

# Linux development on the PlayStation 3, Part 1: More than a toy

Please do adjust your monitor

Skill Level: Intermediate

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The Sony PlayStation 3 (PS3) runs Linux®, but getting it to run well requires some tweaking. In this article, first in a series, Peter Seebach introduces the features and benefits of PS3 Linux, and explains some of the issues that might benefit from a bit of tweaking.

When Sony first announced that the PlayStation 3 would be able to run Linux natively, a great deal of excitement ensued. Early on, it was a bit of a challenge to get Linux natively installed. The supported installer ran a custom script that hand-mangled a Fedora Core 5 or 6 install DVD into a runnable system with a special PS3 kernel. People put in hours and hours of effort to get other systems, such as Ubuntu, working. Terrasoft's Yellow Dog Linux, with an actual graphical installer that ran on the PS3, was the king of the hill.

Time has passed, and a great deal has changed. Fedora 7 installs on the PS3 out of the box, with the most challenging parts being selecting the PS3 storage driver so it can find the install DVD, and remembering to specify a video mode on the initial install command line so you'll be able to see the installer.

So, you can run Linux on the PS3. It's easy. The problem is, it doesn't necessarily run well. If you picked the PS3 up as a cheap Cell development system, it's a little frustrating to discover that, having followed the default install procedure, you have a system that comes up with a hundred megs or more of swap in use by the time you get to a shell prompt.

#### About this series

This series of three articles looks at PS3 Linux as a prospective development environment.

This first article, Part 1, introduces the basic configuration knobs and widgets specific to the PS3, shows you how to use them effectively, and suggests the kind of trickery that might get improved performance or a more usable display.

Part 2 and Part 3 then delve into some of the performance and tuning issues that, while they might apply on any system, are particularly useful for turning your PS3 from a proof-of-concept demo into a working system.

### Getting started

Grab Fedora 7. (Fedora 8 probably works too, but I had Fedora 7 handy when I started typing.) Obviously, you might get better results in some ways from one of the more natively tuned distributions, or one of the distributions built around being small and efficient, but Fedora 7 has a huge advantage: it's supported by the Cell/B.E. SDK. (So is RHEL 5.1, but Fedora 7's nicer.)

I'm a big fan of using Bittorrent for downloads, because it helps spread the load out. This means that you should leave your client running until you've uploaded at least as much as you've downloaded; open source software is about cooperation, and cooperating on bandwidth costs is a great starting point. It'll take a while to download the whole DVD image (see Resources), so while you're waiting, here's some background on PS3 Linux.

The PlayStation 2 ran Linux as well, but it was a bit of a pain. Sony released a special kit for it, which ran only on the older, thick PS2s and required an optional hard drive. There was no support for the later (more common) "slim" PS2 units, and the kit quickly disappeared. But, fundamentally, it disappeared because it was mostly a proof of concept; the system didn't have all that much memory, and without special compiler tools, the CPU was just a fairly standard MIPS core. The vector units were not widely supported or documented outside of proprietary tools.

By contrast, the PS3 has had support for running Linux since before it was released, and Sony has made support code and packages widely available. The "Cell addons" CD released around the system's launch included direct support for Fedora 5 and 6, but it also provided all the files needed for other distributions to develop PS3 ports. As a result, Fedora 7 simply works on the PS3 without the need for a separate CD, although you still need to use the Sony downloads to install the bootloader. The add-on software CD (see Resources) continues to get updates with new kernel versions.

#### Understanding the hypervisor

The PS3's base specs are 256MB of main memory, a Cell/B.E. processor, wired ethernet (and 802.11b/g wireless, on some models), a graphics unit called RSX (with 256MB of its own memory), and a SATA disk drive. There are also some peripheral attachments available, including USB ports, a card reader on some models, and Bluetooth. However, this is not the machine PS3 Linux runs on.

#### Where's the other SPE?

The Cell Broadband Engine has 8 SPEs. PS3 Linux has 6. One is reserved by the hypervisor. Where's the other one?

The answer is that the PS3 ships with one SPE disabled. This allows the use of chips where a single SPE was defective, improving chip yields and reducing costs. So, although the theoretical design of the Cell/B.E. has 8 SPE cores, there are only 7 available on PS3 hardware. One of them runs only security tasks assigned to it by the hypervisor, leaving 6 available for Linux, or for games.

On the PS3, Linux runs under a hypervisor—in essence, PS3 Linux is running on a virtualized machine, similar to a Xen virtualized machine. The hypervisor provides controlled and filtered access to the PS3's hardware. For instance, Linux code has no direct access to the RSX graphics processor. Rather, a special device is provided that allows limited access to it, providing for a reasonably efficient 2D framebuffer.

The hypervisor provides a number of translations. For instance, as mentioned, the hypervisor provides Linux with a virtual framebuffer device, which the hypervisor then implements using the RSX graphics core. Similarly, Linux has no access to the SATA hard drive. Instead, it has access to a SCSI drive, which maps only onto the region of the internal drive that was allocated for the "Other OS" partition. It is simply physically impossible to access the part of the disk being used by PS3 game software.

The network hardware is perhaps the most interesting. PS3 Linux can access either the gigabit wired ethernet or the 802.11g wireless, but not both at once. When you configure the network interface, if you specify it as a wireless interface with an SSID. The hypervisor uses the wireless; otherwise, it uses the wired interface.

# Understanding consumer electronics video modes

If you're reading this with a PC hardware background, the video modes are going to sound weird. Rather than describing them in terms of total resolution ("1024x768") or given cryptic names ("XGA", "SXGA", and so on), most of the video modes used are described exclusively in terms of vertical lines of resolution. In the US, using the NTSC standard, the usual resolution of a standard-definition television (SDTV) is 480 lines of resolution—but wait! Actually, there isn't enough bandwidth in the signal to draw 480 lines per frame, so in fact, you get two alternating frames of 240 lines, which are then displayed simultaneously, *interlaced* with odd-numbered lines coming from one frame, and even-numbered lines from another. This is called "480i," with the i indicating an interlaced resolution. (Some systems don't even do 480i, doing instead only 240 lines total.)

Many DVD players, as well as some game consoles (such as the last-generation Xbox, some GameCubes, and the PS2), also support an additional option, available only when using component video cables, called "480p." The "p" stands for *progressive*, and indicates that the whole 480-line frame is drawn all at once. Some TV vendors refer to 480p support as Enhanced Definition TV (EDTV), in contrast with High Definition TV (HDTV).

Higher resolutions are 720p (720 lines, progressive scan), 1080i (1080 lines, interlaced, which is two alternating fields of 540), and 1080p (1080 lines, progressive scan). Competition among these, and budget-conscious hardware developers, mean that some devices support only some of these.

None of these resolutions inherently specify a horizontal resolution, but on the PS3, you can generally safely assume that the output will be scaled for a 16x9 display by default.

Finally, all of these resolutions include *overscan*—on a standard television, the image is normally displayed slightly beyond the edges of the display, to ensure that there are no black bars around the image, which many users find distracting. So, the default Linux handling is to use only part of the display, rather than the full theoretical resolution. For each of these video modes, there's a corresponding "full screen" video mode that actually uses all the space. Terra Soft has an excellent page on video modes (see Resources).

So, let's discuss the amended specifications. PS3 Linux runs on a virtual machine that has a Cell/B.E. processor with 6 SPEs, about 212MB of main memory, a single network interface, a SCSI disk (plus several more SCSI disks if you have a card reader), a SCSI device that may be a DVD-ROM, CD-ROM, or possibly a Blu-ray reader, and functional USB and Bluetooth ports. Graphics are provided by a special framebuffer device, which supports a broad array of video modes (see Understanding consumer electronics video modes).

### Plan your development environment

To make good use of a PS3 for development, first decide what you need out of the development environment. If you are comfortable abandoning X entirely, it'll save you a huge amount of memory (the Fedora default of running Gnome is, perhaps, not one of the most memory-conserving strategies). A lot of the system setup utilities are most accessible through X, but they can take a long time to run. I ran the graphical package updater under Gnome, and it took several hours. This is probably

because the process had a total memory footprint of 375MB, substantially more than the physical memory available. It spent most of its time waiting for the swap disk, thrashing like Emacs on a VAX.

The lesson here is that available memory is going to be your biggest weakness on the PS3. Turn off services you don't need as quickly as possible. Run xterm instead of gnome-terminal. If you need multiple windows, consider running *screen* instead of multiple xterms.

### **Display options**

If you're going to run headless, don't worry too much about these. But if you want to run with a display that you're going to look at, you need to consider display options. The best quality comes from using the PS3's HDMI output. If you have a computer monitor, HDMI to DVI cables can be had quite cheaply, but be sure your monitor supports High-bandwidth Digital Content Protection (HDCP). If it doesn't, you'll get a black screen, or possibly brightly-colored static. If you're using a KVM switch, note that the switch too, not just the display, has to support HDCP! Unfortunately, there appears to be no way to turn this "feature" off; you simply can't get an unencrypted signal. While this makes some economic sense for a device that plays high-definition movies, it can be a bit frustrating to need special permission to view your X desktop. HDMI/DVI supports pretty much every video mode the PS3 has to offer, both the consumer electronics modes, such as 720p, and the PC modes, such as WXGA.

If you can't do HDCP, or don't have a DVI-capable monitor, your next best bet is component video. Component video, mostly accepted by TVs, but also by some computer monitors, is very similar to plain old VGA, only it comes out as three RCA connectors, one red, one green, and one blue. The component video cable is an additional-price addon—but it's the same as the component video cable for the PS2, if you had one of those. Component video can reliably support 720p and 1080i displays, but may not work for 1080p (see Understanding consumer electronics video modes if you're not sure what this is). Component video offers both higher resolution and better clarity than the next two options.

If you can't do component, you might have a device that supports S-video. S-video supports 480i, but divides the signal into two separate channels, luminance and chroma (that's "brightness" and "color"), giving better sharpness than your final option, composite video. Composite video is the plain old RCA jack, usually colored yellow, that is compatible with nearly everything. If you can possibly avoid composite, do.

Note that the Fedora 7 installer is essentially unusable with anything under 720p, unless you force it into text mode. Really, if you plan to use the PS3 as a development system, you ought to favor higher resolution modes. Linux systems have developed an affinity for larger displays, and the Fedora windowing environment is just plain awful on a low-resolution display. Furthermore, the

lower-resolution displays, especially over composite cables, are very hard to read, with horrible blurring.

My system was set up for WXGA (1280x768) over DVI, and this is quite usable. It's enough desktop real estate for a couple of windows without overlap.

### Install Fedora

By now your Fedora DVD should have downloaded, so the next step is to install it. Follow the usual PS3 instructions for getting your disk partitioned (you do lose all your data if you do this, so make backups!) and the Other OS boot loader loaded. When the time comes to put in the Fedora DVD, and boot from it, enter linux64 text or linux64 video=720p at the kboot prompt. 720p is the minimum usable installation video size; if you don't have component or DVI output working, use text. Booting with the default options resulted in the installer apparently freezing with a Fedora logo on screen; in fact, the installer's window was larger than the default display area, leaving me with no option but to power the machine down and try again.

After this, go ahead and get all the current updates from Fedora's update servers, and install them. This will take quite a while, as will the initial install. In both cases, once it gets started, go do something else for a couple of hours.

### Next: Installing PS3 addons

Part 2 of this series discusses getting the latest PS3 addons installed and updated on your system, and some of the configuration changes you can make to reduce the basic memory footprint until you've got a bit of breathing room.

# Resources

### Learn

- See all parts in the Linux development on the PlayStation 3 series.
- An introduction to Linux on the PLAYSTATION 3 (developerWorks, January 2007) is the first in another series about running Linux on the PS3.
- Read Sony's guide to the OtherOS feature, including the download of the installer.
- Terra Soft's page listing video modes is very helpful.
- Wikipedia's Linux for PlayStation 3 is a good starting place for learning more.
- In the developerWorks Linux zone, find more resources for Linux developers, and scan our most popular articles and tutorials.
- See all Linux tips and Linux tutorials on developerWorks.
- Stay current with developerWorks technical events and Webcasts.

#### Get products and technologies

- The Fedora project makes it very easy to obtain DVDs.
- Get the PS3 linux distro kit (also known as the "addons CD") from this wonderful collection of interesting Cell-related things.
- At the Cell Broadband Engine Resource Center on developerWorks, you can get the Installing FC7 on PS3 (SDK 3.0) (Updated 01/15/08) infobomb.
- Order the SEK for Linux, a two-DVD set containing the latest IBM trial software for Linux from DB2®, Lotus®, Rational®, Tivoli®, and WebSphere®.
- With IBM trial software, available for download directly from developerWorks, build your next development project on Linux.

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### About the author

#### Peter Seebach

Peter Seebach has been collecting video game consoles for years, but has only been running Linux on them recently. He is still not sure whether this is a Linux machine that plays video games, or a game machine that runs Linux.

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