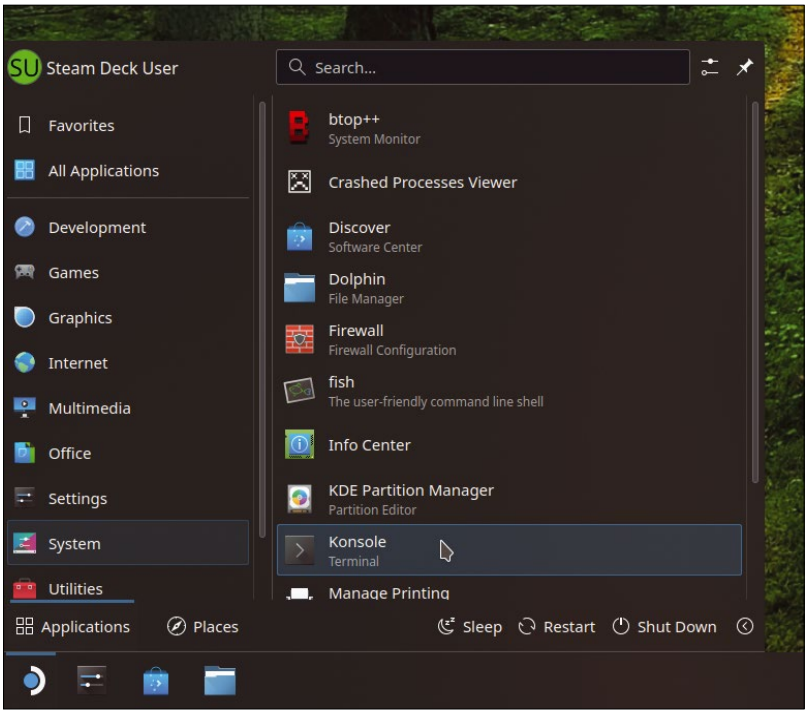

Figure 7: How to summon a command-line terminal in Desktop mode.

Install with Flatpak

The package manager of choice with SteamOS is Flatpak. Because SteamOS allows you to read and write to the `/var/` directory, Flatpak can install software in its usual default location of `/var/lib/flatpak`. This means that you can use Flatpak right away without running into any complications stemming from the read-only parts of the SteamOS filesystem.

The easiest way to explore available Flatpak packages is the Discover application. To use it, click the Application Launcher and select *System* | *Discover*. The window that opens lets you browse for software available from the Flathub application repository, all of which is just a click away.

For your first Flatpak foray, consider installing a web browser! The Steam Deck doesn't ship with any web browsers preinstalled – but Chrome, Firefox, and a bevy of other familiar favorites are all readily available through Discover. Even if you're unlikely to use your Steam Deck for day-to-day web access, you'll likely find a browser handy to have for one reason or another as you continue your explorations of the device's Linux side.

For more versatile use of Flatpak, you can run the `flatpak` command-line program from a terminal window (see [5] for more information).

Don't Use Pacman

Avoid using Pacman to install software on SteamOS – despite the fact that Pacman is the typical package manager for Arch Linux, the distribution from which SteamOS is derived. Pacman packages generally expect that the root user can freely modify any part of the filesystem – something SteamOS discourages by putting most of the filesystem behind a read-only lock. While you can disable this lock and install software using Pacman anyway, doing so runs the risk of unpredictable behavior after subsequent SteamOS updates, for reasons described in the next section.

To help keep your Steam Deck healthy and up-to-date, restrict yourself using the Flatpak package manager.

Advanced Use

SteamOS puts two safety layers between the factory-default state of the `deck` user and unfettered access to the entire system.

First, you can let `deck` run superuser commands by assigning it a password. To do this, run the `passwd` command in a terminal window and supply a password when prompted. From then on you can have the `deck` user run commands as the superuser by using `sudo`, just as you would on a typical Linux system. To remove this ability, remove the `deck` user's password by running `passwd -d`.

For complete access to the filesystem, including the parts that SteamOS normally locks away behind a read-only barrier, run

```
sudo steamos-readonly disable
```

I don't recommend doing this casually, because it lets you accidentally mess up the core operation of your Steam Deck – or even expose it to remote attacks by clever malefactors. At the very least, files that you write to the normally read-only directories risk being quietly overwritten the next time SteamOS downloads and applies an OS update image.

In all of my Steam Deck experimentation, I've never felt the need to flip the `steamos-readonly` switch. But, if you ever really need it, it's there. If you do flip it, you can always reset it with

```
sudo steamos-readonly enable
```

Exit Desktop Mode

To return to gaming mode, perform any one of the following actions:

- Open the *Return to Gaming Mode* icon on the desktop, as shown in Figure 8.

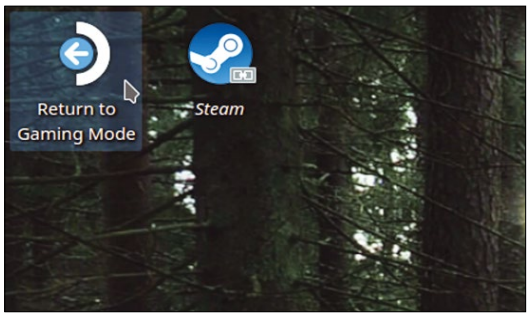

Figure 8: Get me out of here!

- Restart the Steam Deck.
- Log out.

After a moment, the full-screen, console-style Gaming mode returns to the external display, if it's still connected, or to the Steam Deck built-in screen.

Happy Hacking!

Among game consoles, and even among consumer hardware in general, the Steam Deck offers an unusual amount of trust and transparency to its users. Its Desktop mode presents an environment that invites curiosity, exploration, and tinkering among Linux users of all skill levels, operating in the interestingly purpose-built environment of a game console rather than a general-purpose PC. Even experienced Linux users who love gaming will likely find new inspiration from exploring the power and potential granted by the surprisingly exposed inner workings of SteamOS.

If you own a Steam Deck but haven't popped its hood yet, then I hope this article inspires you to explore. For more information, see Valve's FAQ about the Steam Deck Desktop mode [6]. ■■■

Info

[1] RetroDECK: *https://retrodeck.net/*
[2] EmuDeck: *https://emudeck.com/*
[3] Heroic Launcher: *https://heroicgameslauncher.com*
[4] "Steam Deck – Basic Use & Troubleshooting Guide": *https://help.steampowered.com/en/faqs/view/69E3-14AF-9764-4C28*
[5] Flatpak: *https://docs.flatpak.org/en/latest/using-flatpak.html*
[6] Valve Desktop mode FAQ: *https://help.steampowered.com/en/faqs/view/671A-4453-E8D2-323C*

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