FreeBSD Laptop 🐡 Shootout

There has never been a BETTER TIME to run FreeBSD on a LAPTOP

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While many people in the computing and IT industries still have desktop computer systems, the majority of us who spend our time looking at screens are often looking at laptops. FreeBSD runs well on modern laptops, and in this article, we'll look at a few choices that are particularly well suited to those who want to take FreeBSD with them wherever they go.

Like all open-source operating systems, FreeBSD has had a long, and sometimes difficult, relationship with laptop systems, most often because laptop vendors have been capricious in their selection of parts. The consolidation of most of the major functions of a laptop onto a single processor die has actually improved life for laptop users because it has meant the I/O devices used by the system, including SATA for disk, common video for the display, and networking, on both wired and wireless, are relatively common across a wide range of hardware. A laptop from Dell and one from Lenovo have more in common from the standpoint of their I/O devices now than ever before, and, as a result, the number of device drivers and other pieces of OS software that have to be maintained and tracked over time has shrunk. The various I/O busses have also consolidated, bringing similar economies of scale for the OS developer. All this has translated into more laptops working "off the shelf" with FreeBSD.

For this article, we'll talk about the resources available to help in picking a laptop for FreeBSD as well as some of the gotchas in running our favorite OS in a mobile environment. We'll also talk about four specific laptop models that offer good support for FreeBSD.
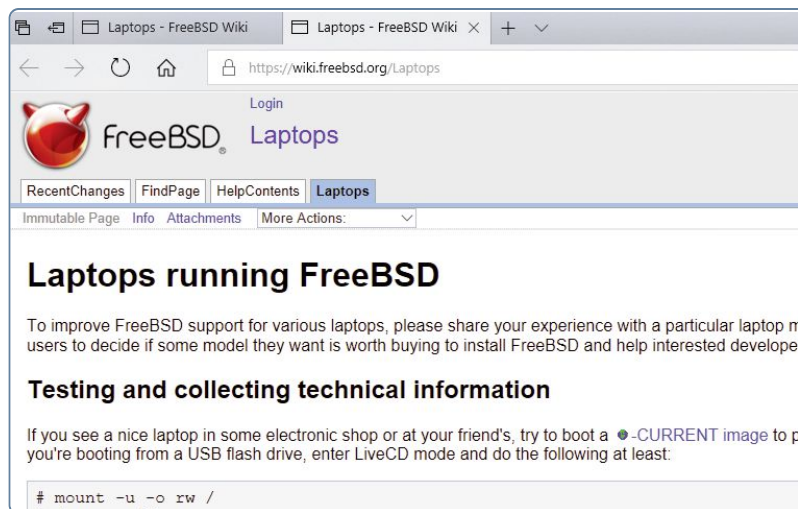
How to Pick a FreeBSD Laptop

Laptops differ from larger systems in a few important ways. They always include a built-in screen and keyboard and they are expected to run on battery power for much of the time they're in use. These three factors—screen, keyboard, and battery life—are very important when selecting a laptop. Another consideration is the type of storage available on the system. Some laptops can be equipped with both an NVME solid-state drive as well as an internal SATA disk, which for FreeBSD users means you can run a ZFS mirror in your laptop, an option we'll discuss later.

Perhaps the best resource for those trying to choose a FreeBSD laptop is the Laptops page on the FreeBSD Wiki (https://wiki.freebsd.org/Laptops). This wiki page is updated and maintained by people who are using FreeBSD on their laptops every day.

The main page of the Laptops wiki is a table of laptops that are currently usable with FreeBSD. The model name in the left column is a link that will take you to detailed information on a particu-

lar laptop model. The main page has columns for Graphics, External DP/HDMI/VGA, Sound, WiFi, Ethernet, USB, Suspend/Resume, Needs config, and Year introduced. Each column contains either a check mark, indicating the feature works out of the box; a blue on white info marker, indicating that some special configuration is necessary; a yellow marker with an exclamation point, which means the feature has not been tested; or, finally, a red mark indicating the feature does not work. The notes column is a set of free form notes that can be used to explain minor nits or other things that do not fit into the columns. Specific instructions on how to get any of the features that need a particu-

Laptops running FreeBSD

To improve FreeBSD support for various laptops, please share your experience with a particular laptop m users to decide if some model they want is worth buying to install FreeBSD and help interested develope

Testing and collecting technical information

If you see a nice laptop in some electronic shop or at your friend's, try to boot a ⊙-CURRENT image to p you're booting from a USB flash drive, enter LiveCD mode and do the following at least:

```
# mount -u -o rw /
```

Laptop	Graphics	External DP/HDMI/VGA	Sound	WiFi	Ethernet	USB	Suspend / Resume	Needs config	Year introduced
/Dell_XPS13_9360	✔ vt & scfb work in console & X	✔ drm-next	✔	✖	✔	✔	✔		2017 wifi is ATH10K but field replaceal using intel drm-next drivers, suspend/r HDMI all works. ethernet + HDMI requi additional adapter. wifi support is comi 12.x
/System76 Galago Pro	scfb: ✔		✔		✔	✔			
/Thinkpad_T470s	✔	✔	✔	✔	✔	✔	✔	yes	2017
/Thinkpad_X270	✔ drm-next		✔	✔	✔	✔	✔	no	2017Q1

lar configuration to work are contained in the particular model's sub page within the wiki. Note that none of these columns talk about the laptops in terms of comfort, such as how well the pointing device works or the feel of the keyboard. If you're interested in reading a review of how the device feels, you should search the web for reviews written by the press as the wiki is meant as a technical reference. If we look at the sub-page for the Thinkpad X270 (https://wiki.freebsd.org/Laptops/Thinkpad_X270), the laptop on which this article is being written, we find two sections, an Overview, which lists the particular devices present in the laptop, and Notes, which call out any things that ought to be of interest to someone who is trying to use this model.

The four laptops we'll discuss in detail were all released during 2017 and are all well supported by FreeBSD. They are the Dell XPS 13 9360, the System 76 Galago Pro, Thinkpad T470, and Thinkpad X270.

ZFS on Laptops

One of the nice features of FreeBSD is support for the Zetabyte Filesystem (ZFS). Most people think of ZFS as a system for managing large datasets with

many terabytes or petabytes, but ZFS has a few features that make it particularly useful to laptop users as well. When ZFS was first imported into the FreeBSD system, laptops were not really powerful enough to run the filesystem, which tends to use a lot of memory. But on a modern laptop, where 16G of RAM is a cheap and easy option, ZFS works quite well. FreeBSD's installer can install your laptop with ZFS by default and this is what we suggest for all laptop users. The two features of ZFS that should be of interest to laptop users are mirroring and snapshots.

If your day-to-day system is your laptop, you probably can't afford to have it be down for long should the disk fail. A ZFS mirrored laptop will allow you to replace either drive, should it fail, without losing any data and with very little interruption to your work flow. Three of the laptops reviewed in this article have the ability to have two storage devices present and used simultaneously. These are the System76 and the two Thinkpads. When using ZFS in a mirrored mode, make sure they get similarly sized disks because the ZFS volume created with a mirror will be the size of the smaller of the two drives. You cannot use a 512G drive to mirror a 1T drive; the resulting storage pool will be only 512G and you'll have wasted half a terabyte.

The Thinkpad models cannot be configured with two drives from the factory; you will have to add the second drive yourself. If you're not the kind of person who spends a Saturday tearing down your laptop, but you still want the second drive, it's best to go with System76, which will give you the option to order one of their systems with two drives installed. If you're going to run ZFS on your laptop, remember to order the maximum amount of RAM, which is 32G on the System76 and 16G on the other three models. Once you install your system, update your

"Choosing a Laptop is Like Picking COMFORTABLE CLOTHES"

sysctl.conf file to give only 4G of RAM to ZFS: vfs.zfs.arc_max=4026259968.

Short of a complete loss of a disk, the other day-to-day annoyance is accidental deletion of data. Having ZFS on your laptop means that you have access to easy snapshots, but you have to actually remember to take the snapshots to be able to use them later. By default, ZFS doesn't take the snapshots for you. The zfstools package can help you set up automatic, rolling snapshots, and we strongly recommend you install and set up this package soon after installing your new laptop.

Graphics Support

One of the biggest challenges to open-source operating systems continues to be the secrecy that surrounds the inner workings of various graphics chips. Consolidation in the industry has removed some of the players, and thereby made it somewhat easier for projects run by volunteers to keep up with the shrinking number of graphics chipsets, but the fact that getting reliable information about how graphics chips work or are supposed to be programmed is something that everyone in the field has to put up with. Unlike some other leaders of open-source operating systems, we will not show, graphically, just what we think of these restrictions, but it nevertheless is something you need to consider when choosing a laptop.

When people think of graphics on FreeBSD, they naturally think of Xorg, the most recent incarnation of the X11 system originally developed at MIT in the 1980s. X11 and the Xorg software continue to be the main system for people developing graphical applications on FreeBSD and other open-source UNIX-like operating systems. So, when you choose a laptop, your main concern is whether Xorg runs on the system; if so, how much configuration it requires; and whether or not a driver exists to take advantage of some of the more advanced features of your laptops graphics chips. The Xorg system comes with many different graphics device drivers, including `scfb` that works on nearly any chipset produced in the last 5 years, as well as an even more basic driver called `vesa`. Over the last 18 months, a concerted effort has been made to port and support more advanced drivers that come from the Linux world. The collective name for these more advanced drivers is `drm-next`. Unlike the vesa and scfb drivers, the drm-next drivers support many, if not all, of the features found in the latest chipsets, including acceleration and power-saving modes. While you might think acceleration is only useful for games, this is not the case, because modern graphical user interfaces have elements such as shadows and shine and other useless bling that pretty much require acceleration to work. More importantly to a laptop user are the power-saving features. The screen and graphics are some of the most power-hungry components in a laptop and being able to take advantage of power savings in these subsystems will significantly extend battery life.

One last consideration for graphics drivers is that those in the drm-next collection most often handle suspend and resume correctly. As John Baldwin points out in his article in this issue, getting suspend and resume to work on a laptop is non-trivial, but it is a feature that most of us expect.

Four Laptops for Your Consideration

We all spend a lot of time working on laptops. The following four systems come up time and again as venerable veterans of the FreeBSD road warriors: Dell XPS 13, System76 Galago Pro, Thinkpad T470, and Thinkpad X270. We'll discuss each one and how well it works with FreeBSD. Note we'll be covering technical aspects of how well they work, but not the feel of using them. Choosing a laptop is like picking

comfortable clothes, which means it's best to try them on in person before plunking down one to two thousand dollars to buy one.

Dell XPS 13

The XPS 13 is touted by Dell as a Developer's Laptop, but they don't say which developers they mean. We rather suspect that they don't mean kernel developers, because who in their right might would develop a laptop for them!?

The XPS 13 works well with FreeBSD, supporting the latest graphics drivers from drm-next, which means that the system also reliably suspends and resumes from RAM. The onboard battery gives 8 to 10 hours of power in typical usage, which is a typical working day. So long as you're willing to run a recent version of FreeBSD, something from the CURRENT branch, the built-in wireless works as well.

The configurable options on the XPS 13 are somewhat limited, with a maximum RAM of 16G and four choices for storage, 128G, 256G, 512G, and 1T on PCIe flash disks. The XPS 13 does not have space for a 2.5-inch spinning drive or SSD, so the ZFS mirror trick mentioned earlier will not work. The screen can either be a 1920x1080 or a QuadHD 3200x1800. The model that is referred to on the FreeBSD wiki page is the 1920x1080. One thing to remember about having a lot more pixels is that those pixels draw power, reducing the battery life you might get from the system. The battery in the XPS 13 is of a fixed size and cannot be customized or upgraded, as in other laptops mentioned here.

System76 Galago Pro

System76 is an interesting company specifically dedicated to making laptop systems for open-source software and the only company we've ever seen that specifically allows you to open their system without voiding the warranty.

The Galago Pro is the smallest and lightest of the System76 systems and it can be configured with lots of different options. One of the first that you'll notice is the ability to have both an NVME flash drive and a SATA flash drive, meaning that you can have a laptop with a ZFS mirror. It can be configured with 32G of RAM, which is quite a lot for a laptop. The display is QuadHD (3200x1800) and works well with scfb, unaccelerated Xorg driver. The only real drawback to the Galago is battery life, which stands at a paltry 4 hours in typical usage.

Thinkpad T470

The Thinkpad series has been a stalwart of the open-source community for over a decade. People love these systems so much that Lenovo issued an anniversary edition of one of their systems last year, and a hobbyist group started building modern motherboards to go into old X61 models that haven't been produced in many years. You often see various Thinkpads when you meet up with FreeBSD folks and so we're covering two of their models here.

The T470 is a 14-inch laptop and therefore the largest and heaviest of those we're going to cover. Like the System76, it can be equipped with 32G of RAM as well as two forms of storage but having both NVME and a SATA drive is not an option on the Lenovo website, so you'll have to order the laptop with one type of storage and then add the second one on your own. The cheapest option is likely to get a system with a built-in NVME drive and then buy a 2.5-inch SATA SSD and install it yourself.

The T470 works well with FreeBSD, which is unsurprising because several of the FreeBSD developers use one in their day-to-day work. The accelerated drm-next drivers are supported, and the system correctly suspends and resumes. The system can be purchased with a larger external battery giving the system 14–18 hours of battery life between charges.

Thinkpad X270

The X270, part of the X series, is the smaller cousin to the T470 listed above and is the system on which this article is being written. The X series has a long history with FreeBSD and with many of the project's developers who worked for many years on the X220 and X230 series—some of the first laptops on which accelerated graphics and suspend/resume worked reliably. There continues to be a brisk trade in parts for the earlier X series laptops, since many people are incredibly faithful to them.

The X270, like the T470, works well with FreeBSD, but is smaller and lighter, and if you fly with FreeBSD, you will definitely want to consider this model as more portable as well—possibly usable in an economy seat. The X270 can only be configured with a maximum of 16G of RAM, so if you know you need a lot of memory, you should probably look into the T470 or the Galago Pro. Accelerated graphics from the drm-next driver as well as suspend/resume work as expected. Like the T470, the X270 can be configured with two types

of secondary storage, and, again, you'll have to set this up on your own, and also like its bigger cousin, it can be equipped with a larger external battery. The 72-watt hour battery in addition to the internal 24-watt hour battery give you a whopping 96-watt hours, which, in day-to-day usage, translates to about 12 hours of power.

In Conclusion

If you're a true fan of FreeBSD and want to use it everywhere and as often as possible, this is definitely doable with modern laptops and without compromising on important features such as accelerated graphics, long battery life, and suspend/resume. As an added bonus, you can have an even safer laptop experience if you get two drives and use ZFS mirroring. Following the FreeBSD Laptop wiki page will give you the latest information on which laptops work well with FreeBSD, and, if you happen to purchase a model that's not on the list, please consider contributing your information to the wiki, as this is how you can help our open-source system advance.●

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