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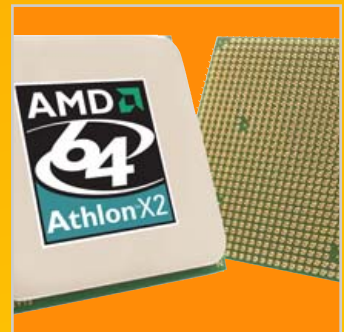
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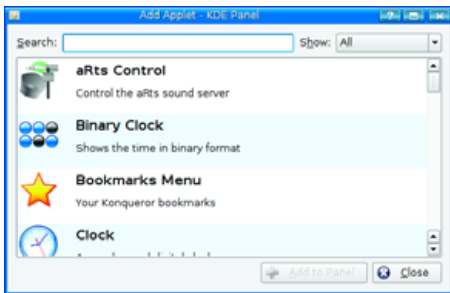
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HIGH-PERFORMANCE COMPUTING

The term "high-performance cluster" elicits both a sense of excitement and a feeling of intimidation. The latter need not be true, because clustering and high-performance computing isn't really rocket science, as you'll see from our articles next month. Whether you're clustering for redundancy, availability or to create a compute-intensive graphical representation of quantum dynamic collision of atoms, you'll find Linux to be a natural. We'll cover DRDB, heartbeat, the multiplatform distributed computing Condor and even MILLE-XTERM for scalable X-terminal deployment.

In addition, our columnists put priorities in perspective. Does it make sense to obsess over perfection when using quick-and-dirty shell scripting? And, when it comes to security, worrying is good if you're worrying about the right things. We'll tell you what some of those "right things" are.

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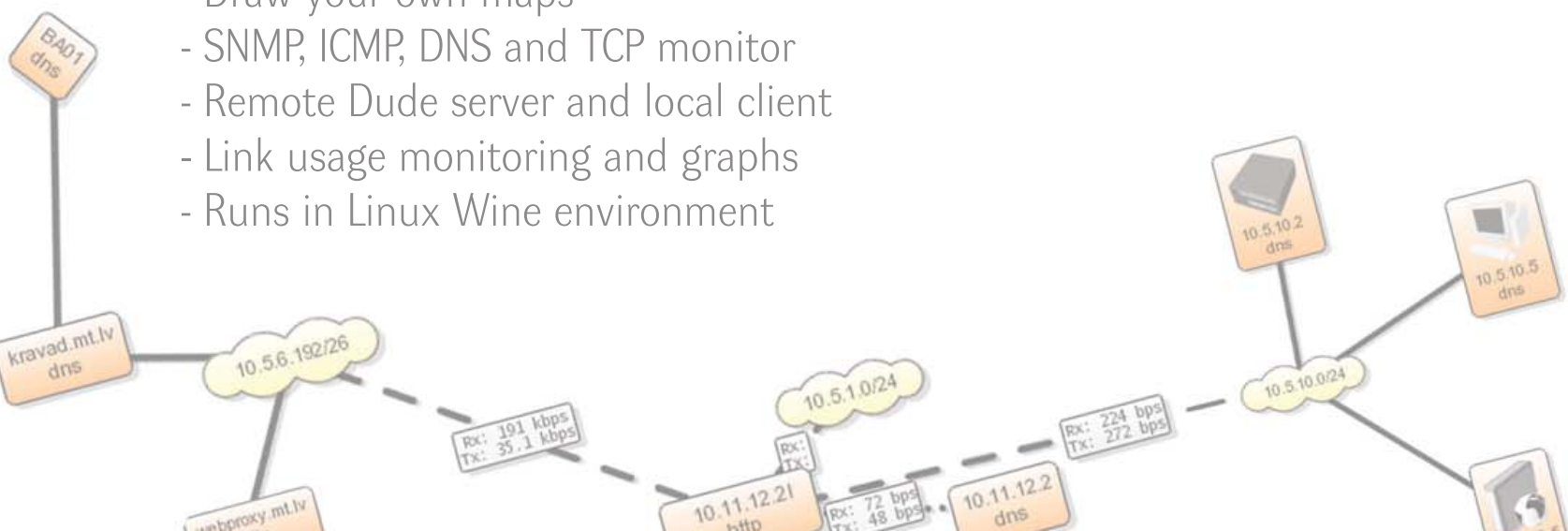
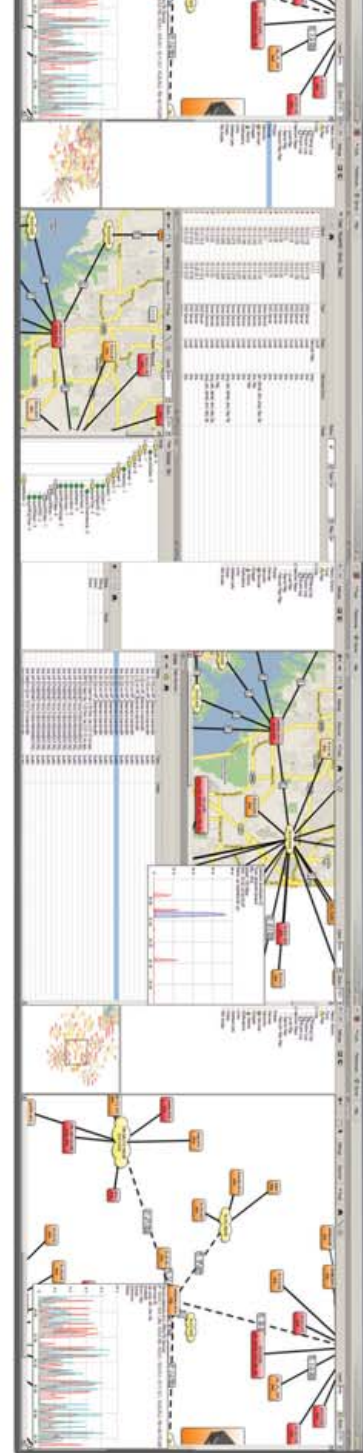
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In Defense of GNOME

I think *LJ* and even Linus couldn't be more off the mark with their GNOME comments. Choice is great, but when there are too many choices, you just don't really know what to do. I've always found that KDE was far too busy for me to work with, and GNOME < v.2 was like that too (I remember the days when GNOME was paired up with Enlightenment). I'd like to work, not configure. Coincidentally, when I asked my CompSci friends to pit KDE vs. GNOME, none of them came to the defense of KDE. And, lots who replied are friends whose opinions I respect, and a good handful of them, *gasp*, use Apple laptops with OS X.

--

Benton Lam

An Easier Way to Keep Linux in Suspense

I enjoyed the May 2006 issue, especially all the articles on virtual machines. I have a lot of experience dual-booting various Windows and Linux OSes. Recently, I have been playing around with VMware on Linux and Windows, and I think I have an interesting killer app for running a Windows host with a Linux guest: Suspend. I never have been able to get Linux to do a proper software suspend to RAM except on IBM T and X laptops. So running XP on the system lets me play 3-D games and standby and resume very reliably. I can click on VMware and run all my favorite Linux tools and toys with ease. I also can save lots of money in electricity and still have my computer respond in seconds, not minutes.

--

Stuart Boreen

Gentoo Emerges Victorious on AMD64

In *etc/rant* [June 2006], the complaint seems to be not so much about Linux's poor AMD64 support as much as it is about Debian and Ubuntu-based distros' AMD64 support. I bought an AMD64 system about a year ago, installed Gentoo (because why use 32-bit packages if you don't have to), and it worked (and still works) flawlessly. The Gentoo/AMD64 devs did a wonderful job of making sure the very few packages that don't work with AMD64 completely have another method of installing. Need Flash? `emerge (install) mozilla-firefox-bin`. Java nplugin comes with `emul-x86-java`. Need `win32codecs`? `emerge mplayer-bin`. Everything else can be emerged completely as normal.

--

John

MS Office Compatibility Is a Must

To "da editor in chief": I wanted to write a few times, since it's great to see you at *Linux Journal*. I think the position is a perfect fit. I followed you through the years at other rags and like your style very much. I hated to see you go, but everyone moves on hopefully to bigger and better things.

First thing I want to say is the column name is also perfect.

Second, SUSE does ROCK indeed. I've been using it since around version 5, and I've been more or less happy, but 10 really ROCKS. I have both an i86 and AMD64 machines running 10—both installed the correct version flawlessly. That's what I call smooth.

I'm sorry I must disagree with you on your first article [February 2006], which basically stated that Linux office suites should not look like Microsoft products or mimic them in any way. Statistics report that Microsoft Office has more than 90% of the office market—it is the product to beat. My last gig was at a very large Microsoft shop with 6,000 people in the US. Now, that's a lot of licenses. Because of the compatibility of products like OpenOffice.org, I was able to load my laptop with SUSE and use OpenOffice.org to edit documents created with Word. I also was able to send these docs back and forth with changes, and nobody was the wiser that it was done on a Linux box with OOo. If the compatibility of OOo with Office wasn't there, I would still have XP on my laptop. I was able to use the company LAN, WAN, VPN and so on with no problems. The problems I did have were with Excel and PowerPoint, because these weren't so compatible, and/or my expertise with them was not so good. I'm a programmer, not a CPA or salesman. The bottom line is, if I can use OOo as a replacement for Office, I can run Linux. If not, I have to run Windows.

Maybe in ten years, when Open Document will be the standard file format, we can have different products with a different look and feel, because they will all write the OD file format. At the moment, we have to beat the leader at its game, which in both the enterprise and desktop areas is really the only game, but Linux is becoming a major player and open-source products like OOo are fast becoming a "drop-in" replacement for Microsoft. We can't let Linux fall to the wayside just like the Mac did, because it wanted to be different and not have anything to do with MS. Microsoft helped Mac be its own entity and be different, and basically made Apple pie out of them. Now only the crust is left. No threats from any Mac area of expertise.

Thanks and good luck. I might not agree with everything you say, but I definitely will be reading your page every month.

--

Jeffrey Lapchinsky

What Good Do Rants Do?

How is ranting about the inadequacies of Fedora 5 accomplishing anything good [June 2006]? Complaining about disk labels? Have you tried doing `iscsi` without labels? Let me know how long `/dev/sda` remains the same disk after reboot. (LVM disk IDs notwithstanding.)

--

Tu

I hope ranting about Fedora's current method of using disk labels inspires Fedora to implement them



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better. As I suggested, all they have to do to fix the problem I encountered is create better labels, such as FC5ROOT instead of /.—Ed.

Has Fedora 5 Left Nick Breathless?

A good rant this month about Fedora [June 2006]. I was nodding my head as you trashed the default partition labeling and dissed the glacialness of Yum. I occasionally have to use Fedora at work—to prevent myself from using Dan’s Boot and Nuke to solve all of Fedora’s problems at once, I just keep muttering to myself, “at least it’s not Windows, at least it’s not Windows....” Finally, apart from a small jab at Debian about licensing, you haven’t had a go at Debian or Ubuntu for ages—have you run out of puff?

--
Sonia Hamilton

Fusing SSHFS with Your System

I just received a copy of the June 2006 *Linux Journal*, and as I was browsing through, I saw the article on SSHFS. I finished reading the article, and I thought, “WHOA! I could so use this!” So I rushed home to install.

I am using Debian (sarge), so I opened up synaptic, searched for sshfs and there it was! I installed it, and followed along with the article about how to configure it. I set up the usermod, and my empty directory and then...failure. Bleck: sshfs Me@ip: /remotefolder "fusermount: fuse device not found, try 'modprobe fuse' first FATAL: Module fuse not found.

I looked around and found that I needed to create a module for the kernel. Again using synaptic, I downloaded module-assistant and fuse source. I already had my kernel-headers installed, but a few of the other systems did not. That package is required for the installed kernel. This command seemed to work well (take note of the quotes):

```
apt-get install kernel-headers-`uname -r`
```

Once they were installed, as root I ran:

```
module-assistant build fuse
```

Followed by:

```
m-a install fuse-source
```

```
modprobe fuse
```

At this point, you must reset your login. Either reset GNOME/KDE, or if you did this in another terminal session, log out and back in.

Now, I reran as my user: sshfs Me@ip: /remotefolder, entered my password, and it worked!

From this point on, I had no other problems with following the article. Thank you so much for pointing out this gem. My household runs Debian Linux and telling my wife and guests how to use

SSH all the time to transfer files can be bothersome at times. Now there is just a folder with the different links they can click on! Thanks LJ!

--
Chris Stackpole

Tail between Its Legs

I recently upgraded my distro, and all these little scripts I have all of a sudden, didn’t seem to work. Why? Because the utilities head and tail have now decided that tail -2 is no longer valid syntax. You see, if I had half a brain I should know that the “proper” syntax is tail -n 2 or tail --lines=2. They really should have pushed harder for tail --may-I-please-see-the-last 2 --lines. Just because -# numeric arguments [worked] for more than 20 years is no reason I should have an expectation for it to continue. After all, -n 2 is “standard”, you know, and I should just suck it up and look around on every single machine I upgrade and make sure I haven’t committed the mortal sin of using deprecated syntax. My clients just love paying me to do that.

--
Keith Smith

Great rant! Want my job?—Ed.

Deconstructing Constructive Criticism

I have been reading your etc/rant column since you began writing for LJ, and some points you bring up are valid and need to be said. I would like to provide suggestions to make your comments more fruitful as well as acceptable to others.

From a reader’s perspective, your style seems to be to offer criticism in an attempt to create positive results. That criticism, however, is destructive—not constructive. Constructive criticism encourages improvement. Destructive criticism destroys what we have already built, and thus your comments are seen as a digression from the cause of Linux. Let’s deal a better hand of cards.

--
Valden

Thanks for your comments. I’ve changed the name of the column so that I won’t have to rant every month, but I wanted to respond to your concerns. I abhor character assassination, the last resort of someone with no substantial defense, so it is never my intention to engage in character assassination. So my point regarding Fedora 5 wasn’t to call the Fedora developers boneheads. My point was that Fedora’s approach to partition labels is bonehead. As I pointed out in the column, Fedora could use labels that aren’t likely to conflict with other distributions, such as FC5ROOT instead of /. This is what I consider constructive criticism, even if it is wrapped in a politically incorrect tone, which is simply my rant style.

In short, I think where we disagree is on what constitutes constructive criticism. I think you’re looking for constructive-sounding criticism.—Ed.

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diff -u

WHAT'S NEW IN KERNEL DEVELOPMENT

Work continues on the **git** revision control system. Recently, **Linus Torvalds** eliminated the dependency on an external diff program,

resulting in execution times a sixth of what they had been under Linux and a fiftieth of what they had been under Cygwin. At the same time, other folks are adding colorization support to git's diff output. In other git news, **Petr Baudis**, the Cogito maintainer, has been working on **rename support**. One of git's innovations is that renames are detected at read time, when someone wants to track the history of a file, rather than at write time, when the file actually changes. But, implementing this read-time detection is a challenge. Petr and a variety of others, including Linus, have taken it up with great fervor recently.

Several bits of kernel infrastructure are on the chopping block, notably **DevFS**. The option to use DevFS has been disabled since 2.6.13, three releases ago, and **Greg Kroah-Hartman** has posted patches to remove the DevFS code from each subsequent kernel release. The **blkmttd driver**, allowing memory devices to appear as block devices, is on the fast track out of the kernel. The **block2mtd driver** does the same thing and hasn't seen a bug report in more than a year, and in any case, blkmttd conflicts with **H. Peter Anvin's klibc** project, which is vying for kernel inclusion. **Andrew Morton** was more than happy to push the blkmttd removal patch over to Linus, without requiring any fermentation time in the -mm tree.

As mentioned above, H. Peter Anvin is pushing for klibc inclusion into the kernel. Klibc is a small, in-kernel libc, that allows certain kernel projects to exist in user space, safe in the assumption that the interfaces they need will be available when they need them. In this way, Linux continues to

become more like a **microkernel** over time, without making the kind of speed sacrifices that have marginalized microkernels over the years. Linus expressed his desire to see the kernel gradually become more modular in this way several years ago, and rather than a massive sudden effort to accomplish it, there seems to be a gentle ongoing assumption that if code can be moved out of the kernel, this is a good thing. Apparently, klibc is one of the good-thing enablers.

Documentation is a rare and precious stone in the Open Source world. Recently, **Chuck Ebbert** put together some additions for the **ptrace(2) man page** that he'd gathered together from the linux-kernel mailing list, the source code and his own experimentation. Various folks, including **Daniel Jacobowitz** who had authored much of the functionality Chuck had documented, were happy to see this work, and Daniel offered a bunch of suggestions for improvement.

The **2.4 kernel tree** continues to rest in "deep maintenance mode" as **Will Tarreau** puts it. **Herbert Rosmanith** had asked if **TPM** would be back-ported from 2.6, but it looks like that almost certainly will not happen. Willy has been maintaining a group of 2.4 patches gathered from various places, not necessarily in the hopes of seeing **Marcelo Tosatti** accept them into the official 2.4 tree, but more to enable 2.4 users to keep up to date on various

drivers, without having to jump all the way into a 2.6-based system. With 2.4 apparently stationary at last, this puts more pressure on the **2.6 developers** to find a way to bring stability to the kernel. Recently, Linus Torvalds began insisting that new 2.6 code would be accepted only for two weeks after an official release. After that, only bug fixes would be taken. Some developers chafe at this restriction, but there does not seem to be any huge outcry against it. However, although this means that most 2.6 kernel releases will tend to be fairly stable from an up-time perspective, it does nothing to stabilize the behaviors and interfaces between kernel releases. For that kind of stability, someone will need to have a new idea.

Ingo Molnar and others have implemented "lightweight user-space priority inheritance" support for **futexes**, which they say represents a significant milestone toward providing true real-time support for user-space applications. The issue is very controversial, partly because—as Ingo said in his announcement—an alternative set of priority inheritance code had been "circling Linux for years" that had bad overhead problems, buggy implementations and was just a mess. Real-time support in Linux is more widely controversial as well, because of the complexity it tends to add to the kernel.

—Zack Brown

Picasa on Linux

In May 2006, *Linux Journal* was the first publication to learn that Google planned to introduce a Linux version of Picasa, the company's digital photo management and sharing software. This is the first time Google has chosen Linux as the first additional platform for a formerly Windows-only product. In the past, Google has expanded first on Macintosh. Here's hoping that Google Earth and other originally Windows-only Google products will migrate to Linux as well. Google runs its massive search engine on Linux servers. Although Google won't disclose how many servers they run, the company is widely regarded as the largest deployer of Linux in the world.

Picasa began as the product of a Pasadena, California company by the same name. Picasa was founded in October 2001. Google bought the company in May 2004.

—Doc Searls

USER FRIENDLY by J.D. "Illid" Frazer



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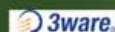
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LJ Index, August 2006

1. Percentage of Global 2000 companies that will have formal open-source management strategies by 2010: **90**
2. Percentage of companies that have deployed or are considering deploying open-source applications: **81**
3. Percentage of companies that say open source has helped lower IT costs: **67**
4. Estimated dollar savings at Backcountry.com, thanks to open-source order management: **150,000**
5. Percentage cost of open-source Zimbra e-mail to Backcountry.com vs. proprietary alternatives: **10**
6. Thousands of pages in Backcountry.com's internal wiki "knowledge management system": **6.2**
7. Thousands of unique visitors per week to Backcountry.com, as of April 2006: **100**
8. Thousands of SKUs (stock-keeping units) at Backcountry.com: **80**
9. Number of new daily SKUs at Backcountry's Steepandcheap.com subsidiary: **1**
10. Top daily dollar sales so far (as of April 2006) at Steepandcheap.com: **26,000**
11. Millions of dollars taken by Backcountry.com in 2004 sales: **27**
12. Millions of dollars taken by Backcountry.com in 2005 sales: **52**
13. Number of persons employed by Backcountry.com: **260**
14. Percentage of Backcountry.com employees doing in-house open-source programming: **10**
15. Millions paid by Red Hat for JBoss: **350**
16. Number of mentoring organizations approved for Google's Summer of Code: **102**
17. Billions of dollars Intel plans to spend marketing inexpensive computers in emerging markets: **1**
18. Sites surveyed by Netcraft in May 2006: **81,565,877**
19. Millions of new hostnames on the Net by May 2006: **7.2**
20. Apache Web server market-share percentage in May 2006: **64.76**

Sources: 1: Gartner, Inc. (via *CIO Insight*) | 2–14: *CIO Insight* | 15: CMPnetAsia | 16: LinuxDevices | 17: Knight Ridder Newspapers | 18–20: Netcraft.com

—Doc Searls

They Said It

Open source is a great way for a small, hungry company to build on a sophisticated platform and get a competitive edge—an edge that's precisely tailored to their specific needs—far more cheaply than it could with proprietary software.

—Eric Von Hippel, www.cioinsight.com/article2/0,1540,1959013,00.asp

If nobody is dismissing you as hype, you are not loud enough.

—Bruce Sterling (at SXSW 2006)

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Linuxfest Northwest 2006

Linuxfest Northwest, the largest users group conference in the Pacific Northwest, is held annually in Bellingham, Washington, 20 miles south of the Canadian border, less than two hours from Seattle by car. Linuxfest is put on each year by the Bellingham Linux Users Group in a joint effort with other users groups from the area. Linuxfest is always free of charge and open to all; this year, an estimated 800 people attended.

Each year, I am impressed by the top-notch presentations Linuxfest manages to get. More than 40 presentations covered topics from general interest to advanced systems administration. Presenters included people from IBM, Novell, Sun Microsystems and Oracle. Also, for the third year, Chuck Wolber held the Alpha Geek competition. There were only four time slots for all these presentations! They easily could expand Linuxfest to a two-day festival, without even needing to get more presenters.

Danny O'Brien of the Electronic Frontier Foundation (EFF) gave a presentation called "Incoming! What's on the EFF's Radar". He briefly explained the EFF and then covered the topics that the EFF currently is most worried about. He is a very engaging speaker.

Todd Trichler of Oracle explained "Oracle Contributions to Linux"—why Oracle is good for Linux and Linux is good for Oracle. Oracle has made numerous contributions to Linux, including the Oracle Cluster File System (OCFS2), which is now in the main kernel. Oracle has its own team of Linux kernel developers, and this lets Oracle provide complete support—no matter what breaks in a Linux Oracle system, they can fix it, period. They cannot offer that level of support for any proprietary operating system.

Ted Haeger of Novell showed off the results of "Desktop Innovation on Linux at Novell"—changes inspired by usability testing, new desktop search features (Beagle), a music player (Banshee), a photo manager (F-Spot) and a whole bunch of slick 3-D-accelerated eye-candy effects.

Linuxfest is hosted each year by the Bellingham Technical College (BTC), which is a perfect venue for a technical conference. The BTC culinary arts students served up a barbecued salmon lunch again this year; the weather turned rainy, but people braved the elements to get the salmon.

The exhibits room included Google recruiters; Linux-related businesses, such as Pogo Linux; users groups; Internet hosting services; free software projects, such as Ubuntu Linux and MySQL; and a computer hardware swap meet.

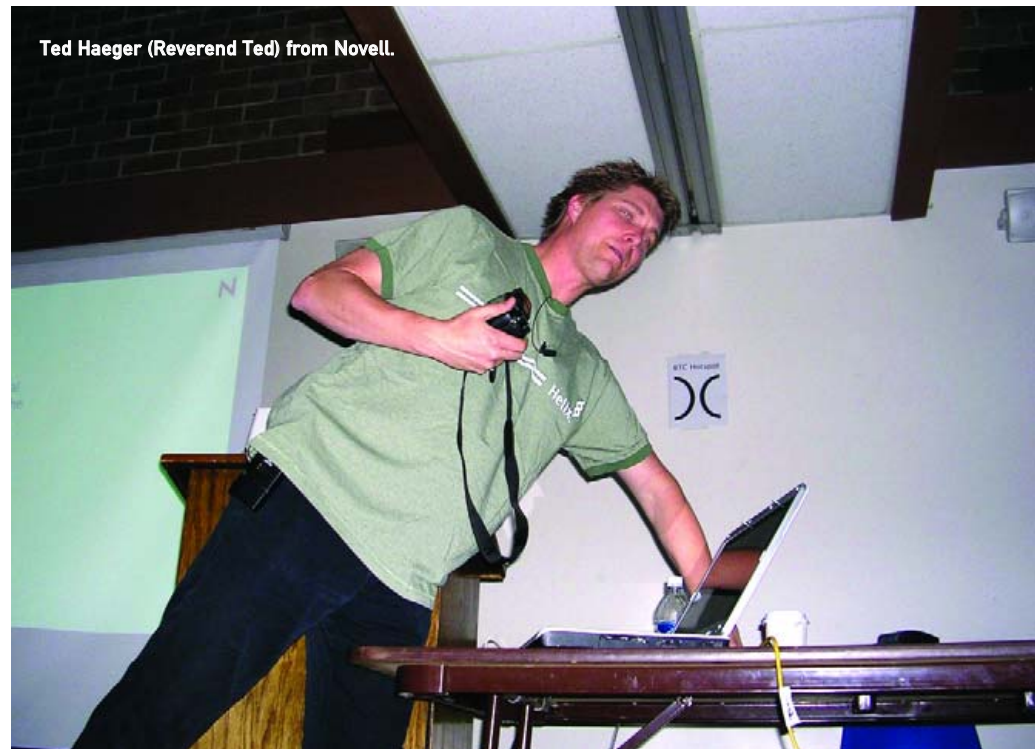
The day finished with the annual fund-raising raffle. Several thousand dollars' worth of donated prizes included server hosting services for up to a year.

Linuxfest Northwest 2007 is already being planned for Saturday, April 28, 2007. Be there if you can!

—Steve Hastings



Danny O'Brien from the EFF; his T-shirt says, ++ungood



Ted Haeger (Reverend Ted) from Novell.

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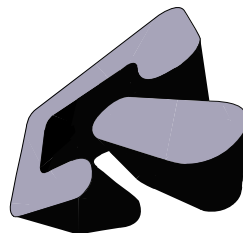
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REUVEN M. LERNER

eBay Web Services

Access eBay development and test support in addition to its comprehensive Web services API.

eBay's Web services API allows programs to search through on-line auctions, but only if the programmer doesn't get too frustrated first.

During the past few months, we have looked at the Web services offered by two of the largest companies on the Internet, Amazon and Google. Each of these companies has enormous databases at the core of their businesses. By opening up some of that data to the public via Web services APIs, they have made it possible for outside developers to create new and interesting applications. No longer must we write "screen scraper" programs that parse the HTML produced by Amazon or Google. Now, we can write a program that requests precisely the data we want and receives it in exactly the format we need.

Another major on-line contender is eBay, and its database of on-line sales might well be the largest ever assembled. eBay began solely as a site for on-line auctions, but it has moved far beyond that in recent years—with a fixed-price subsidiary (Half.com), fixed-price sales on the main eBay site (Buy it now) and third-party "stores" where people sell a variety of goods for a fixed or variable price.

For several years, eBay has run a developer program for programmers interested in tapping into its database. However, until recently, this developer program required that developers pay in order to participate. From a business perspective, it might have initially seemed foolish for eBay to give away access to its sales database, particularly when the developer program clearly costs money to set up and maintain. Whether it was due to pressure from Amazon and Google, or from individual developers, or if eBay simply decided that it would benefit from additional publicity and outside developers, eBay dropped fees—making it possible for everyone to try this service.

This month, we look at several aspects of the eBay Web services API. The API is too rich and extensive to discuss fully, so we look at the functionality that I believe most people will be interested in using—namely, that which lets you search through existing eBay auctions for items that are of interest. By the end of this article, you should understand how the API works, how to write programs that use REST to search through eBay's database and how to use that information for personal and business needs.

Getting Started

The idea behind Web services is quite simple. Instead of treating an HTTP transaction as a request for an HTML document, why not think of it as a remote procedure call? The HTTP request then becomes a method for invoking a procedure on a remote server, with the URL indicating which method should be invoked and the HTTP response containing the result of the call. In nearly all cases, the response is an XML

document, allowing for the invoked procedure to return a complex data structure.

There are at least three different styles for invoking a Web service, and eBay supports all of them. SOAP is perhaps the most sophisticated method, using XML in both the request and the response, but it is also the most complex and the most likely to run into cross-platform incompatibilities. This is partly because SOAP has tried to standardize all of the possible method calls, data types and scenarios that might be needed—leading to a somewhat bloated specification and many places where vendors disagree on how best to adhere to the specification.

eBay also supports invoking Web services with what it calls the XML API. Because SOAP also consists of XML, I find this terminology to be a bit confusing, but Amazon also describes things in this way. So, until someone creates a useful acronym or name, we're stuck with it. APIs based on XML are basically stripped-down versions of SOAP, without much of the overhead associated with it, such as namespaces and highly specified methods to marshal complex data structures. eBay says it is possible to use either XML or SOAP to access the full functionality of its Web services.

If I had to choose between SOAP and XML, I usually would use XML. But eBay provides a third interface, which is more limited than the SOAP and XML APIs, but far easier to work with. This third option is known as REST (short for representational state transfer), and anyone familiar with URLs should immediately understand how it works. The parameters are passed in the URL, using the standard name=value syntax. A REST invocation thus looks like `http://www.example.com/method?param1=value1¶m2=value2`.

REST invocations are useful only for searching through eBay's catalogs. If you want to monitor sales, adjust your shopping basket, add listings to your store or even send messages to sellers and buyers, you must use the XML or SOAP API. The size of the API documentation says it all: eBay's REST documentation is 29 pages long, and documentation for the SOAP and XML APIs is more than 1,600 pages long in each case.

Because the application we are building is supposed to search only through existing offers, rather than add a new item for sale, we can get away with using the REST API. The REST API makes it easier to jump right in, and it provides all of the functionality with less programming overhead.

Registration

Before you can use eBay's Web services, you first must register. I'll now say something I've never had to say before in the history of writing this column: I cannot guarantee the directions I provide here will work. I had an extremely difficult time registering with eBay's developer system, despite spending hours

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trying to do so, and I worry that many readers of this column will face similar challenges.

The first confusing issue is the fact that eBay has several different computer systems, each with its own user database. The first (www.ebay.com) is the main, regular eBay system, on which you already have a user name and password if you ever have bought or sold something on eBay.

A second system (www.sandbox.ebay.com), known as the sandbox, is where eBay developers can test their applications without having to use up their monthly quota of requests (described in greater detail below) and without having to risk damaging a working on-line store. You can do anything you want inside of the sandbox, including create new users (to simulate interactions with those users), but the database is separate from the main eBay site.

Finally, there is the eBay developer site (developer.ebay.com), which allows access to the APIs, certification of applications and documentation. Access to this site requires a third user name and password.

I suggest that aspiring eBay developers register with all three of these sites—starting with the main eBay site, continuing with the developer site and ending with the sandbox. Technically speaking, you don't need to register with the sandbox if your applications will be used only on the production eBay system. However, I found enough places in which URLs mistakenly took me to the sandbox, rather than the developer site, so obtaining a sandbox login would be a prudent move. Was I sent to the sandbox because it's the same as the developer site? Because of a bug? Because of something that went wrong in my configuration? I wish I could say; I spent a great deal of time trying to figure it out and am simply trying to avoid pain for readers of this article.

Part of the confusion is that the sandbox looks and feels exactly like the regular eBay site. This is largely a good thing, except that it means the only way to distinguish between the sandbox and the usual eBay site is by looking at the URL. Even confirmation e-mail messages from the sandbox were identical to e-mailed notices from the production eBay site.

Once you have all three logins, you need to generate a set of production keys: a developer ID, an application ID and a certificate ID. These IDs uniquely identify you and your application, although the role of each key is not obvious to me. (The eBay documentation indicates that each application has its own key, but I could not figure out how to generate a new set of keys for a separate application.) Each developer may have only one set of such production keys. Although the term application ID implies that there would be a separate key for each application you create, this does not seem to be the case.

If you are going to use eBay's production system, then you need to certify your application. There are two levels of certification. One, known as self-certification, allows you to make up to 10,000 requests to eBay's servers per month. Self-certification, as its name implies, requires that you fill out a short Web-based form describing your application. Upon submitting the form to eBay's server, you are sent an e-mail indicating that your application has been self-certified. This e-mail message contains a link to a URL from which you can pick up your production keys, as well as a code that you must enter to retrieve those keys.

Using this confirmation code, you then return to the eBay developer site, where you enter it. This results in the generation of your three production keys: the devID, applID

and certID (sometimes referred to in the documentation as AuthCert).

If you are planning to use XML or SOAP, this is the end of the certification process; your application will need to send these IDs in the HTTP request headers. But we are using REST, which is supposed to simplify things—and although our actual method invocations eventually will be simpler than the XML and SOAP alternatives, we have not quite finished our task if we want to use REST.

This is because REST parameters are passed in the URL, and it would seem that eBay has (rightly) decided that passing the devID, applID and certID parameters would be ugly and unnecessary. To use REST, it is necessary to create a REST token, which creates a new, encoded string based on the three production keys. To generate the REST key, go to the REST token site, at developer.ebay.com/tokentool. Indicate that you want to use the production environment, that you want a REST token, and then enter your three production keys.

Then, if you're like me, you'll get an error message. Try as I might, I couldn't get past an eBay login screen that was displayed each time I tried to generate the REST token. Needless to say, I was quite frustrated by this point, and I began to wonder how (and why) a multibillion-dollar company could make it so difficult for developers to use its API. (In contrast, I was up and running within about 30 minutes after deciding to use the Google, Bloglines and Amazon APIs. The difference couldn't be starker.)

I never really figured out what happened. Perhaps I wasn't logged in to eBay, although I thought I was logged in to all three sites (the main site, sandbox and developer site). It also could be that I was using Firefox, which is known to have problems with the registration. In the end, I used a different browser just so I could get the REST token. There were some messages on the eBay developer forums indicating that other Firefox users were having similar problems. It might have had to do with one of eBay's SSL certificates expiring several months earlier, although I doubt it. It seems to me that the login portion of eBay's site is in need of better quality control.

Making Queries

Once you have gotten through the registration nightmare, you can make queries. The REST API is well documented and is quite straightforward to use. First, let's look at a simple program that sees how many matches we can find to a particular text string. The program, shown in Listing 1, is written in Ruby and is similar to some of the Amazon- and Google-searching programs presented during the past few months.

The program begins by retrieving our search parameters, automatically placed in the ARGV variable. We iterate over each element of ARGV, calling each individual argument `query_string`. We then use a hash to create an easily understood set of name-value pairs, in which the hash keys are the parameter names and the hash values are the parameter values. We then use a bit of Ruby magic to combine them, first turning them into pairs with `map`, and then using `join` to connect the pairs together with `&`. In the end, we have a string we can pass to eBay's server.

In this particular example, we're using the `Query` method in the REST API. `Query` allows us to enter a text string, for which eBay will then search. The way that eBay has grown somewhat organically over the years becomes apparent when you use its Web services. You must explicitly indicate

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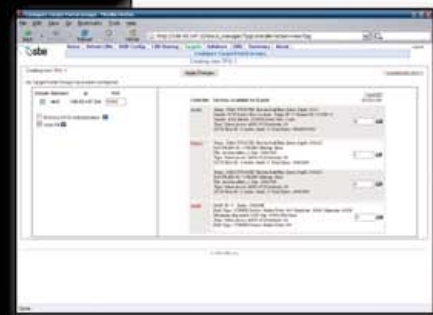
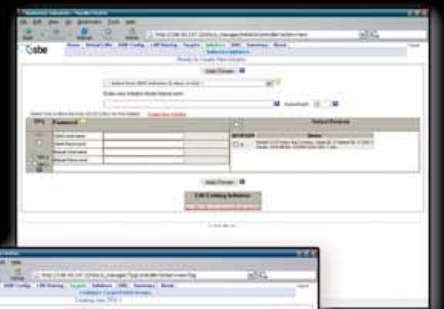


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Listing 1.
ebay-lookup.rb

```
#!/usr/bin/ruby

require 'net/http'
require 'rexml/document'

if ARGV.length == 0
  puts "#{$0}: You must enter at least one argument."
  exit
end

output = ""

# Iterate through each of our arguments
ARGV.each do |query_string|

  output << "Searching for: #{query_string}\n"

  # Put together an eBay parameter string
  ebay_params = {'CallName' => 'GetSearchResults',
    'RequestToken' => 'XXX',
    'RequestUserId' => 'YYY',
    'Schema' => 1,
    'ItemTypeFilter' => 3,
    'SearchInDescription' => 1,
    'StoreSearch' => 3,
    'DetailLevel' => 3,
    'Query' => query_string}.map {|key,value|
    "#{key}=#{"value"}"}.join("&")

  # Ask eBay what it knows about our query_string
  ebay_response = Net::HTTP.get_response('rest.api.ebay.com',
    '/restapi?' << ebay_params)

  xml = REXML::Document.new(ebay_response.body)

  # Get basic information
  how_many_matches =
  xml.root.elements["PaginationResult/TotalNumberOfEntries"].text

  output << "Number of matches: #{how_many_matches}\n"

end

# Show everyone what we've learned
puts output
```

if you want to search in stores as well as auctions. We also must indicate whether we want auction items, fixed-price items or both. Thus, our example searches through all stores (because `StoreSearch = 3`), auctions and fixed-price items (`ItemTypeFilter = 3`), in descriptions as well as item titles (`SearchInDescription = 1`), and with a fair amount of detail returned (`DetailLevel = 3`).

We also indicate we want `Schema = 1`. This tells eBay we want to receive a response using eBay's new XML schema, rather than the older one that is now being deprecated.

We then take `ebay_params`, a string created from our

name-value pairs, and pass it to `Net::HTTP.get_response`. This sends an HTTP request to eBay's server (`rest.api.ebay.com`), using the appropriate path (`/restapi`), followed by our name-value pairs.

When we get a response—and our sample code here assumes that we do receive a response—we expect that it is formatted in XML and parse it using Ruby's built-in REXML library. We grab the total number of entries in eBay's database containing this search string and use the `text` method to extract the text from between the `<TotalNumberOfEntries>` tags. Finally, the program displays its output, showing us how many items on eBay contain this text string.

The API is relatively fast, allowing us to perform lookups for a particular string in relatively short time. That said, popular search strings can take far longer than rare words. A search for an ISBN took 1–2 seconds on my computer and indicated how many sellers were offering that ISBN for sale. A search for the term auction, not surprisingly, took more than 30 seconds to return a result and indicated that 29,458,603 sellers mentioned that term in the title or description. Obviously, the choice of search term, as well as the number of sellers and the quantity of text searched for that term, will have a significant effect on the performance of your application.

eBay's API makes it possible to perform Boolean searches of various types. Putting two words together within quotation marks (URL-encoded, of course) allows you to search for a phrase. You can search for two words in the same auction by linking them with commas.

You also can include and exclude particular sellers. If you are a seller on eBay, you might want to look at all of your items—or all of your competitors' items, ignoring yours. These functions make it easier to navigate through the complex world of eBay, which sells a staggering variety of goods from all over the world.

Differences and Considerations

eBay's API, particularly for SOAP and XML, is rich and extensive. This is in addition to the simple, but limited, REST API that we used for the example in Listing 1. However, eBay's tagging of metadata, or information about each listing, is rather limited, especially when compared with Amazon. Perhaps this is because of the difference between the two sites. Amazon, as a vendor with inventory, knows and can pull up information about each item's dimensions, weight and ISBN. By contrast, eBay's only real information about each sold item is its categorization, asking price (and bidding information) and the text used to describe it.

There is a provision in the SOAP and XML APIs to look for items by `ExternalProductID`, which can be an ISBN or UPC. But when it comes to metadata describing each object, Amazon has beaten eBay hands down.

Amazon also is friendlier when it comes to registration and usage. Amazon makes it easy to register and easy to get started. Its forums are full of friendly people with useful advice. And, it sets relatively straightforward rules of use for its data.

eBay also differs from Amazon in how many queries it allows an application to make. Amazon doesn't restrict the number of queries, except by saying there should be no more than one per second, per IP address. eBay, by contrast, has a 10,000-query limit for each application. However, this limit can

be raised substantially if you go through a more thorough certification process, giving eBay more information about your application, how it works and how you intend to use it.

The companies also differ in how many results they return. Each page from eBay contains up to 400 items, as opposed to Amazon's ten. In both cases, you can request subsequent "pages" of data, until you get information about all of the listings that matched your query. In this case, eBay's larger format is a significant improvement for people looking for popular items that might be available from many sellers.

Finally, eBay offers a dashboard showing which calls you have made and which were not compliant with its compatibility rules. This is an excellent feature—especially the part where it tracks how many queries succeeded and failed. I don't expect many of my REST queries to fail after I have debugged them, but it's possible that this could happen.

The bottom line is that I'm far more impressed with everything having to do with Amazon's Web services. eBay clearly is trying to improve things, with extensive documentation, developer forums and a help desk offering paid support. Nevertheless, it remains far inferior to what Amazon is offering. And, although they are not directly comparable, they also are inferior to Google's offerings in the Web services arena.

That said, eBay is a major player in the e-commerce world, and access to its data might well be worth the pain you encounter in using it. Plus, once you have gotten over the registration hurdles, you likely will be using only a handful of API calls, with minor tweaks and changes over time.

Conclusion

eBay's recent changes to its developer program are a welcome step forward. With three interfaces (SOAP, XML and REST) and an extensive set of methods available for developers to use, it's possible to glean all sorts of data from eBay's stores and auctions. Unfortunately, this all comes with a price; with less metadata and an unnecessarily confusing registration process, eBay's offering is far less impressive than it could be. ■

Resources for this article:

www.linuxjournal.com/article/9066.

Reuven M. Lerner, a longtime Web/database consultant, is currently a PhD student in Learning Sciences at Northwestern University in Evanston, Illinois. He and his wife recently celebrated the birth of their son Amotz David.

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François! The kitchen is a disaster! What are all these computers and computer parts doing all over the floor? I nearly broke something tripping over the stack of hard drives you conveniently put right inside the door. You are trying to build the Ultimate Linux Box? Yes, I know it's the theme of this month's issue, but you can achieve that goal without making the place look like a parts superstore. Honestly, *mon ami*, must we go through this every time this issue appears? Last year, it was a supercomputer cluster. This year, it's...what are you building anyhow?

Never mind. It is my belief, François, that the Ultimate Linux Box isn't necessarily the one with the fastest processor or the one with a googolbyte of RAM, although that certainly would be very cool. It's the box that lets me get access to the information I want right now. Luckily, that Linux system is often the one we are already running—with a few enhancements, that is. You might think you have to go a long way for those enhancements, but some already are installed as part of your Linux system. What you must do is turn them on. I'll explain later, *mon ami*. It appears that our guests have arrived.

Welcome, everyone! It is wonderful to see you all here at *Chez Marcel*, where exquisite wines meet exceptional

Linux and open-source software. Sit down and make yourselves comfortable. François, please head down to the wine cellar. There are two cases of 1999 Elia Brunello by Colleceto Di Palazzesi from Tuscany, Italy, in the East Wing. Please, hurry back. I'm sure our guests are more than ready for a glass of wine.

It is good to have you here, *mes amis*. François and I were just discussing what can transform a great Linux box into the Ultimate Linux Box, and I was suggesting the answer might be software.

Whenever I sit down to a new Linux desktop, the first change I make is to the panel, whether it be KDE or GNOME. Each environment can incorporate applets into the panel—compact little extensions or programs that can give you access to resources or information at a glance (or a click). One of the most useful I know of is the dictionary applet. Second to that is the weather applet, which, if I can't look out of the window, lets me know the weather conditions outside.

Adding these applets is easy. If you are running KDE, right-click on a blank section of your Kicker panel and select Add Applet to Panel. The Add Applet dialog appears with a list of programs you can use to populate your Kicker panel. Each program (or applet) is listed alphabetically with a short description. Look for the dictionary applet and the weather applet as well. To add an applet, simply click the Add to Panel button.

To use the dictionary, simply enter a word. There's no configuration for the dictionary applet, but you need to right-click on the weather icon to configure it for your location. GNOME desktop users follow an almost identical process for installing applets. Right-click on the bottom (or top) panel and select Add to Panel. A window of the same name appears with a list of available applets (Figure 2). Once again, select Dictionary Look up and Weather Report. Click Add, or drag your applets to the panel in the location of your choice.

As with the KDE example, you need to configure the weather applet by right-clicking and selecting Preferences. Whether you are running KDE or GNOME, clicking on the weather icon brings up a detailed report of your local conditions. Check out Figure 3 for a sample of these applets on both desktops.

Now, our desktops have become increasingly useful with only a little change. We are constantly up to date on weather conditions, and we can do word searches from the panel. Speaking of applets and searches, here's another great one—this time for GNOME users. It's called Deskbar, and it's another must-have. Deskbar is a one-stop infocenter that uses a system of plugins to give you dynamic searches in all those places that are important to you. It can do

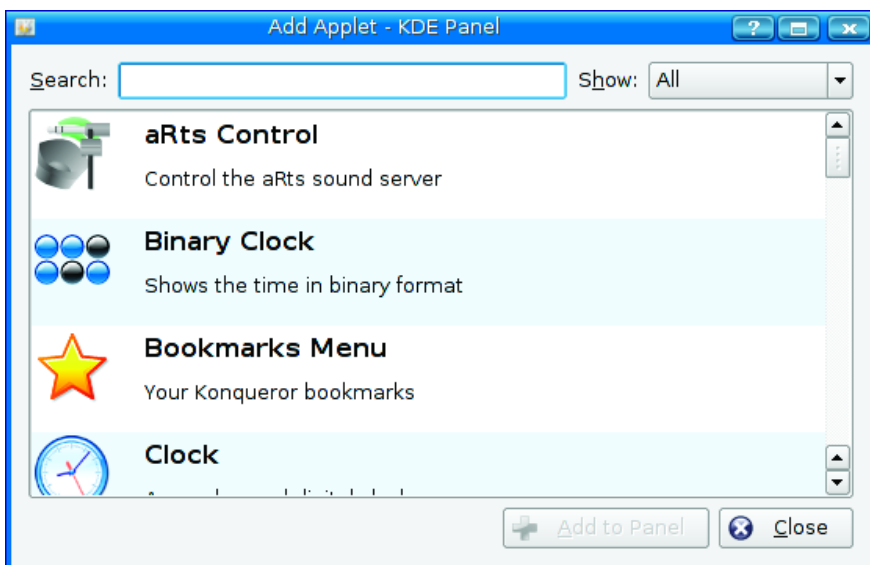
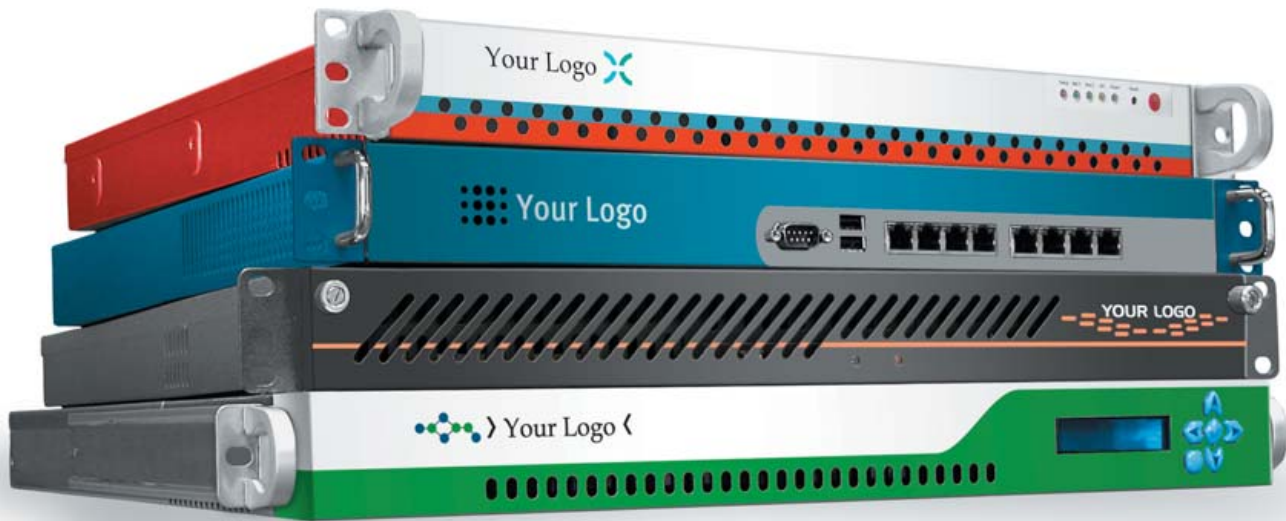


Figure 1. Several applets are available. Scroll down and select the dictionary and weather applets.

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Figure 2. Adding applets under GNOME is very similar.

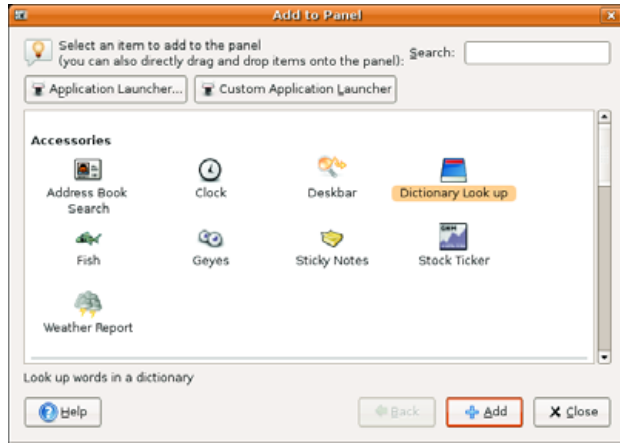


Figure 3. The weather and dictionary applets in their respective desktop environments.

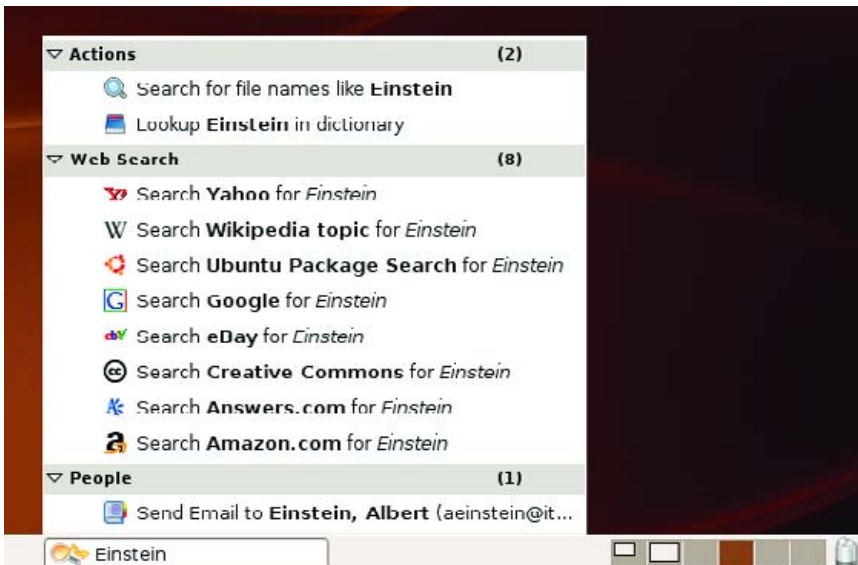


Figure 4. Deskbar is your one-stop search field. It can help you locate information on the Web, contacts in your address books and more.

lookups on your favorite search engine, search through your address book, find files, open files or folders for you, locate applications and more (Figure 4).

To get Raphael Slinckx's Deskbar on your panel, load it from the applet Add to Panel dialog in GNOME. Recent distributions should have it included, but if it isn't there, check out the Web site (see the on-line Resources). You always can download source, but binaries also are available on the site for a number of popular distributions. To use Deskbar, simply type in the term for whatever you are seeking, and it will do the rest.

When I mentioned plugins, what I didn't say is that not all of them are activated by default (though most are). For instance, Deskbar will not only post your search to Google, but it also will search as you type. This is Google Live and requires that you have an account with Google. Once you do, you can activate this plugin. In other cases, such as the dictionary search, you'll find that the plugin is inactive primarily because the dictionary applet already serves that function. To activate (or deactivate) plugins, right-click on Deskbar and select Preferences.

Deskbar even can search using Beagle if you have the package installed. Beagle, you ask? Ah, that might take a few minutes. Perhaps we should have François make sure all your glasses are full while I set things up on this end.

Beagle is a desktop search engine. It is designed to bring to the desktop what search engines like Google bring to the Web. Beagle indexes your documents, presentations, notes, music, images, e-mail (KMail and Evolution) and a whole lot more. Beagle is in the early stages of development, but it is already very usable and fast. To stay on the leading edge of this exciting project, you really need to build it from source, which, I admit, can be daunting while you seek out all of the appropriate prerequisite packages. However, a visit to the Beagle Web site (see Resources) will point you to binaries for many popular distributions, including SUSE, Fedora, Mandriva, Ubuntu and others. Some distributions have Beagle in their download or contrib sites, so check there first.

Beagle does its indexing in the background with the use of a daemon named beagled. You can start beagled at the command line (you do not have to run as root), or you can fire up the Beagle search window. That program is named beagle-search. When you start the program, it looks for the running Beagle daemon. If it doesn't find it, a button on the search window lets you launch the process. Beagle starts indexing immediately, but if you have a lot of data—and don't we all—it may take a while before you can do a comprehensive search.

Searching is child's play. Simply type your search term in the Find field, and Beagle immediately returns everything it finds relevant to your search (Figure 5). By default, it locates information based on the date. Click Sort on Beagle's menu bar, and you can change the sort criteria to Name or Relevance.

Beagle originally was written as a GNOME project, but it works very well in a KDE environment and makes no distinction as to what environment you run. You can use the default beagle-search interface with KDE, but you may want to take a look at Stephan Binner's Kerry Beagle, a great KDE interface to the Beagle desktop search. Kerry provides some great additional enhancements, including a system tray icon so that the search interface drops nicely out of sight when it's not needed.

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Some distributions have the package in their contrib repositories (SUSE and Kubuntu, to name a couple), but source also is available from the KDE-Look.org site (see Resources).

When you run Kerry Beagle, it starts minimized with a magnifying-glass icon in the system tray. Click the icon to bring up the search window or press Ctrl-Shift-spacebar. When the search dialog appears, it checks to see if the Beagle daemon (beagled) is running. If it isn't, you are given the opportunity to start it now. To search for a term, enter it in the Search field at the top and click Find. Search results appear below, with a default of five to a page (Figure 6).

Your total number of results is listed in the bottom left. Click Next Results to see the next five items. You can change this default of five by right-clicking on the system tray icon and selecting Configure Kerry. Aside from the number of search results per page, the configure dialog lets you add additional folders to index (and others to exclude from indexing). Having to start the Beagle daemon each time you log in can be a pain. Luckily, automatically starting the daemon when you log in to KDE is another thing you can set through the configuration menu.

The clock on the wall, *mes amis*, she is telling us that the hour is late. We soon should be heading home to dreams of our own individual ultimate Linux systems. François no doubt will try to create something out of the chaos in kitchen. In the meantime, I know that he would be delighted to refill your glasses one more time before we say good night. Please raise your glasses, *mes amis*, and let us all drink to one another's health. *A votre santé! Bon appétit!* ■

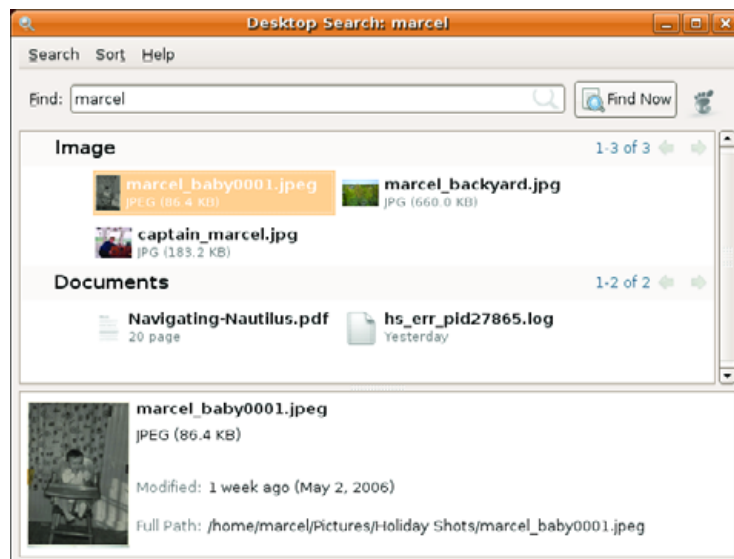


Figure 5. Beagle's desktop search is fast and simple.



Figure 6. Kerry Beagle is a great KDE-based front end to the Beagle desktop search program.

Resources for this article: www.linuxjournal.com/article/9067.

Marcel Gagné is an award-winning writer living in Mississauga, Ontario. He is the author of the all new *Moving to Ubuntu Linux*, his fifth book from Addison-Wesley. He also makes regular television appearances as Call for Help's Linux guy. Marcel is also a pilot, a past Top-40 disc jockey, writes science fiction and fantasy, and folds a mean Origami T-Rex. He can be reached via e-mail at mggagne@salmar.com. You can discover lots of other things (including great wine links) from his Web site at www.marcelgagne.com.

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DAVE TAYLOR

End Game

Want to bet you can find a problem in our final Blackjack script?

This is the last column in our *Blackjack* series, and in this column, I show the final snippets of code needed to weave all of the disparate pieces of the game script into a playable game. For obvious reasons, I can't present the entire script here in the magazine (it's almost 300 lines long), so instead I highly encourage you to pop over to the *Linux Journal* FTP site and grab a copy of the script as you read along (<ftp.ssc.com/pub/lj/listings/issue148/9051.tgz>).

As with many betting games, *Blackjack* has evolved to have many esoteric rules with splitting pairs, insurance and various other things that take something relatively simple and make it more complex. We'll ignore all of that, however, and also ignore the betting component of the game too (this is a [geek] family magazine, after all) and just focus on the game play.

Dealer Gets One Card Up

Therefore, the first thing we need to know is that the player can see both cards as dealt and one of the two cards that the dealer deals for itself. That's the first piece of code we need to add, and because we aren't allowing insurance or betting, it needs to be included immediately after the tests for blackjack in the code:

```
echo -n "*** Dealer's hand: "
showCard ${dealer[1]} ; echo -n "$cardname, "
echo "(card face down)"
echo ""
```

From a strategic perspective, if you have even a rudimentary grasp of probability, you'll know that cards with a value of ten are far more likely than any other card value in the deck. If the

dealer has an eight or nine showing, for example, odds are very good that it has 18 or 19 as a hand value. That'll, therefore, change your own playing strategy too, perhaps making it more likely that you'd take another card if you have an interim hand value of 17; whereas, if the dealer had a five showing, for example, you might be more likely to stick with a hand value of 16.

In previous columns, you've already seen the basic script to display and calculate a hand's value, so this is nothing new:

```
echo -n "*** Dealer's hand: "
showCard ${dealer[1]} ; echo -n "$cardname, "
showCard ${dealer[2]} ; echo "$cardname"

handValue ${dealer[1]} ${dealer[2]}
```

But, now we're going to add a loop below this that will keep taking cards until the hand value is 17 or higher (that's standard Las Vegas *Blackjack* rules: 16 and lower the dealer "hits" or takes another card, and 17 or higher the dealer "stands" or sticks with its hand).

This is a bit tricky, so take your time reading it:

```
while [ $handvalue -lt 17 ]
do
    dealer[$nextdealercard]=$(newdeck[$nextcard])

    showCard ${dealer[$nextdealercard]}

    nextcard=$(( $nextcard + 1 ))
    nextdealercard=$(( $nextdealercard + 1 ))

    echo "" ; echo "*** Dealer takes: $cardname"

    handValue ${dealer[1]} ${dealer[2]} ${dealer[3]} \
        ${dealer[4]} ${dealer[5]}
done
```

With some good routines and variables already in place, it turns out to be surprisingly succinct to have the dealer play its hand out. Hurray for that bit of good design!

Who Won the Game?

Now that we have the game-play logic, it's simply a matter of having the set of conditionals to figure out who won or whether the game ended with a tie:

```
if [ $handvalue -gt 21 ]
then
    echo "**** Dealer busted! Player wins with \
        $playerhandvalue!"
    playerwin=$(( $playerwin + 1 ))
elif [ $handvalue -eq $playerhandvalue ]
then
```




```

echo "**** Dealer and player tie with \
    $handvalue points."
elif [ $handvalue -lt $playerhandvalue ]
then
echo "**** Player wins with $playerhandvalue"
playerwin=$(( $playerwin + 1 ))
else
echo "**** Dealer wins with $handvalue"
dealerwin=$(( $dealerwin + 1 ))
fi

```

Whaddya think? Enough code listings?
Let's see how the game plays now:

```
$ sh blackjack.sh
```

```

**** Welcome to Blackjack.sh! ****

Dealer's hand: Queen of Hearts, (card face down)

You've been dealt: 2 of Spades, 7 of Hearts

H)it or S)tand? (recommended: hit) hit

You've been dealt: 10 of Diamonds

H)it or S)tand? (recommended: stand) stand

You stand with a hand value of 19

Dealer's hand: Queen of Hearts, 4 of Hearts

Dealer takes: Queen of Clubs

**** Dealer busted! Player wins with 19!

```

You can see that we had 2S and 7H (9 points), took a card, 10D, giving us 19 points. We stayed with that, and the dealer revealed that it had QH 4H, 14 points, and took another card which proved to be QC, which took the dealer over 21 points. We won!

There are a few more nuances to the program, including keeping track of how many times the dealer or player wins, and at the point where you're asked "hit or stand", you now can type in quit (or q) to quit. Then, it'll show you:

```

H)it or S)tand? (recommended: stand) q

Player quits. Standings: dealer wins: 5 and player wins: 3

```

There's Still a Bug

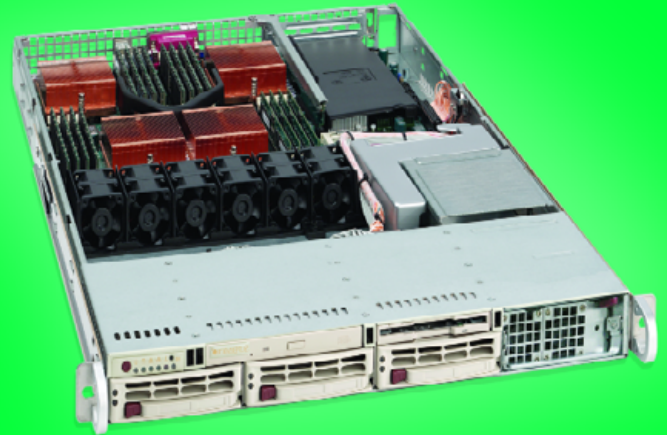
There's also one outstanding bug in the code, and I invite you to dig around and figure it out. If the dealer is dealt an Ace in play, it's automatically counted as 11 points, not one or 11, as it should be. Your challenge: figure out where that problem arises and how to fix it. If you think you know, e-mail me your proposed solution (perhaps a diff of your version versus the version on the *Linux Journal* FTP site), and we'll see how you did.

Next month, we'll crack open a completely different shell script task and see what we can do to help your day-to-day Linux administrative tasks, because we've probably wasted plenty enough ink on a casino game for this year! See ya then. ■

Dave Taylor is a 26-year veteran of UNIX, creator of The Elm Mail System, and most recently author of both the best-selling *Wicked Cool Shell Scripts* and *Teach Yourself Unix in 24 Hours*, among his 16 technical books. His main Web site is at www.intuitive.com.



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MICK BAUER

An Introduction to Novell AppArmor

Who says “easy-to-use mandatory access controls” is a contradiction in terms?

In my article “Security Features in SUSE 10” (*LJ*, April 2006), I described Novell AppArmor, a partial implementation of mandatory access controls (MACs) that is now part of SUSE Linux. Since that writing, Novell has released the source code of AppArmor under the GPL. It’s entirely possible that in the near future, AppArmor will be ported to other Linux distributions that support Linux security modules.

This is great news. In my opinion, AppArmor represents a major step forward in making MAC technology a feasible option for system administrators who want strong security controls but don’t have the time or patience to configure and maintain a complicated “trusted OS” such as SELinux.

This month, I introduce the concept of mandatory access controls, describe the difference between Novell AppArmor and NSA SELinux, and show you how to get started with AppArmor on your SUSE systems.

Introduction to Mandatory Access Controls

The easiest way to describe mandatory access controls is to contrast it with discretionary access controls (DACs). Most general-purpose operating systems use a DAC security model, in which the owner of a given system resource (file, directory and so forth) can set whatever access permissions on that resource they like. Stringent security controls, in general, are optional.

By contrast, a computer with MAC has a global security policy to which all users of the system are subject. A user who creates a file on a MAC system generally may not set access controls on that file that are weaker than the controls dictated by the system security policy.

Most DAC implementations have several major problems, emphatically including both Windows and Linux (except SELinux). First and most obvious is that, as with any scenario involving human beings, making any type of work optional all but ensures that work won’t get done very often. It takes work to use careful security settings consistently, even in a DAC system.

Another problem with DAC is that DAC-based OSes tend to have a “winner take all” security model, in which the only way to get anything important done on the system is through the superuser account (root in Linux/UNIX, Administrator in Windows). Wholly compromising a system using such a security model is generally a simple matter of hijacking some process on that system that runs with root/Administrator privileges.

On a MAC-based system, however, the only thing the superuser account is used for is maintaining the global security policy. Day-to-day system administration is performed using accounts that lack the authority to change the global security policy. As a result, it’s impossible to compromise the entire system by attacking any one process. (Attacks on the superuser account are still possible, however; for example, by booting the

system into single-user mode from its physical console.)

If mandatory access controls are superior to DACs, why aren’t they ubiquitous? Unfortunately, although MAC schemes have been available on various platforms over the years, they traditionally have been much more complicated to configure and maintain than DAC-based operating systems. Creating an effective global security policy requires detailed knowledge of the precise (intended) behavior of every application on the system. Furthermore, the more restrictive the security controls are on a given system, the less convenient that system becomes for its users to use.

AppArmor vs. SELinux

AppArmor isn’t the first mandatory access control scheme for Linux, nor is it the most comprehensive. It shares DNA, so to speak, with SELinux, a project of the US National Security Agency. (The shared DNA is the Linux Security Modules, which provide kernel support for MAC.)

SELinux is a bundle of kernel modules and user-space configuration tools that implement three different types of MAC:

1. Type enforcement (TE): associates a security “label” with every system object.
2. Role-based access controls (RBACs): define particular actions and contexts in which system objects may be involved.
3. Multi-level security (MLS): defines access controls against objects based on data classification (sensitivity).

In SELinux, all three types of access controls (TE, RBAC and MLS) are applied across the entire operating system. This requires major system applications to be SELinux-aware wherever possible, and it also requires extensive setup by a knowledgeable system administrator (that is, one who has carefully researched SELinux). On the one hand, SELinux is truly comprehensive. On the other hand, configuring it is a fairly major undertaking.

Novell AppArmor has a more modest objective: to restrict the behavior of selected applications in a very granular but targeted way. In focusing on applications (at the expense of roles and data classification), AppArmor is built on the assumption that the single biggest attack vector on most systems is application vulnerabilities. If the application’s behavior is restricted, the behavior of any attacker who succeeds in exploiting some vulnerability in that application also will be restricted.

For example, suppose you’re running a Web application that runs as user nobody and uses user input to update a local text file. On a typical system, if an attacker compromised that Web application, for example, by sending unexpected input,



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the attacker might succeed in gaining a remote shell with the privileges of nobody. If that Web application were protected by AppArmor, however, all the attacker would be able to do is alter that single text file. It wouldn't be possible for the attacker to spawn a remote shell (an unexpected action) or to read or write any other files.

Comprehensive? By no means. For non-AppArmor-protected applications, the usual (limited) user/group permissions still apply, no controls regarding data classification are provided, and normally, only a subset of applications on the system have AppArmor profiles.

For the most part, root is still root, and if you use root access in a sloppy or risky fashion, AppArmor generally won't protect you from yourself. But, if an AppArmor-protected application runs as root, and becomes compromised somehow, that application's access will be contained, root privileges notwithstanding, because those privileges are trumped by the AppArmor policy (which is enforced at the kernel level, courtesy of Linux security modules).

AppArmor is therefore only a partial implementation of mandatory access controls. But on networked systems, application security is arguably the single-most important area of concern, and that's what AppArmor zeros in on. What's more, AppArmor provides application security through an easy-to-use graphical user interface that is fully integrated with YaST. (GUI tools are now being developed for SELinux as well, but just how easy to use these are is open to debate.)

Still, I'm stopping well short of suggesting AppArmor is interchangeable with SELinux. If, for example, you run Linux in a multiuser environment (in which users have shell or database accounts) involving highly sensitive data, there really is no substitute for the comprehensive layers of access controls in SELinux.

Getting Started with AppArmor

Although AppArmor's open-source license hopefully will lead to ports on other Linux distributions, for the time being AppArmor is available only for SUSE Linux and SUSE Linux Enterprise. The rest of this article, therefore, is necessarily specific to SUSE. I'm scratching only the surface here. For detailed information on how to configure and use AppArmor, see the AppArmor Admin Guide Using Yast, whose path is `/usr/share/doc/packages/subdomain-docs/ug_apparmor.pdf`, provided you've installed SUSE's subdomain-docs package.

Note: prior to being acquired by Novell, AppArmor



Figure 1. YaST's Novell AppArmor Module

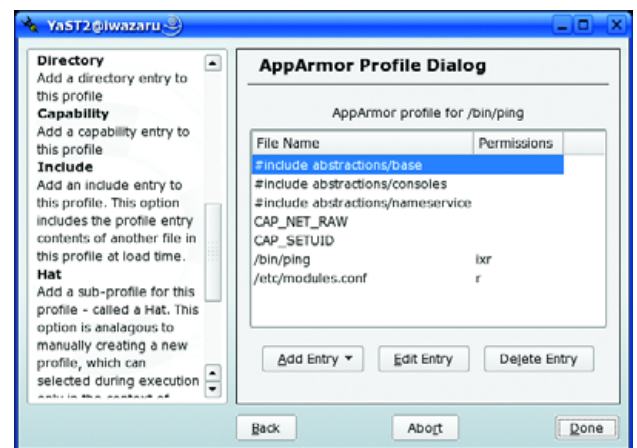


Figure 2. AppArmor Profile for ping

previously was called Immunix SubDomain. Many of AppArmor's filenames and package names still include the word subdomain.

AppArmor has its own YaST module, called Novell AppArmor (Figure 1). As you can see, most of the applets in this module deal with creating and managing AppArmor Profiles. Each application protected (confined) by AppArmor must have its own AppArmor profile. Profiles can be created

TWO HANDY COMMANDS

You can identify all the commands and daemons on your system that are both owned by root and have their setuid bit set (that is, that run with a user ID of root no matter who actually executes them), with a single command:

```
find / -user root -perm -4000 -print
```

As with any other `find /` command, this takes a few minutes to complete, but the output hopefully will be a short list. In the Internet-connected era, it's very bad form indeed to set the setuid

bit on any root-owned executable unless it's absolutely necessary, so modern versions of Linux distributions tend to be very sensible in this regard. Still, you may be surprised by what you find.

One more handy command, this one peculiar to AppArmor, is unconfined. When run without arguments from a command prompt, this command lists running network daemons that are not protected by AppArmor. You must be root, and AppArmor must be enabled, for the unconfined command to work.

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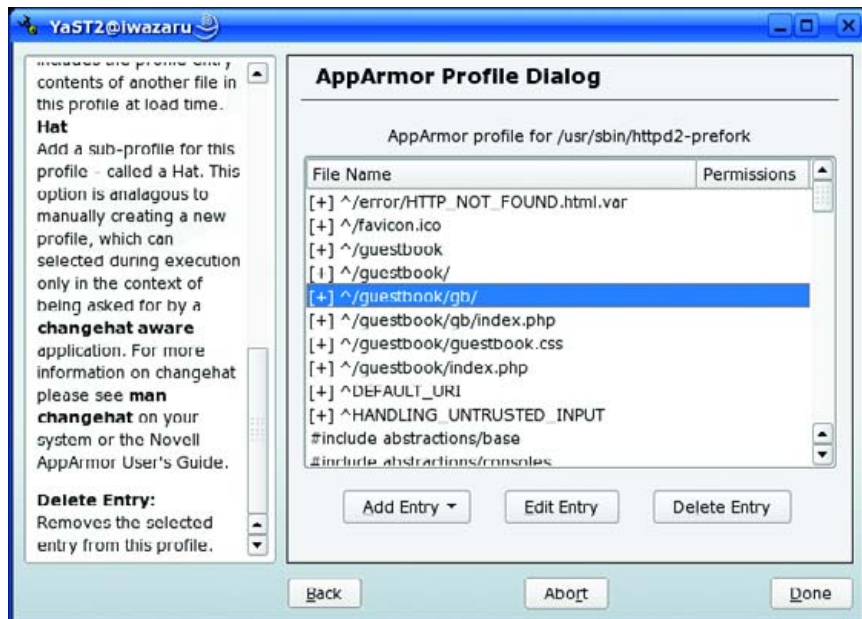


Figure 3. AppArmor Profile for httpd2

manually or by using the Add Profile and Update Profile Wizards or with the Manually Add Profile applet.

The AppArmor control panel is used to enable and disable AppArmor and to enable, configure and disable AppArmor security event notification. Important note: any time you enable AppArmor manually, you must restart every AppArmor-protected application (simply rebooting is your safest bet). An application must start while AppArmor is already running in order to benefit from its protection. Obviously, if AppArmor is enabled at boot time, you don't need to worry about this.

Two types of applications are particularly important to protect: programs that run setuid root (that is, run with root's privileges) and network applications. AppArmor comes preconfigured with profiles for a variety of setuid-root programs and network applications, including Apache, ping, Firefox, Opera, Evolution, sshd, ld, Postfix, Squid and Ethereal.

Figure 2 shows the ping default profiles. As you can see, it consists of #include statements that reference the contents of other profiles, access controls on POSIX capabilities (setuid, kill,



Figure 4. Contents of gb Hat

sys_boot and so forth) and file access controls.

There's actually a fourth element that Web server profiles may contain—hat definitions. Figure 3 shows part of the profile for httpd2 (Apache 2). The entries at the top of the profile that begin [+] are hats. A hat is simply an embedded profile, a sub-profile, if you will. Only profiles for hat-aware applications can have hats, and even at that, you must have SUSE's libimunix and mod-change-hat packages installed for hats to work.

The most common use of hats is for Web applications that are run without actually being part of httpd daemons. Figure 4 shows the contents of just such a hat, corresponding to a guestbook application on my Web server. The index.php script referenced in Figure 4 mainly needs read access to some files, but it also needs to both read and write to the guestbook file itself (book.gb) and also Apache's access log (access_log).

If this seems confusing, don't worry. It's seldom necessary to create profiles (let alone hats) manually. On many systems, you won't need to create new profiles at all—periodically running the AppArmor Update Profile Wizard when things don't work as expected may suffice. This wizard scans /var/log/messages for AppArmor-generated error messages and allows you to update the corresponding AppArmor profiles accordingly (either to allow or continue to disallow the event that triggered each error). Where appropriate/applicable, Update Profile Wizard even will create new hats, again assuming you've installed the libimunix and mod-change-hat packages.

How to Create a New Profile Quickly

If you need to create a new profile from scratch, there are several ways to do so, all explained in detail in the aforementioned Admin Guide Using YaST and also in the AppArmor Advanced User's Guide (/usr/share/doc/packages/subdomain-docs/adv-ug-apparmor.pdf). Here, however, is the easiest method:

1. Run the Add Profile Wizard, being sure to specify the full path to the program you want to protect when prompted for the application name. You will be prompted to run the program, during which time AppArmor runs in "learn" mode, and builds a profile by observing the application's behavior.
2. After the Add Profile Wizard closes, restart your application (if a daemon) and test it as thoroughly as possible. If everything works properly, you're done.
3. If anything failed in the previous step, run the Update Profile Wizard. Based on your answers to the Wizard's prompts, the AppArmor profile you just created (plus any other applicable profiles) will be updated.
4. Repeat steps two and three until the application works the way it did before you created its AppArmor profile. This may take more than two iterations.

That's basically it! The excellent documents in /usr/share/doc/packages/subdomain-docs explain not only the above procedure, but also how to use the Add Profile Manually applet and even how to create profiles from scratch using your text editor of choice.

Miscellaneous Notes

Before I close this month's column, I leave you with a couple observations based on my experiences tinkering with AppArmor over the past couple of months. First, I must stress the importance of having a healthy local logging facility. As you can see, AppArmor relies heavily on `/var/log/messages` not only for providing you with a good audit trail, but also for providing its own wizards with crucial configuration intelligence. Therefore, if you have a customized system logger, make sure that there's at least a symbolic link from `/var/log/messages` to wherever your subdomain messages end up.

For example, on my chrooted `syslog-ng` installation, my subdomain messages are written to `/var/syslog-ng/var/log/messages`. Before AppArmor would work properly on this system, I had to create a symbolic link from `/var/log/messages` to this location. I also had to edit `/etc/logrotate.d/syslog` so that the "real" messages file would be rotated when too large or old; otherwise, the symbolic link was destroyed by my `logrotate` cron job. (Obviously, I should have updated `logrotate.d/syslog` already, back when I configured `syslog-ng`—by the time I got around to this, `/var/syslog-ng/var/log/messages` had grown to an embarrassing and unwieldy size.)

Also, I should point out that, just like all of YaST's modules, you don't need to be running the X Window System to run the Novell AppArmor YaST applets. You shouldn't be running X on Internet-connected servers, both because it's almost never necessary and because X has a very rich history of so-called local privilege

escalation vulnerabilities. It may seem tempting to ignore such vulnerabilities if you're worried about non-local attackers, but "local" is usually a misnomer. If attackers gain shell access via, for example, a buffer-overflow attack against some network daemon, they often can exploit so-called local privilege escalation vulnerabilities to promote themselves to root.

I hope you'll forgive me, therefore, for using attractive screenshots of the X version of YaST in this article—I assure you that the content and functionality is identical in the text-only versions of these applets.

Finally, a tip—in the course of repeatedly running the Update Profile Wizard to make my guestbook PHP script work, AppArmor for some reason forgot I'd dealt with two particular events in `/var/log/messages` and prompted me over and over about these two events. The problem went away when I manually deleted the corresponding lines in `/var/log/messages`, and I haven't experienced that particular anomaly since. The problem may have had more to do with my weird `syslog-ng` behavior than with anything in AppArmor, but I mention it in case you experience anything similar. AppArmor's log messages always contain the string `SubDomain`. ■

Mick Bauer (darth.elmo@wiremonkeys.org) is Network Security Architect for one of the US's largest banks. He is the author of the O'Reilly book *Linux Server Security*, 2nd edition (formerly called *Building Secure Servers With Linux*), an occasional presenter at information security conferences and composer of the "Network Engineering Polka".



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JON "MADDOG" HALL

No Shoes, No Shirt, No Problem!

Separating the truth from fairy tales about pony tails.

I like seaside bars and restaurants, particularly those that are right on the beach. You are walking along the sand, right at the waterline, and when you crave a refreshing drink, you simply walk up, sit down and order one. You are probably barefoot and bare chested (assuming you are a man, but in some places women too), and you enjoy the warmth of the sun on your face and body while you eat your meal and drink your beverage. "No shoes, no shirt, no problem!"

There are a lot of restaurants in the United States, even those right on the beach with signs saying, "No shoes, no shirt, no service!" Whether this be an issue of health code, puritanical residuals or the fact that some people do not like to look at hairy bodies while they eat, I am not sure, but these signs show up in the most unlikely places, not just where you might expect them.

I always have believed that if people do their jobs right, show enthusiasm, are respectful of other people and are relatively clean and free of body odor, that how they dress or wear their hair should be their own choice. Particularly their hair, because it is hard to cut and grow your hair due to a nine-to-five job schedule. A person could put on a suit or a tie if the

sandals or pony-tails, but his off-hand remark was generated to show the lack of real business knowledge that goes with a lot of (not all) Free Software advocates and businesses. Many advocates of Free Software are programmers themselves (or system administrators or people who have been in the computer industry for a long time), so the concept of going in and changing the software, tracking the changes, integrating the changes back into the original source code pool is not mysterious. What does seem to be mysterious is a lack of understanding about how large corporations (or even small businesses) really work.

Likewise, the bulk of the business people making decisions today have never written a line of code, or if they did, it was back in their college days when they almost failed that "stupid programming course". In fact, most business people would love not to have to worry about computers at all. This desire is what leads to the e-business advertisements by IBM and to "Business on Demand".

Business people *do* understand, however, that their business cannot survive in the relatively short run if they do not have any computer resources. Some businesses could not

It seems to me that even with a larger number of people now involved with free software that the number of people actively having fun appears to be decreasing, or at least not increasing in the same proportions as users.

occasion called for it, and I have done that from time to time. I even have a picture of me wearing a tuxedo aboard the first Linux Lunacy cruise. I think I looked rather dashing, but I still prefer to wear shorts and a T-shirt.

In June 2000, *Linux Journal* had a rather ugly guy on the front cover, dressed in a suit, with a mirror in the background which showed his barefoot reflection wearing shorts and T-shirt. The reflection was pointing at him with a combination of horror and dismay, but the message was that Linux was moving into the world of big business, and the "barefoot days" had to make a little room for the suits.

Still, it amazed me recently when an IT manager who is an advocate of Free Software was in New Zealand for the Australian Linux User's Group meeting and made the statement that part of the trouble with Free Software was that people went around talking about it with "sandals and pony-tails".

Of course, the press had a field day with this. I was still getting questions about it four months later at LinuxWorld Toronto, when a reporter for *Report On Business*, a cable TV show, brought it up in an interview. Fortunately, I had time both to talk to the manager who had made the comment and to formulate an answer, so I was ready.

The manager, of course, has nothing against either

provide service with outages measured in seconds—catch-22.

So, when the sandal wearers come up and say, "Free Software", the business people say, "24-hour, seven-day-a-week-support". The sandal wearers kind of shuffle their feet and go, "Well, maybe eight-hour, five-day-a-week." The answer is not good enough.

The business people say, "I need these applications", and the sandal wearers tell them (with a wave of the hand but no concrete examples) that they can "do it all with thin clients and a Web site". Not good enough.

The business people say, "I need support in Hong Kong, Brazil, New York and Moscow", and the sandal wearers offer them support in Silicon Valley. Not good enough.

The business people say, "I need some type of road map to show me where Linux is going, so I can plan better." The sandal wearers tell them to read the mailing lists. Not good enough.

The business people say, "I need binary compatibility between the distributions so I can protect my investment in software." The sandal wearers tell them to do "everything in source". Not good enough.

The sandal wearers complain that the large companies do not support Linux up and down their product lines, not

understanding the economics of how much it costs these companies to qualify the (several) distributions of Linux for which customers might ask.

The sandal wearers have great ideas for doing business with Free Software, but no written business or marketing plan showing how the idea might be successful, and although it is true that a business and marketing plan does not guarantee success, it at least shows that you gave thought to it.

These examples of lack of knowledge and understanding are what gets the Free Software community the image of being sandal wearers.

So far, I have wailed on about the sandal wearers, but the suits also have their foibles. There are many examples of the suits not understanding the sandal wearers, or even trying to "let their hair down". Although I will cover most of these in a later column, I think the most famous of these types of considerations was the casual Friday, where people were encouraged to come to work in more casual clothes. It was reported that one large company had to hire psychologists to help its middle management employees through their personal crisis of not wearing a suit.

I often ask myself if the fun is disappearing in Free Software. I remember in the early days of Linux how we had fun at events like the Linux Expo and the Atlanta Linux Showcase. Paintball contests, hot sauce judging contests, a contest for designing a new desktop for Linux and other fun things in which the community could participate. It seems to me that even with a larger number of people now involved with Free Software that the number of people actively having fun appears to be decreasing, or at least not increasing in the same

proportions as users.

If there is one thing that Linus has taught me in my association with him, it is to strive always to have fun. There are, of course, days when you have more fun, and days that are not as much fun, but over all, it should be fun. Maybe if you are not having fun, you are really in the wrong business.

[Speaking of fun, the 15th anniversary of the first Linux release of code is coming up in September 2006—we should all plan for some fun to help celebrate it.]

So, although I will keep my suit pressed for those more formal presentations and cruise-ship parties, maybe I will keep my beard and long hair to remind me to have fun. On the other hand, maybe I will not totally put away my sandals, but I will polish my wing-tips while continuing to learn what businesses need to function and help the Free Software community supply those things to the business community. I will try even harder to walk that line between sandals and pony-tails and suits.

In the meantime, you will find me at the *Alideia dos Piratas*, digging my toes in the sand and having a drink with the warm sun shining on my back. ■

Jon "maddog" Hall is the Executive Director of Linux International (www.li.org), a nonprofit association of end users who wish to support and promote the Linux operating system. During his career in commercial computing, which started in 1969, Mr Hall has been a programmer, systems designer, systems administrator, product manager, technical marketing manager and educator. He has worked for such companies as Western Electric Corporation, Aetna Life and Casualty, Bell Laboratories, Digital Equipment Corporation, VA Linux Systems and SGI. He is now an independent consultant in Free and Open Source Software (FOSS) Business and Technical issues.



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DOC SEARLS

Progress Report toward Independent Identity

Silo-free identity systems begin to emerge and converge.

Last September's cover story examined the Identity Metasystem, proposed by Kim Cameron and his team at Microsoft, in support of personal identities that are independent of any vendor's silo. Microsoft's inaugural member of the Identity Metasystem is an identity selector called InfoCard and is due for inclusion in Vista when that operating system arrives in 2007. (It will be back-implemented for XP as well.)

Since then, the Identity Gang has grown in number, and it has held a series of meetings and workshops where progress has been dramatic and encouraging. In a meeting at Harvard in December 2005, Paul Trevithick of Social Physics introduced Higgins, a framework for building user-centric identity-enabled services. At the Internet Identity Workshop in January 2006 in Berkeley, creators of OpenID, LID and XRI/XDI joined various pieces to create Yadis: a new and simple combined lightweight identity system. At the Mountain View IIW in May 2006, a large conference room was packed with participants from Red Hat, Higgins, Identity Commons, XRI/XDI, the IETF, LID, Novell/SUSE,

deployment of interoperable implementations by the time that Windows Vista ships.

Since then, progress has been so rapid and varied (within and between different participants) that it's hard to follow exactly what's going on. When I asked Paul Trevithick to summarize it for *Linux Journal* readers, he wrote back:

The situation is extremely fluid. The Red Hats, Novells, independents and others are all bouncing around trying to understand what's really going on.

There are now at least three efforts afoot that as either a total or a partial goal include creating an open-source capability to interoperate fully with Microsoft's InfoCard system and especially the specific ways that it uses WS-Trust and related protocols:

1) OSIS: effort appears to be defined as a clone of Microsoft's InfoCard software but for Mac and Linux.

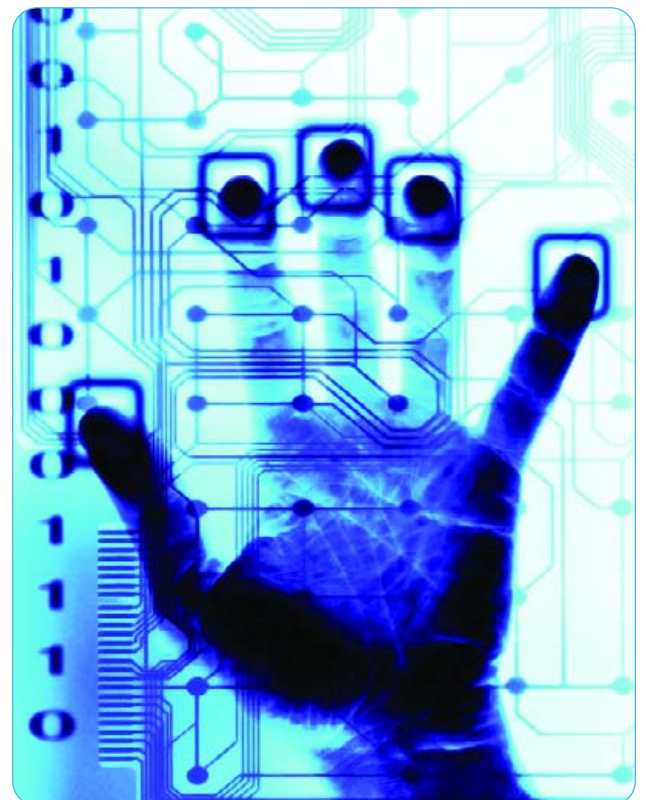
Why, other than adherence to principles of niceness, are all these projects working to keep things from breaking as they grow in converging directions?

VeriSign, Tucows, OpenID and other interested parties, to engage Kim Cameron and Mike Jones of Microsoft—and to talk about open-source implementations of InfoCard.

That conversation has since been formalized in a series of phone calls and a mailing list called OSIS (Open Source Identity Selector). A report on the first of the weekly OSIS conference calls began with this:

We reaffirmed that the initial goal of the project is to build InfoCard selector implementations for non-Windows platforms that are compatible with the Microsoft implementation, with targets possibly including GNOME, KDE, Mac and mobile devices.

We agreed that the goal is to move quickly, enabling



2) Higgins: one of the highest priorities is to provide full interoperability with Microsoft's InfoCard and thereby to provide equivalent functionality on non-Windows platforms. (Higgins also has goals that are beyond authentication and security, and it will support other protocols.)

3) The UNC Lab of Information Integration, Security and Privacy Project (www.sis.uncc.edu/LIISP) under Dr Gail-Joon Ahn, which was presented at IIW2006.

...and there may be others. Kim has stated that Microsoft will provide technical support to any and all groups to enable them to achieve interoperability.

Two additional points. First, Dr Ahn's implementation is ready in advance of Microsoft's own. (To an enthusiastic reception by Microsoft folks at the May 2006 IIW, where the system was demonstrated.) Second, I know of at least one commercial InfoCard-compatible implementation, which should be ready by the time this issue is published.

Phil Windley, author of *Digital Identity* (O'Reilly, 2005) and an organizer of the Internet Identity Workshops, said:

For us to have a metasytem, we need identity selectors for Linux desktops, Macs and other platforms. It's impressive that the identity community accepts Kim Cameron's vision—that there needs to be interoperability. It's Kim's political acumen that enables this. He just put out the Laws and said, "Here's a system that obeys these, and it's open." It's important that InfoCard isn't Microsoft Kool-Aid. If Microsoft stopped, all this other stuff could keep working.

I've been impressed, all through this process, at how committed all these different development projects are to staying open toward each other, in the general directions where they might converge. For example, InfoCard and Yadis are solutions to different problems, yet there are design decisions both communities can make today that will be interoperable at some point in the future when their uses overlap.

As we know too well, being open source doesn't prevent market-halting incompatibilities and failures to interoperate. Why, other than adherence to principles of niceness, are all these projects working to keep things from breaking as they grow in converging directions?

Phil Windley says there may be a couple of subtle reasons. First, "Sometime early last year, the competing participants got to the point where they said, 'We don't have to be enemies. We can work together.'" Second:

Some of the developers realized that relying parties—say, any Web site that has to rely on an identity credential from an identity provider—don't have to support different systems. It's the identity provider—the Amazons and Googles and eBays of the world—that will have to play in all those systems, if they want to be in the game. They have the incentive, as well as the ability, to interoperate. If you're Amazon, and want your customers' identities to be useful across a lot of Web sites, you have an incentive to interoperate. Now look at it the other way around. If the relying parties needed this, and not the identity providers, interop would always be "someday".

Instead, I think we're likely to see user-centric "independent" identity in widespread use sometime in the next two years. ■

Doc Searls is Senior Editor of *Linux Journal*.



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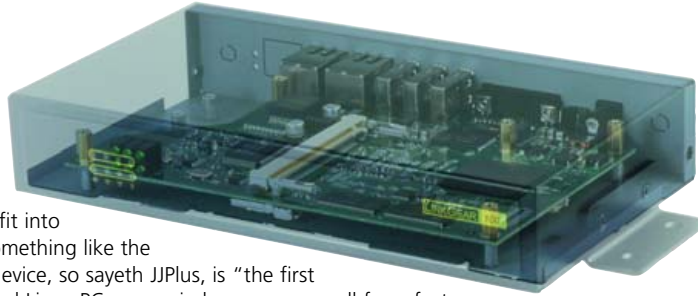


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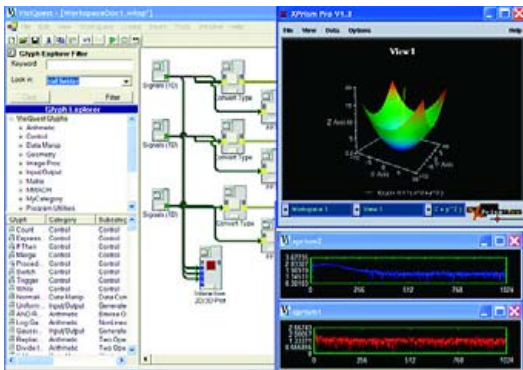
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JJPlus Corp.'s LinkGear Series 100



If Q were to make a Linux server to fit into 007's jacket pocket, it might look something like the LinkGear Series 100. This compact device, so sayeth JJPlus, is "the first affordable replacement for Intel-based Linux PC servers in low power, small form factor applications." Measuring in at 38mm x 203mm x 112mm (1.5" x 8" x 4.4") and weighing 0.55kg (1.2lbs.), this little guy is a standard Linux server, sporting an SH4-7751R RISC processor that consumes 2 Watts of power. Other standard features include a pre-installed Linux OS (2.6.12 kernel) based on GNU glibc and RPM; built-in firewall and wired or wireless gateway features; two mini-PCI slots for wireless networking; USB 2.0; and a NAND-flash block device driver compatible with fdisk, lilo and ext3 filesystem tools. Optional features are an internal IDE/CF-ATA storage adapter, an 802.3af-compliant PoE module, a Wi-Fi mini-PCI card and more. Also included are complete native and cross-development tools, sources and binary RPMs. Mr Bond, you've foiled the bad guys again, this time with the firewall in your pocket!

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AccuSoft's VisiQuest

Those in our community involved in data and image analysis—researchers, scientists, engineers and educators, among others—will be interested in the latest update to the VisiQuest software application from AccuSoft. VisiQuest's raison d'être is to perform complex image and data analysis tasks using visualization. The latest release, per AccuSoft, features a "toolbox with 60 additional functions for image registration and segmentation tasks". Included therein is a plethora of new functions or "glyphs" that help solve the challenge of mapping data of a rotated image to a fixed image. What's more, users can utilize these glyphs in a drag-and-drop environment without the need for proprietary programming languages; users can also roll their own glyphs in C, C++ or Perl. In addition, AccuSoft announced a price reduction and a new, bundled purchasing option. Supported platforms include Linux, Mac OS, Windows and UNIX.

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Mandriva Kiosk

Your valiant editor dithered a bit on whether to include this item, the Mandriva Kiosk service, thinking it more at home in *TUX*, our sister publication for the Linux desktop. As you can see, the desktop enthusiast in me cannot be subdued! According to the company, Mandriva Kiosk is "a Web-based one-click software installation service" that offers "access to the latest versions of the most popular applications through a simple installation process". Packages with multiple dependencies, such as KDE and GNOME, are aggregated into bundles and treated as a single entity from the user's perspective. Although the initial range of available applications is a bit sparse, the offering will presumably grow over time. Although many of you may balk, arguing that you lose valuable control of your system, I call on your inner evangelist. Have you not a mother-in-law you wish to lure away from the dark side? Subscriptions to Mandriva Kiosk start at 29.90 EUR (around \$38 US) per year. Only newer releases of Mandriva Linux are supported.

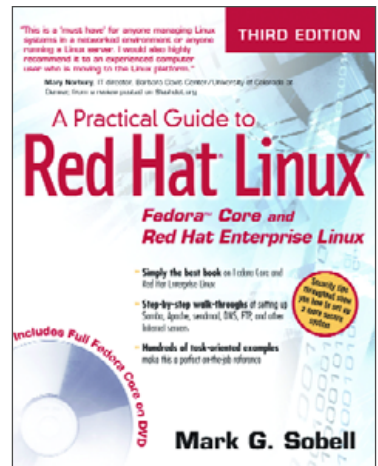
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Mark Sobell's A Practical Guide to Red Hat Linux: Fedora Core and Red Hat Enterprise Linux, 3rd Edition

Good golly, so many wonderful Linux books, so little time! We hope to better use this space to tell you what's hot off the press and perhaps worth a further look. Now, it is a good sign if, in today's competitive market, a book makes it into a 3rd edition, which is the case with Mark Sobell's *A Practical Guide to Red Hat Linux: Fedora Core and Red Hat Enterprise Linux*. The publisher, Prentice Hall, describes the book like so: "In 28 chapters, this book takes you from installing a Fedora Core (updated for Fedora Core 5) or Red Hat Enterprise Linux system through understanding its inner workings to setting up secure servers that run on the system, as well as working with GNOME, KDE, Samba, sendmail, Apache, DNS, NIS, and iptables." This new 3rd Edition includes beefed up info on system administration, security issues, networking and server set up. The publisher also notes how Sobell "knows every Linux nook and cranny", indicating that this book is especially comprehensive. *A Practical Guide* spans nearly 1,100 pages and includes a DVD with the full Fedora Core 5 OS.

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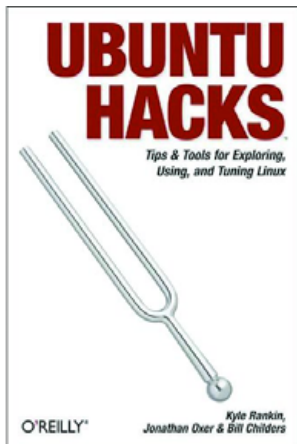
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Bill Childers, Jonathan Oxer and Kyle Rankin's *Ubuntu Hacks* (O'Reilly Media)

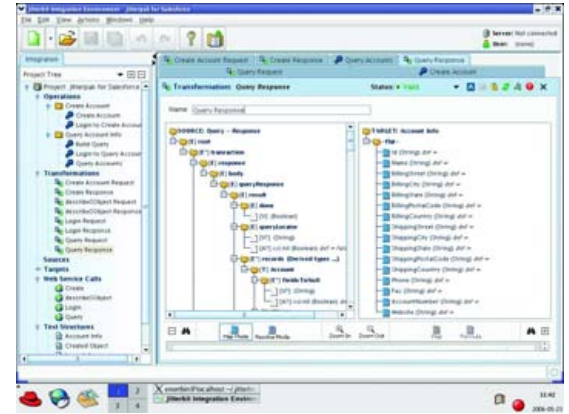
Yes, dear Reader, yet another book, based on the mildly presumptuous assumption that you love them as much as I. If the Ubuntu distro is your fancy, you'll be happy as a clam, for an avalanche of great Ubuntu books hits booksellers this summer and autumn. Naturally, I must insert a shameless plug for my friend and fellow *LJ* editor, Marcel Gagné, whose title *Moving to Ubuntu Linux* should be available sometime around now. However, the focus of this blurb is a title from Tim O'Reilly's library, namely *Ubuntu Hacks* from the trio of Bill Childers, Jonathan Oxer and Kyle Rankin. All three authors are self-described "passionate Ubuntu and Kubuntu users". The book is timely because, without a doubt, Ubuntu is far and away the hottest distro out there and one of the most active hubs of Linux-based innovation. *Ubuntu Hacks* is meant to whet the appetite of true hackers, those whom the authors describe endearingly as "creative, having the technical chops to get things done." Regardless of your level of expertise, the folks at O'Reilly Media say that this book will challenge you. It contains more than 100 different hacks, that is, creative ways to get the most out of your Ubuntu system, ranging from the basics through to mobile computing, X11 tweaks, virtualization and emulation, SOHO-level servers, security and more.

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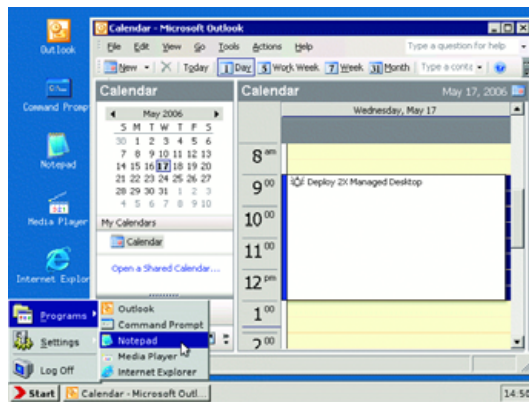
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2X's ThinClientServer

2X wants to bring joy to managing your Windows desktops by turning them into Linux ones—without users suspecting a thing! The company's ThinClientServer, just upgraded to Version 3, is a tool for centrally managing your network's desktops via thin client—that is, both existing "fat" PCs and thin-client devices from any vendor. 2X's approach is to deploy a secure, self-updating, small-footprint, Windows-mimicking Linux desktop to each client, which allows for central administration (Active Directory, LDAP) of users' connection and device hardware settings (RDP/ICA/NX, screen size and so forth), as well as which Windows apps are available. Windows apps are tunneled to clients either via the firm's application server or Citrix Metaframe. The upshot, says 2X, is that you avoid the technical and financial hassles of Windows; desktop administration is simplified (backup, updates and patching and so on); and unauthorized use of removable media is impossible. A free, five-client version can be downloaded from 2X's Web site.

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The Ultimate Do-It-Yourself Linux Box

Start with the ultimate AMD64 motherboard and build on it to create a masterpiece of your own.

NICHOLAS PETRELEY

Some of us just like to do it ourselves. There's something uniquely satisfying about selecting every component in a system. It allows you to balance the exact price/performance trade-off that suits you best. Do-it-yourself is also one of the best ways to ensure that you have a system that won't become obsolete within six months. For example, most AMD64 motherboards support only 4GB of RAM, but our favorite board supports up to 8GB of RAM. We may never upgrade it to the full 8GB, but it's nice to have that room for expansion. You may not get that kind of room for expansion with a pre-made system.

For those with little patience, we'll get right to the bottom line. Our favorite do-it-yourself combo includes the following:

- ▶ Motherboard: ABIT AN8 32X 939
- ▶ Processor: AMD64 4200+ Athlon X2
- ▶ Power supply: Silverstone SST-ST65ZF 650 Watts
- ▶ Memory: two sets of Corsair 1Gx2 TWINX2048-3200PRO modules (four total)
- ▶ Video cards: matched pair of eVGA GF 7900GT 256 (NVIDIA SLI)
- ▶ Case: Silverstone TJ07-S
- ▶ Hard drives: 2x Seagate Barracuda 300GB 7200 RPM 8MB cache SATA 3.0Gb/s
- ▶ DVD R+W: Plextor PX-716AL/SW SATA
- ▶ Monitor: Samsung LCD 204B 20.1"
- ▶ Keyboard: Logitech Cordless Comfort Duo (includes mouse)
- ▶ Logitech G7 Laser Cordless mouse

The above list includes the G7 Laser Cordless mouse simply because that is what we ended up using, but we do not include it in our price lists. Your choice of keyboard and mouse are more personal than just about anything else on your system (save, perhaps, your monitor). We like the keyboard in the Logitech Cordless Comfort Duo but not the mouse. So we replaced the mouse with a Logitech G7 Laser Cordless mouse. We don't assume any of you are going to do the same, so we don't make a fuss about keyboards and mice in this do-it-yourself system.

THE DO-IT-YOURSELF GOAL

Our goal for the do-it-yourself system was to create a high-powered Linux desktop without breaking the bank. Bang for the buck was our motto. We created a powerful system with components that often fell just below the big price breaks, after which you tend to pay a lot more for only minimal performance gains. In addition, we opted for a fan-based enclosure instead of a more expensive (and usually harder to install) liquid-cooling system.

We also include an alternate budget-minded system. Our do-it-yourself budget system is still pricey, but it delivers a lot of power at a considerably lower price than our favorite configuration.

One very important consideration in our choices was, will this work with most Linux distributions "out of the box"? We installed Debian, Ubuntu/Kubuntu, Fedora Core 5, SUSE 10 and Mandriva on our do-it-yourself system. All of these distributions ran without any trouble and without the need for any additional drivers or special driver management. (We did, however, use the proprietary NVIDIA drivers, not out of necessity, but in order to make use of the SLI features of the motherboards.) We also ran Knoppix, MEPIS and Kanotix live CDs without problems.

MOTHERBOARD

We chose to configure our do-it-yourself system around the ABIT AN8 32X 939 motherboard and an AMD64 4200+ Athlon X2 (dual-core) processor. We chose the AMD64 4200+ based on price. By the time you read this, AMD will have lowered the prices on its line of dual-core processors, so you can get more CPU bang for the same bucks than we did. We used two sets of matched pairs of Corsair memory modules (1Gx2 TWINX2048-3200PRO) for a total of 4GB in four slots in dual-channel mode.

The motherboard is the foundation of any do-it-yourself system. We looked at three motherboards, all based on socket 939 AMD64: the ABIT AN8 32X, MSI KN8 Diamond Plus and ASUS AN832-SLI Deluxe. All three motherboards sell for around \$200 US or less, depending on your source. The price difference is not significant enough to choose one over another. All of these motherboards support socket 939 dual-core AMD64 chips and dual-channel memory. All of the motherboards support two video cards configured in SLI mode. We tested the boards with two eVGA GeForce 7900GT video cards configured for SLI.

You aren't likely to be disappointed with any of these motherboards. The MSI comes with the Creative Sound Blaster Audigy system integrated on the motherboard, so Audigy fans will love the MSI. Both the MSI and ASUS boards include two LAN ports vs. one port on the ABIT. So if you want two LAN connections, the MSI or ASUS could be the board for you.

However, it is easy to add network cards and sound cards to motherboards. Despite the fact that the memory controller for the AMD64 is on the chip itself, not the motherboard, it is not possible to force a motherboard to support RAM differently than intended—at least it is impossible to make a motherboard support 8GB of RAM if it is designed to support 4GB or even just 3GB in practice. That is why we felt the ABIT trumped the other boards in the long run. It takes better advantage of the memory addressing capability of the AMD64 processor than the MSI or ASUS. The ABIT motherboard supports up to 8GB of RAM. The MSI and ASUS boards say they support up to 4GB of RAM, but they seem to be designed with 32-bit Windows XP in mind, and therefore use only up to 3GB of RAM by default, even if you have 4GB installed. The AMD64 version of Linux saw only 3GB of usable RAM on the MSI and ASUS boards. Although it may be possible to make all 4GB visible to Linux on the ASUS and MSI boards by playing with BIOS settings, the ABIT saw all 4GB without any BIOS modifications. (The MSI manual implies that it is not possible to make more than 3GB visible on that motherboard, but we did not attempt to prove or disprove the implication.)

FAVORITE SYSTEM, NOT INCLUDING MONITOR, KEYBOARD OR MOUSE

- ▶ **Motherboard:** ABIT AN8 32X 939 (\$200 US)
 - ▶ **Processor:** AMD64 4200+ Athlon X2 (\$360 US)
 - ▶ **Power supply:** Silverstone SST-ST65ZF 650 Watts (\$170 US)
 - ▶ **Memory:** two sets of Corsair 1Gx2 TWINX2048-3200PRO modules (four total) (\$500 US total)
 - ▶ **Video cards:** pair of eVGA GeForce 7900GT 256MB (NVIDIA SLI) (\$678 US)
 - ▶ **Case:** Silverstone TJ07-S (\$365 US)
 - ▶ **Hard drive:** 2x Seagate Barracuda 300GB 7200 RPM 8MB cache SATA 3.0Gb/s (\$200 US)
 - ▶ **DVD R+W:** Plextor PX-716AL/SW SATA (\$150 US)
- TOTAL:** \$2,623 US (not including monitor, keyboard or mouse)

ALTERNATE BUDGET CONFIGURATION, APPROXIMATE PRICES

- ▶ **Motherboard:** ABIT AN8 32X 939 (\$200 US)
 - ▶ **Processor:** AMD64 4200+ Athlon X2 (\$360 US)
 - ▶ **Power supply:** Enermax ELT500AWT 500 Watts (\$100 US)
 - ▶ **Memory:** one set of Corsair 1Gx2 TWINX2048-3200PRO modules (four total) (\$250 US total)
 - ▶ **Video card:** eVGA GeForce 7900GT Signature 256MB (\$360 US)
 - ▶ **Case:** Thermaltake Tsunami VA3000BWA (\$100 US)
 - ▶ **Hard drive:** Seagate Barracuda 300GB 7200 RPM 8MB cache SATA 3.0Gb/s (\$100 US)
 - ▶ **DVD R+W:** PX-750A ATAPI (\$60 US)
- TOTAL:** \$1,530 US (not including monitor, keyboard or mouse)

you populate all four RAM slots, the motherboard clocks back the memory. In our case, it clocked back our memory from 400MHz to 333MHz. This happens regardless of the memory size of the modules you use. The motherboards will clock back the RAM based on the fact that you have populated all four slots, not based on the total RAM in the system.

Again, it should be possible on all of these motherboards to adjust the BIOS settings to reset the clock speed back to 400. The BIOS on one board may make it more difficult to do so than on another, but by the time we addressed this issue, we already were sold on the ABIT. We were able to change the clock speed back to 400 on the ABIT board very easily. We simply set the DRAM timing settings to run "By SPD" (by the speed of the modules). This reversed the clocking back of the RAM and set the speed back to 400. We haven't experienced any instability at this speed, so it appears to be quite safe to make this change. Granted, you may not notice a performance improvement with the higher speed. When it comes to RAM, latency settings tend to affect performance more than speed. We did not risk changing the latency settings to something other than the specifications of the memory modules.

At this point, you should ask yourself whether you really need 4GB or more RAM. A total of 4GB could easily be overkill for many, if not most, users. If you think you will be content with less RAM for the life of your system, that gives you more reason to consider the MSI or ASUS boards, because all three boards will handle two 1GB modules (for a total of 2GB) equally well. But if, like us, you're a glutton for RAM, the ABIT is the clear choice, regardless of whether you run a 32-bit or 64-bit Linux system.

POWER SUPPLY

Never underestimate the importance of a good power supply for your do-it-yourself system, especially if you intend to use two video cards configured in SLI mode. You can experience all kinds of bizarre symptoms of instability if you underpower your system with an inadequate power supply. Don't go for anything less than a 500-Watt power supply if you intend to use two video cards in SLI mode. Go even higher if you intend to add other PCI cards to your system. And, when you shop for power supplies, be careful to look for efficiency ratings. Some power supplies boast good peak output, but the sustained output can still be inadequate.

There's almost no point in choosing a power supply based on its rated mean time between failures (MTBF), that is, how long it should last. We suspect these figures reflect how long the power supply lasts assuming the fan never fails. Unfortunately, power supply fans fail all the time. The power supply overheats, and kablooeey, so much for the mean time between failure rating. Your mileage may vary, but we've had the best luck with Enermax power supplies and their fans.

You will need a power supply with a 24-pin power connector to the motherboard for any of the motherboards we tested. You also will need a power supply with connectors for two video cards, so that you can use these motherboards in SLI mode. We chose the Enermax ELT500AWT 500-Watt power supply for our system. It sells for about \$100 US, depending on your source. We also used a Silverstone SST-ST65ZF 650-Watt power supply for a similarly configured system. It sells for about \$170 US, depending on your source. We've had these power supplies only for a few weeks at the time of this writing, but they both work

well so far—knock on wood.

CASE

We pulled out all the stops when it came to a case for our Ultimate Do-It-Yourself System. We chose the Silverstone TJ07-S case, which sells for about \$365 US, depending on your source. This is quite expensive for a case, but it is worth the investment. First, the thing is huge. It's larger than

We populated the ABIT with four 1GB RAM modules, for a total of 4GB. If you run 32-bit Linux, you should still be able to use all 4GB of RAM. A properly configured 32-bit Linux kernel will map the RAM such that a portion of it goes to the kernel and the rest goes to user space. Linux splits up the RAM depending on how you have compiled the kernel (or how it is precompiled on your distribution).

All of these boards have one more unexpected memory quirk. When

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FAVORITE SYSTEM WITH ACCESSORIES

- ▶ **Motherboard:** ABIT AN8 32X 939 (\$200 US)
 - ▶ **Processor:** AMD64 4200+ Athlon X2 (\$360 US)
 - ▶ **Power supply:** Silverstone SST-ST65ZF 650 Watts (\$170 US)
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 - ▶ **Video cards:** Pair of eVGA GeForce 7900GT 256MB (NVIDIA SLI) (\$678 US)
 - ▶ **Case:** Silverstone TJ07-S (\$365 US)
 - ▶ **Hard drive:** 2x Seagate Barracuda 300GB 7200 RPM 8MB Cache SATA 3.0Gb/s (\$200 US)
 - ▶ **DVD R+W:** Plextor PX-716AL/SW SATA (\$150 US)
 - ▶ **Monitor:** Samsung LCD 204B 20.1" 1600x1200 (\$400 US)
 - ▶ **Keyboard and mouse:** Logitech Cordless Comfort Duo (\$75 US)
- TOTAL:** \$3,098 US

case, as it has top-mounted fans you can block by leaving manuals or other paraphernalia on top of the computer.

VIDEO CARDS

Yes, you can use two NVIDIA cards in SLI mode on Linux—if you don't mind running the proprietary NVIDIA driver, which taints the Linux kernel. We chose a pair of eVGA GeForce 7900GT cards with 256MB of RAM. These cards are a great compromise between price and performance. The combination of cards totals at about \$500 US, which is less than the price of a single NVIDIA 7900 GTX card (about \$570 US). eVGA sells basically the same cards with different clock speeds at different prices. For example, budget-minded folks can get a single eVGA GeForce 7900GT Signature 256MB (same basic model as the ones we used in SLI mode) with higher clock speeds for about \$360 US.

You obviously have more choices than eVGA when it comes to video card manufacturers. We chose eVGA for our examples simply because the company produces a large selection of prices and configurations of NVIDIA cards, which made it easy to pick cards to fit varying budgets. We've had good success with other brands as well.

If you opt to use the NVIDIA proprietary drivers, you need to add the following line to your `xorg.conf` file:

```
Option      "SLI"      "Auto"
```

We also recommend that you dig through the NVIDIA HOWTO to learn how to specify whether you're using a digital or analog connector. Some monitors like to guess which interface you're using for five seconds or so, which can cause annoying delays when you start your desktop.

any tower case we've ever tried. This gives you tons of room to work when you insert cards and cable the system. On the other hand, if you're looking for a case you can place on top of the desk instead of beside it, this is definitely *not* the case for you.

The hard drives are tucked away in two separate removable compartments, and each compartment is cooled with its own separate 120mm fan. It has two more 120mm fans at the top of the case, and two rear 92mm intake fans. The case is remarkably quiet, considering it has six fans, not including the CPU fan, power supply fans and so forth. All this ventilation keeps everything very cool without having to invest the time and effort in creating a liquid-cooled system.

The case has a flip-down front accessory panel with connectors for audio, USB and FireWire. The panel is flush with the front of the case, so you simply press on the bottom of the panel to open it. Some people might be annoyed that there's no spring loading, no button and no catch for the panel, either in its open or closed state. We have no complaints with it though.

The only way to press the reset switch is to use a wire tool, which you insert into a small hole in the front of the case. Some people will hate this feature, others will appreciate how it protects you from accidentally resetting your system.

You can certainly find adequate cases for far less money, and some of them may even place things like the accessory jacks in more convenient locations. But, we found this to be a superb case primarily because of how easy it is to work inside it (thanks to its gigantic size) and superior ventilation without having to use liquid cooling.

If you're going to go the budget route, there are so many decent cases from which to choose, we're hard pressed to recommend one over another. Each has its advantages and disadvantages. We chose the Thermaltake Tsunami VA3000BWA, which sells for just over \$100 US at most outlets. It's not as high class as the Silverstone, and we found it frustrating to get the DVD drive installed, but it's a fair case for the price. It has a flip-up top accessory panel. People who leave things on top of their computer case will find this inconvenient, but the same must be said of the Silverstone

DRIVES

You've got a wide range of drives to choose from, and good SATA drives are amazingly inexpensive. We chose two Seagate Barracuda 300GB 7200 RPM drives with 8MB Cache. These drives are SATA 3.0Gb/s drives, so they're fast, and all three motherboards can handle these types of drives. We chose two identical drives for RAID 0 configuration, which produces even faster disk access (though without any fault tolerance). You can pick just one of these if you're on a budget. They go for about \$100 US each. If you're not a fan of Seagate for any reason, you can get other brands of drives that work just as well for about the same price.

Plextor offers a SATA DVD R+W drive, the PX-716AL/SW for about \$150 US. This drive has the following write speeds: DVD+R at 16x, DVD+RW at 8x, DVD-R at 16x, DVD-RW at 4x, CD-R at 48x, CD-RW at 24x, DVD+R DL at 6x and DVD-R DL at 6x. It offers read speeds at 16x DVD-ROM and 48x CD-ROM. Be careful when selecting a SATA-based DVD/CD drive, however. You can run into Linux installation problems if you choose a Linux distribution with a kernel configured such that it doesn't recognize a SATA DVD/CD drive properly.

We chose a Plextor PX-750A ATAPI drive for our budget combination, because it costs only about \$60 US. You can find cheaper drives, but the less you pay, the noisier and more unreliable they tend to be.

ACCESSORIES

Of course, you will need, at the very least, a monitor, keyboard and mouse to have a complete system. We don't make much of a favorite monitor, keyboard or mouse because your favorites will depend a great deal on your personal tastes. Some people like wide monitors; others don't. Some people like wireless keyboards; others don't. Some people like ergonomic design; others don't.

Our summary sample configurations do include a monitor, keyboard and mouse. We did so only to give you an idea of the total price you can expect if you are going to put together a complete system. Your total price probably won't change much if you choose a different keyboard or mouse, but monitor prices vary greatly depending on what kind of monitor you want. So, take our prices with a grain of salt. If you opt for a big, wide-



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TIPS FOR DOING IT YOURSELF

1) Mount your CPU carefully. The CPU itself is generally very easy to mount. The AMD64 is particularly easy because the pin locations prevent you from inserting it incorrectly (previous versions of AMD CPUs prevented you from inserting the chip incorrectly too, but not as well as the AMD64).

The CPU heat sink/fan combination can be anything from a breeze to a nightmare to install, depending on many factors. Some motherboards locate the CPU in awkward places, or place heat pipes and other components too close to the mounting bracket. Sometimes it's just hard to get the heat sink mounted for no particular reason.

There are lots of third-party CPU heat sinks and fans available. If you are going to use one, find one that mounts easily. Some of the best coolers require you to place a bracket beneath the motherboard, or even if they don't, they are installed most easily before you mount the motherboard in the computer. Consider this possibility before you install the motherboard.

2) Examine the layout of your case before installing anything. For example, in some cases (no pun intended), you may find that it is easiest to install the power supply first. Many cases place the power supply across from the location where your DVD/CD drive will go. It's usually much easier to mount the drive after the power supply is installed than vice versa. If you install your drive first, you may find yourself having to twist and turn the power supply just to get it into a position where it will slide into place. If you've already installed other things, like your motherboard,

this can lead to disaster, since the twisting and turning may scrape components on the motherboard.

Another common problem occurs when you install your hard drives before you install add-in cards like your video card. Many cases place the hard drives directly across from the video card. We have actually had the experience where we had to move a hard drive to another slot in order to make a video card fit.

3) Suck it in and blow it out. Mount your fans in such a way that you get the best possible air circulation. Fans blow air in one direction. Make sure you mount the fan such that it blows the right way. It's way too easy to simply mount fans willy-nilly, and have the near-the-CPU case fan blowing onto the processor instead of drawing the hot air out, which is what it's supposed to do.

4) Drives get hot too. You can lengthen the life of your hard drives and keep your whole computer considerably cooler by making sure you have fans blowing on the hard drives. Good cases provide ways to mount fans that cool your hard drives by pulling air off them and blowing the air out of the case. The Silverstone case we used cools drives extremely well. But if your case doesn't fan your drives, you can always buy drive fans that mount on the bottom of the drive. Beware, however, that some cases make it impossible to use these under-the-drive fans. They may not provide enough room, or they may have unusual drive mounting schemes that prevent you from using these neat-o devices.

5) Tie-wraps are your friends. Loose

cables can create nightmares in the long run. They flop around and can get caught in fan blades. When you're finally done assembling your system and are satisfied everything works properly, get in there and tie your cables together. Make sure you bunch the cables in such a way that they remain out of key ventilation paths or other sensitive areas.

6) Video cards can be surprisingly fragile. They are notoriously easy to break if you don't handle them carefully. We've knocked a capacitor off at least two video cards in our history of assembling do-it-yourself computers simply by holding the video card in the wrong place while removing it from the package or while inserting it into its slot in the computer. It's also easy to knock capacitors off the boards while moving cables or otherwise doing work inside your computer. We're not talking about handing the video card to the Incredible Hulk, who presses too hard on these things. The capacitors almost jump off the board with very little pressure applied. We're not sure why video card manufacturers mount these components so precariously, but they do, so beware.

7) There is a jumper, switch or other device on your motherboard that allows you to clear the BIOS settings. Use it to clear the BIOS settings before you boot your do-it-yourself system for the first time.

8) Read your manual with respect to installing RAM modules. All the motherboards we tried support dual-channel access to RAM, but you have to insert the modules in a certain order for dual-channel to work.

screen monitor, you're obviously going to pay more.

We chose for our example a Samsung 204B, because it has a fairly large screen (20"), good resolution (1600x1200), good contrast ratio (800:1) and an unusually fast response time (only 5ms). It's a great monitor for work and gaming, at a good price—about \$400 US.

Extremely budget-minded people can go for something like the Acer AL1515, which is smaller (15"), lower resolution (1024x768) and much slower (16ms). This monitor can be good for work but terrible for gaming. But the price is much lower at about \$150 US.

As for keyboard and mouse, we chose two Logitech combinations, the Wireless Comfort Duo (about \$75 US) and the wired Internet Pro (about \$18 US). You have a lot of wiggle room here. You can get better keyboards and mice without having to spend a whole lot more money, but

the Comfort Duo should be enough for most users. We happened to replace the mouse that comes with the Comfort Duo with a Logitech G7 Laser Cordless, but you may find this mouse to be a royal pain, because it requires you to swap batteries as much as twice daily. Fortunately, it comes with two lithium ion batteries, one of which stays in a charger while you use the other. But because this is an unlikely choice for many people, we stuck with the Cordless Duo as the standard choice for the preferred system.

PLAYING WITH PRICES

We put together two systems, a great system and a more budget-minded system. If you have money to burn, you easily could pump up the great system into an ultimate system. Trick it out with the two best NVIDIA cards

ALTERNATE BUDGET CONFIGURATION WITH ACCESSORIES

- ▶ **Motherboard:** ABIT AN8 32X 939 (\$200 US)
- ▶ **Processor:** AMD64 4200+ Athlon X2 (\$360 US)
- ▶ **Power supply:** Enermax ELT500AWT 500 Watts (\$100 US)
- ▶ **Memory:** one set of Corsair 1Gx2 TWINX2048-3200PRO modules (four total) (\$250 US total)
- ▶ **Video card:** eVGA GeForce 7900GT Signature 256MB (\$360 US)
- ▶ **Case:** Thermaltake Tsunami VA3000BWA (\$100 US)
- ▶ **Hard drive:** Seagate Barracuda 300GB 7200 RPM 8MB cache SATA 3.0Gb/s (\$100 US)
- ▶ **DVD R+W:** PX-750A ATAPI (\$60 US)
- ▶ **Monitor:** Acer AL1515 (\$150 US)
- ▶ **Keyboard and mouse:** Logitech Internet Pro Desktop, PS/2 Wired Standard Keyboard Mouse Included (\$18 US)

TOTAL: \$1,698

on the market in SLI mode. Add a liquid-cooled system that you connect to everything in the box that generates heat. Go for the top-of-the-line AMD64 processor instead of the 4200+. You'll pay a lot more, but you'll get what you pay for. The AMD Athlon 64 FX60 Toledo runs for just under \$1,000 US.

The second combo uses a less-expensive case, a single video card and less memory in order to save cash. You can cut other corners as well, but we chose those components that were at a price threshold where a better component would cost significantly more money. For example, at the time of this writing, the difference between an AMD64 4000+ and an AMD64 4200+ is about \$30 US, but the price difference jumps to \$100 US between the 4200+ and the 4400+. As mentioned earlier, AMD is likely to have restructured all these prices by the time you read this, so the threshold where the price jumps probably will be different. Choose accordingly.

The same tends to hold true for video cards. There's a point at which the price increase doesn't get you much extra performance, so you have to think hard in order to decide whether you want to spend the extra cash for the edge. At the time of this writing, the NVIDIA 7900GT series is affordable and fast. If you really need a budget card, the eVGA GeForce 6600GT 256MB PCI Express x16 goes for about \$150 US, and although it doesn't compete well with the 7900 series, it's no slouch.

Perhaps no category includes a wider variety of prices than monitors. We didn't explore the vast range in our do-it-yourself kit, simply because a choice of monitor can be intensely personal. We can't tell you which one you'll like best, but we can tell you that the price difference between a monitor you like and one you love can be as much as \$1,000 US or more. We're very happy with the Samsung 204B. You might need more, or you might be happy with less. ■

Nicholas Petreley is Editor in Chief of *Linux Journal* and a former programmer, teacher, analyst and consultant who has been working with and writing about Linux for more than ten years.

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The Ultimate Linux Desktop

Puget Custom Computers packs a lot of power into our Ultimate Linux Desktop.

DEE-ANN LEBLANC

When determining the basic specifications for what the Ultimate Linux Desktop should be capable of, one thing Editor in Chief Nicholas Petreley and I agreed on was that it should have at least two NVIDIA SLI GPUs. If you're not familiar with SLI (Scalable Link Interface), this technology allows you to run two or four GPUs (Graphics Processing Units) either on a single card or a pair of cards to increase video performance. It works by splitting the processing work to render video among the GPUs for each frame.

Why care about something fancy like SLI? Aside from the cool factor, the Ultimate Linux Desktop needs to run modern games made available for Linux. *Doom 3*, *Quake 4* and *Unreal Tournament 2004* all are capable of taking advantage of this powerful feature, so why miss out? Aside from games, SLI also benefits those doing high-end graphics work, especially 3-D graphics. Any application that uses OpenGL graphics can take advantage of this feature. However, for high-end graphics workstations, you're more likely to go quad SLI (four GPUs) rather than dual (two GPUs).

In conjunction with SLI, the motherboard needs SLI support. For the rest, it was mainly a wish list of what most people would like to see in a desktop computer: plenty of fast RAM, fast networking, great audio, front-panel USB, dual-core CPU and more. Oh, and of course, all of it has to be supported by Linux. Another stipulation was the machine has to come with Linux pre-installed, or if the user has to install Linux themselves, it can't be a difficult operation.

For the Ultimate Linux Desktop, we were going for ease of "set up and go". We weren't considering anything that required hand-tweaking hardware or installs, except for very basic operations. Why be this fussy for the *Linux Journal*, the home of Linux geeks? The desktop is where the Linux community is still getting its legs, and the ability to order a Linux box pre-installed is definitely a helpful boost to beginners. Linux is no harder to install than Microsoft Windows, but average users never install Windows on their own. Many would rather purchase a new machine than try it.

So, enough with the introduction. You want to know what machine won and why.

MEET THE WINNER

The Ultimate Linux Desktop comes from Puget Custom Computers (www.pugetsystems.com). From its High End Gaming Computer category, the setup we received includes a number of



Figure 1. A custom-built machine from Puget Custom Computers is our Ultimate Linux Desktop.

desirable features (Figure 1). This particular configuration costs \$2,882.17 US before tax. There is no monitor, keyboard or mouse included.

The CPU is an AMD Athlon 64 X2 4400+, which runs at 2.2GHz. This isn't the newest or fastest processor in its series, but it's at the juicy price point for most users. This dual-core CPU allows programs built to take advantage of SMP (Symmetric Multiprocessing) to split their processing tasks among the two cores. In general, it's designed for those who use a lot of multimedia or do a lot of multitasking, which pretty well describes the job of an Ultimate Linux Desktop.

The motherboard is an ASUS A8N-SLI Premium, which is designed to make it simple to activate or deactivate SLI support when needed. On many early SLI-based motherboards, you have to open the computer and change a switch setting in order to accomplish this task. The ASUS A8N-SLI Premium allows you to do this in the BIOS instead or by using a Microsoft Windows XP utility (unfortunately all of the utilities for this motherboard are for Windows or DOS). You won't find any serial port on this motherboard, so if you need support for older hardware, you have to pick up a separate card. There also is no floppy drive.

The ASUS A8N-SLI Premium offers support for AMD Cool 'n' Quiet Technology, which adjusts the CPU speed, voltage and power

consumption, depending on what the system is doing. Although this motherboard is more than a year old, its feature collection is still impressive, including:

- ▶ HyperTransport Technology (www.hypertransport.org), which speeds up communication between integrated motherboard components.
- ▶ Dual-channel DDR (Double Data Rate) RAM.
- ▶ Serial ATA (SATA) II hard drive interfaces.
- ▶ Dual RAID controllers.
- ▶ PCI Express controllers.
- ▶ S/PDIF (Sony/Philips Digital Interface) Out to allow digital-to-digital transfer of audio between devices.
- ▶ IEEE 1394a (FireWire), which is now supported under Linux.
- ▶ USB 2.0 connectors.
- ▶ Two Gigabit Ethernet interfaces.

For RAM, this box has two Corsair XMS CMX1024-3200C2 PC3200 1,024MB low-latency sticks. The XMS (Xtreme Memory) product line from Corsair is designed for overclockers and gamers. Rather than choosing the flashy option of the RAM sticks with the LED displays along their tops, Puget Custom Systems went with the less-flashy (and therefore less-expensive) option. We were hoping for fast memory, so this is a real plus—and we encouraged vendors to go more for practical than "bling".

The included hard drive is the Western Digital SATA Raptor 74GB. This drive might be a bit small for what many people want, but you can choose another size if you want a bigger one—and are willing to pay more for it. However, this hard drive is 10,000 RPM, so it flies when it's in use.

When it comes to the video cards, specifically what's included are two eVGA 7900GT CO 256MB SLI cards. These aren't the highest model available for eVGA's NVIDIA 7900 series cards, but again, you can customize the order to go up to the GTX if you want to spend around \$1,000 US more on your computer to get the bleeding edge.

One small drawback may be the Seasonic

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Figure 2. Part of the Cooling Setup for the Ultimate Linux Desktop



Figure 3. The other part of the cooling setup is the actual case layout.

S12 Series 500W power supply. If you want to add many more components to this system, you'll want to upgrade to a larger wattage. On the plus side though, this power supply series is extremely quiet and has split rail technology, meaning that the various devices on your system are all drawing their power from, in a way, multiple smaller power supplies. This feature prevents devices from interfering with each other. On an SLI system, you definitely want this feature in your power supply.

KEEPING COOL

Everyone has heard about things like people being able to cook inside modern computers. If you've run into problems with intermittent crashes while playing high-end games, you also know the pain of video cards and other components that overheat. Although we would have loved a liquid-cooled box, and they will build you one, it can add more than \$1,000 US to the price. Without liquid cooling, however, Puget Custom Systems still provides a machine where much thought was put into how to keep it from overheating (Figure 2).

First, there's the Swiftech MCX159-CU Chipset Cooler. It's a small heat sink and fan that is sandwiched, in this case, between the two video cards (top left). Then, there's the monster Thermalright XP-90 Heatsink with 92mm Papst Fan, which is attached to the CPU (bottom middle). This particular solution is a combination fan, a set of radiating fins and a set of heat-conducting pipes that can radiate as well. There's another fan bolted into a metal frame (upper right) to help cool the video cards

as well, and there's a heat exhaust fan (bottom right) to blow hot air out of the case. Not shown in Figure 2 is another fan for air intake at the front of the case.

The case's design also helps keep the system cool (Figure 3). This Lian-Li V1000B Mid-Tower case is broken into three compartments: one for the hard drives (lower left), one for the power supply (bottom right) and then the upper compartment for the rest of the system. This breakdown creates three separate cooling zones, using small slots to pass cables through without letting too much heat travel within the machine as well.

Many spots on the outside of the case are made of a metallic mesh, allowing heat to pass through easily. You would think that such a setup would make the machine noisy, but in fact, this is a fairly quiet system, mostly because the fans are so large. The bigger the fan, the quieter it tends to be.

OTHER FUN FEATURES

Within the case, as you can see in Figure 3, the cables are wonderfully managed so that the computer doesn't look like someone dropped a bunch of spaghetti into it. The hard drive is installed in the lower left, sideways so you can easily access the important areas—not to mention making it far simpler to pull a drive out or push it in without banging it against other important components.

The front panel (Figure 4) offers a power button (the big silver disc), audio jacks, two USB ports and a FireWire port. If you've ever had to crawl around under desks to get to the back of



Figure 4. The front panel is along the bottom of the machine. You also can see the mesh mentioned earlier.

a machine just to plug in your USB thumbdrive, you know what a pain that can be. Of course, if you keep this case on the floor, you'll still have to get onto the floor to access these



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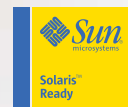


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controls, but it's better than having to go around to the back.

On the back panel (Figure 5), you can see at the top the connectors for both video cards. Below and on the right are the 5.1 analog audio connectors, the two Gigabit Ethernet jacks, four USB ports, a FireWire port, a parallel port, PS/2 mouse and keyboard jacks, and both coaxial and optical S/PDIF jacks for digital audio and features, such as 5.1 surround sound.

One of the perhaps smallest, but most wonderful features of the case is the single screw lock mechanism for removing the side panel. You simply have to twist one large screw by hand (no tools needed) to unlock the panel and pull the panel off. That's it. Then to put it back, slide the panel into place and re-lock the screw.

You also receive a box containing all of the unused parts and bits that came with the hardware included in the machine. There's a sheet that shows where many of the components plug in to the back. There's also a sheet showing you the warranty information for any components that offer them, and this particular box came with a one-year warranty as well. In the box, I also found all of the manuals and CDs involved in the process, including a DVD of

Fedora Core 5 (more about that in a moment).

This is ultimately a practical machine for today, and today's games in particular, hitting all of the best price points. However, if you are especially into games, you might prefer to push further into the bleeding edge and higher costs so you won't have to upgrade any time soon. The flexibility of Puget's customization interface—and the fact that if you ask them to add something to the machine that isn't available on their official list, they'll do so—should take care of those users.

THE ULTIMATE LINUX DESKTOP, AND LINUX

The box arrived with 32-bit Fedora Core 5 pre-installed. SLI was enabled, as verified in the X server logs. The collection of yum repositories recommended by FedoraFAQ.org were in place as well. Flash wasn't installed, but it was a minor annoyance because the repository was already set up. Other than that, everything worked like a charm under both an older 17" CRT monitor and a newer 24" wide-screen LCD.

To check out the performance under pressure, I tried both *Unreal Tournament 2004* and *Quake 4*. Both of these games played

smoothly with the absolute highest video resolutions and effects settings. In fact, *Quake 4* was set to 16x anti-aliasing with anisotropic filtering and 1920x1200 resolution and still played perfectly smoothly.

They have the firewall on with SSH enabled by default, which is a sane option. SELinux is on as well, so users would have to go out of their way to unsecure the machine. I can't think of any real complaints here aside from Flash. The system worked out of the box with Linux in place. Mind you, the installation was 32-bit instead of 64-bit. I could only speculate as to why at this point, so I won't make wild guesses—and I'm sure if I had specifically asked them to install 64-bit, they would have done so.

Really, other than that it just worked, and worked well; you can't ask for more than that from the Ultimate Linux Desktop. ■



Figure 5. The back panel offers most of the hookups, along with many spots for ventilation, including mesh and cut-outs for fans.

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The Ultimate Linux Server

The Aberdeen A261T rackmount server delivers amazing bang for the buck as a rule of thumb—literally.

NICHOLAS PETRELEY



We defined specific parameters that would describe our Ultimate Linux Server before we began our search. To put it simply, the server had to be built for reliability, high availability and provide the best bang for the buck. Only one vendor provided us with a server that met our requirements. Although this made it easy to choose the Aberdeen Stonehaven A261T dual-core dual-processor rackmount server as our Ultimate Linux Server, one shouldn't get the idea that the Stonehaven doesn't deserve its place at the top based on its own merits. This server meets our entry criteria and then some.

The Aberdeen Stonehaven A261T rackmount server has two dual-core AMD Opteron processors for a total of four effective CPUs, and it comes with six 250GB hard drives configured for RAID 5. Aberdeen can provide up to 12TB of storage if you need it. The server comes with redundant power supplies for increased availability. Should one fail, you can hot swap a new one in its place. You also can hot swap the SATA drives.

The A261T is based on the Tyan S2882-D Thunder K8SD Pro motherboard. Tyan has long been a reliable provider of server motherboards, and this particular model is a terrific foundation upon which to build. The server includes an Areca SATA RAID controller. The default Linux software is Red Hat Enterprise Linux Server 4.0, 64-bit (x86_64), which is included with the server along with a handful of driver disks, manuals and other minor goodies.

Here is the official list of the box's features that we tested:

- AMD Opteron 64-bit dual-core 265 (1.8GHz), 1GB per core processor.
- Six 250GB SATA 7,200RPM 16MB cache hard drives with NCQ.
- 1.5TB storage capacity (maximum 3TB).
- 2GB Registered ECC DDR 400 memory (16GB memory capacity).

- Six hot-swap drive bays.
- Available 5.25 for optional tape backup.
- Dual Gigabit Ethernet controllers.
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- Hot-swappable four 10cm fans and two 4cm fans.
- Eight port SATA II 3Gb/s RAID controller (0, 1, 10, 5, 6, 50, JBOD capability) with battery backup module.
- RAID Management Software Installation and User Guides.
- Tyan System Monitor Server Management Software Installation and User Guides.
- Five-year parts and labor warranty.
- Optional: XDAS scalable storage appliance capability.

PERFORMANCE

We ran a series of benchmarks on the A261T. Most of them produced meaningless results, because the A261T was too fast for our benchmarks to stress the hardware adequately. We finally produced our own benchmark based on the siege program, which simulates a number of simultaneous Web clients hammering the server for Web pages. It wouldn't do to serve up static pages for this benchmark, because that would create no significant stress on the server. So we created a Web site based on Apache, PHP and MySQL that includes IFrames, JavaScript and records information about each visitor, so that each page access produces write operations on MySQL as well as read operations.

This turned out to be too much for the server at first. In fact, our dinky workstation outperformed the server by a wide margin. Naturally, this made

no sense, so we went on a troubleshooting spree. The answer turned out to be a poorly configured Apache file (httpd.conf). We suspect that the fault lies primarily with the GUI httpd configuration tool in Red Hat Enterprise Linux, but we haven't had time to back out all the changes and try the process from scratch in order to identify where things went wrong. Regardless, this is an issue with Red Hat EL 4.0, not with the server hardware. Any administrators worth their salt will want to tweak the httpd.conf one way or another to adapt it to their applications, whether they do so manually or via any one of several Web-based or GUI tools.

We didn't find this problem easily, but that's thanks mostly to Murphy's Law, which includes the axiom that one never looks in the right place the first time. At first, we noticed that MySQL was using up an unusual amount of CPU power. Was the outdated MySQL that comes with Red Hat Enterprise Linux 4.0 causing the problem? No. We replaced the 4.x version of MySQL with a 5.x version, and it made no difference. We ran up2date and chose to replace the existing Linux kernel with the latest version. This turned out to be a bigger task than expected. The Red Hat kernel doesn't include support for the Areca RAID controller. Fortunately, Aberdeen provides a CD-ROM with driver code and instructions for creating a module for any new Red Hat kernel and instructions on including this module in the initial RAM disk. Once we found those instructions, it was just a matter of minutes before we had the new kernel up and running. It didn't matter. The new kernel and driver didn't improve performance.

That's when we finally looked at the Apache httpd.conf file. On a hunch, we removed a duplicate Alias line created by Red Hat's GUI

COMPANY INFORMATION

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Table 1.

RESULTS OF THE SIEGE TEST WITH 500 SIMULTANEOUS USERS

Transactions	25,000 hits
Availability	100.00%
Elapsed time	81.29 secs
Response time	0.71 secs
Transaction rate	307.54 trans/sec
Concurrency	218.21
Successful transactions	25,000
Failed transactions	0
Longest transaction	45.36
Shortest transaction	0.00

tool, and we tweaked the pre-fork parameters of Apache. Here is what we ended up using:

```
<IfModule prefork.c>
StartServers 20
MinSpareServers 5
MaxSpareServers 20
MaxClients 256
MaxRequestsPerChild 0
</IfModule>
```

We restarted Apache and MySQL, re-initialized the database and Web site and then nothing seemed to be able to slow this puppy down. The siege benchmark defaults to simulating 15 simultaneous clients. Don't be deceived by this apparently tiny number of clients. The siege benchmark doesn't merely send 15 clients to the Web site, it hammers away at the Web site continually, unlike how 15 real users would. Real people read a page and move on. The siege benchmark doesn't bother reading anything. It just keeps hammering away.

Nevertheless, the A261T laughed at our 15 simultaneous users. So, we kept boosting the number until we hit 500 simultaneous users, which produced enough load to make the server recognize we were there. Table 1 shows the final results of the siege test with 500 simultaneous users.

As you can see, the response time was usually less than one second, which is remarkably fast for the kind of pages we were serving. The server had no problem delivering more than 300 transactions per second with a concurrency of 218 requests.

We had to go back to our workstation and try the same test, given that the workstation previously left the A261T server in the dust at 15 concurrent users. We changed the workstation configuration to match the server, and the workstation couldn't even finish the test at 500 concurrent users. In fact, the only way we could get it to finish was to reduce the number of concurrent users to 100 maximum, and even then it failed one transaction. We produced the numbers in Table 2 on a system with an AMD 4400+ Athlon x2 processor with 4GB of DDR400 RAM and a 300GB SATA 3.0Gb/s drive (no RAID).

Table 2.

SAME TEST, ON THE WORKSTATION

Transactions	4,999 hits
Availability	99.98%
Elapsed time	37.45 secs
Response time	0.05 secs
Transaction rate	133.48 trans/sec
Concurrency	6.80
Successful transactions	4,999
Failed transactions	1
Longest transaction	7.35
Shortest transaction	0.00

This story wouldn't be complete without mentioning our personal blunders. The Aberdeen server made an extremely loud whining noise when we first set it up. We tolerated this noise for what seemed like an eternity (more like two weeks of playing around with the server and running the original benchmarks, which we eventually had to replace). When we'd had enough, we opened up the case to listen to specific areas and feel around for vibrations in order to locate the source of the noise. A slip of the wrist,

and suddenly there was a piece of thumb caught in a CPU fan blade. (Never let it be said that we don't put a bit of ourselves into everything we do.) Now we had not only a loud whine, but also a fan that made a nearly unbearable racket.

It turns out the whine was just the server's way of letting us know one of the redundant power supplies wasn't working. Why wasn't it working? Because we didn't have the power cord pushed in all the way. It turned out we could have saved ourselves two weeks of agony and a band-aid if we'd simply pushed in the power cords more carefully. As for the fan, it worked, if noisily. But we replaced it with one of our own while we waited for Aberdeen to send another. The server wasn't whisper quiet by any means once we had it in normal operation, but it sounded like virtually any other rackmount server that has to push a lot of air in order to stay cool.

The retail direct price for this particular configuration is \$4,999 US. Given the design for reliability and its excellent performance and scalability, we consider the A261T to deliver an awful lot of bang for this buck. This model is very well deserving of our title of Ultimate Linux Server, and we recommend the Aberdeen line of servers without reservation. ■

Nicholas Petreley is Editor in Chief of *Linux Journal* and a former programmer, teacher, analyst and consultant who has been working with and writing about Linux for more than ten years.

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The Ultimate Multimedia Center actually slides in under a million dollars.

JON "MADDOG" HALL AND CLAY CLAIBORNE

Venice Beach is one of my favorite beaches in the world, and when I go to the Los Angeles area, I try to visit the beach, just to stroll along the sidewalk and watch the people. One of the people I like to watch for is my friend Clay Claiborne who owns Cosmos Engineering, and who named his Web site Linux Beach.

Clay is a Linux advocate from way back, and on my last trip out there, he was bragging about the multimedia system he had built for his house using Linux to control it. When I heard about the Ultimate Linux System issue coming up, I put Clay to the challenge.

Now, the first thing a person has to understand is that there is no upper limit for what you can spend on multimedia equipment, and that of course also means the computer system you can buy to capture, edit and play back the multimedia. If I wanted to buy an "ultimate" system, I would simply set aside a million dollars or so and go from there. So, the first place we started with was what a person who had a great love for multimedia, but an average-sized wallet would want in a system. I am sure we will get lots of letters complaining that our system was not "ultimate" enough, but I hope those letters will be outweighed by the ones that say, "Gee, I can almost afford that, and it is really cool—it all works together and it was easy to install."

Along those same lines, Clay designed two systems. Each one is expandable, but one is a bit less expensive than the other, for those with smaller wallets. Clay has pledged to supply us with all the specs and the software he uses on them so people can build them from scratch. For those with more money than time, Clay will be happy to order, assemble, install the software, test and ship them to you, and you may well be happy to buy the service. Your choice.

In honor of his love for the seaside, Clay has named these systems the Linux Beach MultiMedia Center 500 (LBMC 500) and the Linux Beach MultiMedia Center 1000 (LBMC 1000).

First, both systems come with a remote control (who wants to get off the couch?), and both systems are designed to be whisper quiet through the use of specialized cases, careful attention to power supply selection and selection of graphics cards that have no extra fan.

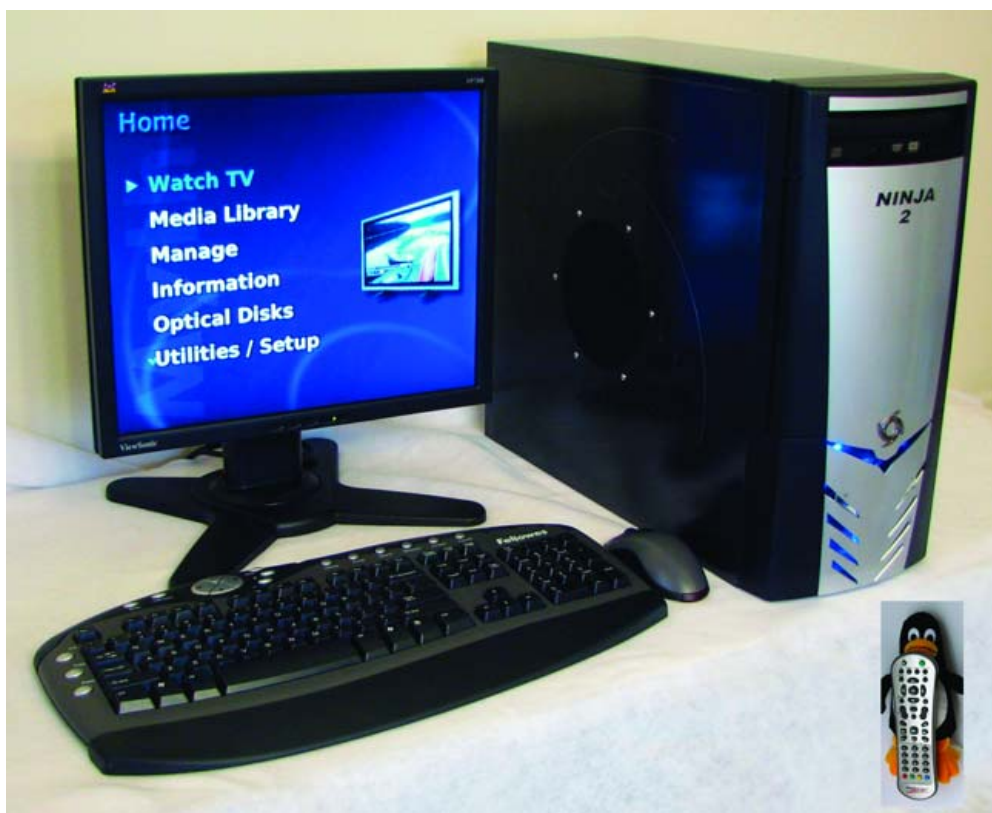


Figure 1. Linux Beach MultiMedia Center with optional monitor, keyboard and mouse—Tux is not available.

The smaller LBMC 500 system uses the Ninja 2 case, which was designed with low noise in mind. Although it does have a door on the front [I hate doors—md] you can get to the DVD without opening it. There are also two USB ports, one FireWire port and a set of headphone and mic jacks on the front for easy access. The power supply is 400W—more than adequate for the smaller system.

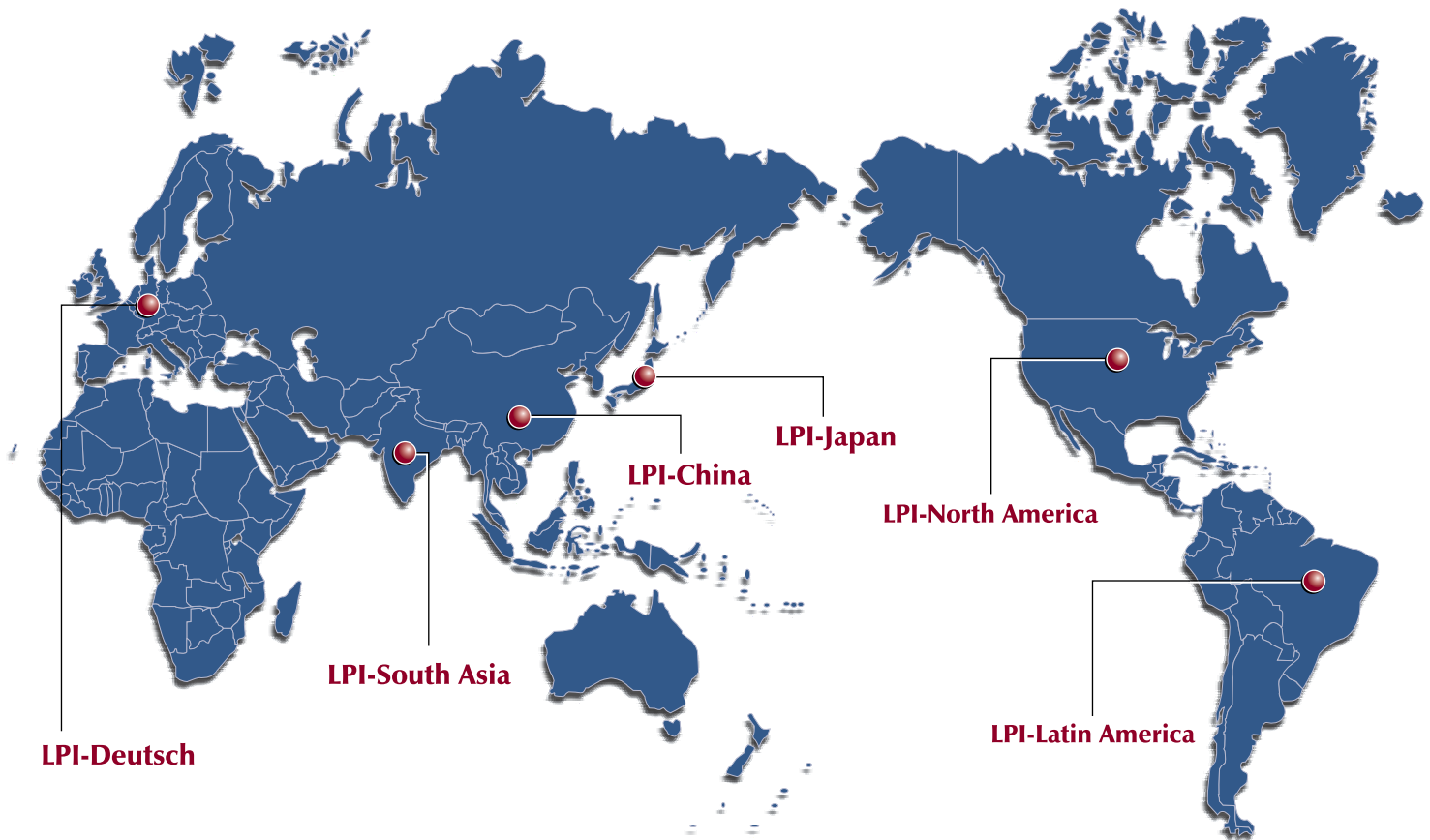
The larger LBMC 1000 is built around the Antec Sonata II case, which also was designed for quiet operation. It uses a SmartPower 2.0 450-Watt power supply that is "smart enough to turn its fan off when it is not needed", as Clay puts it. Following along the lines of "quiet", the CPU fan is also RPM-controlled for low noise levels. Clay says he added blue LEDs

to the front of the case so you will know it is turned on. Unfortunately, with this case, you have to open the front door to get to your DVD drive, but the extra noise muffling makes that reasonable.

At my urging, Clay also chose as an alternative to the Antec Sonata II, the Antec Overture II Quiet Media case for those people who like their media centers to be horizontal instead of vertical. But *please* remember not to block the ventilation holes with "stuff". Both the vertical and horizontal cases have two USB ports, one FireWire and audio ports on the front.

Both systems use the same motherboard, the Gigabyte GA-K8NF-9. The smaller system gives you an 800Mbps FireWire port along with its *eight* USB 2.0 ports. In order not to use those

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high-speed ports for anything other than high-powered storage, the motherboard also gives you S/PIDIF Digital Audio In and Out to drive your surround sound 5.1 or 7.1 audio system, as well as eight channels out to drive analog amplifiers directly. It also gives you a parallel printer port and one RS-232 com port for those legacy peripherals, as well as PS/2 ports for mouse and keyboard. Video out is supplied by standard analog VGA, digital DVI or S-Video for the TV. Two monitors or a monitor and a TV can be used for different signals at the same time. The TV is properly set up with over scan so that everything appears as it should. Video can be captured with the TV tuner, composite or S-Video in. Finally, Gigabit LAN gives you the tightest possible connection to the world.

about twice the CPU power, although either chip is honking at the speeds they are going. And although the larger system comes with 1GB of memory standard, the smaller one comes with “only” 512MB. [maddog remembers when he paid \$23,000 US for 1MB of semiconductor memory and \$128,000 for 64 Kilobytes of Core—he will tell you some time what “Core” is.]

Both systems offer you an upgrade of both CPU and memory to your wallet’s capacity. The CPUs offered for the LBMC-500 are the AMD Athlon 64 3200+ (optional) or the 3700+ or 4000+ as options. For the LBMC-1000, the CPUs are the AMD Athlon 64 2X 4200+ (standard), or the optional upgrade to the 4600+.

Speaking of capacity, the smaller system

by the WinTV part, it is nicely supported by Linux. You also can get the pCHDTV HD3000 as an additional upgrade on both systems. With this second tuner, you get to watch and record high-definition TV, and also record one program while watching another, or record two TV programs at once. Clay tells me that on the larger system you can install enough tuners to record six TV channels at one time. But Clay, I have other things to do with my life than watch TV—like listen to music!

JUST A MATTER OF SOFTWARE

TiVo changed my life. I never watched much TV at all in my adult years, but I was very loyal to the shows I watched. TiVo allowed me to watch what I wanted, when I wanted. A couple of problems though—it was available only in the US, and although it was running Linux, it had big “do not open this box” labels on it. Of course, intrepid Linux hackers ignored this warning, and soon TiVos had much larger storage capacities and remote setup and so on.

Clay calls the software MythTV “TiVo on steroids”, and although *Linux Journal* does not condone drug usage of any type, I have to agree.

The core software of this system is Ubuntu. Clay chose Ubuntu because it gave good basic support to the multimedia, and because he likes their slogan, “I am what I am because of who we all are”. I have to admit that I like that slogan too.

Clay installs all of the core Ubuntu to make it easily available to the end user to tailor. So, you could run your Web server off your multimedia center. You also could use your multimedia center to handle your e-mail. Your choice.

On the other hand, you could use it just to record the TV shows that you want to watch and then play them back again using the MythTV software that Clay integrates. Or, use MPlayer to play your DVDs and other audio/video files in a huge number of formats. Or use XMMS to play back music, create playlists or create visual aids to go with your music.

And, of course, the remote is supported by MythTV, MPlayer and XMMS.

Clay also mentions that although all of the day-to-day audio/video functions can be controlled by this remote, you may want to get a wireless keyboard and mouse to operate the system better.

For complete specs, ordering information, copies of the software, and other things associated with this project, please go to CosmosEng.com/cgi-bin/cosmoseng/004-LBMS2.html for the Linux Beach MultiMedia 500 and CosmosEng.com/cgi-bin/cosmoseng/004-LBMS1.html for the Linux Beach Multimedia Center 1000.

And, for your own sake, get off the couch every once in a while—maybe to get a soda from the fridge.

TiVo is a trademark of TiVo, Inc. Linux is a trademark of Linus Torvalds. ■



Figure 2. The internals of the Linux Beach MultiMedia Center 500; the motherboard is the same as the LBMC 1000.

The larger system gives you the same features, but *three* 800Mbps FireWire ports, *ten* USB 2.0 ports and two RS-232 com ports.

Both motherboards also use the NVIDIA nForce4 chipset on the mainboard to provide the best PCI timing and drive a 3Gb/s SATA bus, two PCI and two PCI-Ex1 slots for expansion. The NVIDIA GeForce video output is driven at twice the speed of an AGP 8X through the PCI-EUR-Express 16 port.

The CPU is the next place that the two systems differ. Although both use a 64-bit AMD processor with an 800MHz memory bus speed and 4GB memory maximum, the larger system uses a dual-core chip, effectively giving you

comes with a MAXTOR 250GB, 7200 RPM SATA drive with 16MB of cache, but it can be ordered with two of these drives in the system for a bit more money. The larger system comes with a MAXTOR drive that is 400GB standard, and a second drive could be added. Both systems sport a Sony double layer (16x) DVD rewritable optical disk drive that can hold up to 8.5GB on a disk. The Sony’s CD-R write speed is 48x.

For those of you who are really starved for storage, the 800Mbps FireWire will give you amazing storage capacities outside the main CPU cabinet.

The TV tuner card in each system is the Hauppauge WinTV PVR150. Don’t be turned off



Figure 3. Linux Beach MultiMedia Center 1000 with optional monitor, keyboard and mouse.



Figure 4. Linux Beach MultiMedia Center 1000 with door open.

Jon "maddog" Hall is the Executive Director of Linux International (www.li.org), a nonprofit association of end users who wish to support and promote the Linux operating system. During his career in commercial computing, which started in 1969, Mr Hall has been a programmer, systems designer, systems administrator, product manager, technical marketing manager and educator. He has worked for such companies as Western Electric Corporation, Aetna Life and Casualty, Bell Laboratories, Digital Equipment Corporation, VA Linux Systems and SGI. He is now an independent consultant in Free and Open Source Software (FOSS) Business and Technical issues.

Clay Claiborne (cjc@Cosmoseng.com) is CEO of Linux hardware integrator Cosmos Engineering Company. He has worked in the computer industry off and on for 30 years. He has been a Linux enthusiast since 1995. In 1996, he developed the concept of selling Linux pre-installed on a hard drive and produced Linux On A Disk. He founded Linux Users, Los Angeles, and was its president for eight years. He currently resides in Venice, California.

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The Ultimate Linux Handheld

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DOC SEARLS AND JIM THOMPSON



We liked the Nokia 770 back when we reviewed it for the February 2006 issue. Since then, the 770 has received generally good reviews from Linux geeks and bad ones from the mainstream press. Rob Pergaro in the *Washington Post* says it “does little, and not very well”. Steven Mannes in *Forbes* says it comes with “lots of built-in frustration”. CNET calls it the “worst-rated product that CNET readers love” and knocks its lack of Ethernet, slow load times and sub-cellular battery life.

Well, we still like it. Here’s why:

1. It is a legitimate and useful handheld Linux computer (2.6 kernel, Debian package management, GNOME UI), yet small and light enough to fit in a shirt pocket. Consider the possibilities.
2. Linux desktop applications are straightforward to port. For example, running GPSdrive and gpsd on the 770 is a simple matter of

loading three packages. With a Bluetooth GPS providing your current location, you can own a “look ma, no wires!” navigation solution for your car or bike that is easy to take with you when you park.

3. It is Net-native out of the box, with a solid browser, excellent Wi-Fi (802.11b/g) and Internet radio stream support.
4. The 770’s 4.3” touchscreen display, with its

800x480, 225 pixels/inch resolution and 16 bits per pixel color depth, is beautiful.

5. The ARM9-based, 250MHz TI OMAP 1710 CPU at the core of the device provides plenty of CPU crunch while conserving battery power.
6. Storage is easily upgradable. For less than \$70 US, we fattened the memory of our 770 with a 1GB SanDisk RS-MMC card.
7. It has an active development community (maemo.org) that keeps enlarging its portfolio of capabilities.
8. It's backed by a giant company that can mainstream the unit through deals with the likes of Linksys and Discovery.com (see the on-line Resources).

We are also intrigued with the Pepper Pad, a 2.3 pound "two-handheld" Linux (MontaVista) computer with a 20GB hard drive, an infrared port (so you can use it as a remote control), a QWERTY keyboard (split to the left and right of the screen, so you can hold the pad with two hands and type with your thumbs—it's easier than you might think) and stereo speakers, among other features. In *TUX* (our sister publication), David Hitrys had kind things to say about the Pepper Pad (see Resources).

We favor the Nokia 770, however, because it fits cleanly inside a new niche—the pocket-sized computer—while the Pepper Pad operates at a price point (just over \$800 US) where there already are piles of Linux-ready notebooks with much heftier hardware. Still, the Pepper Pad is a New Thing, and we hope it succeeds—just as we hope all wide-open Linux-based devices succeed.

Success won't come easy, as long as the manufacturers continue to promote these things as "consumer" devices while they still lack a full portfolio of familiar and easy-to-use applications for nontechnical users. That kind of marketing guarantees negative reviews from mainstream media. The Nokia 770, for example, has the form factor of a PDA and comes from a company whose name is synonymous with cell phone. Yet it is neither. Instead, it is a computer. As a "consumer" computer, it suffers for not being Windows and for failing to meet the average user's expectations of a portable Windows or Palm device.

For the price of a Nokia 770, you can get an HP iPAQ or a Palm Treo. Both work as PDA/cell phones and run lots of ready applications. But, both also trap the user in Microsoft's or Palm's silos (and carrier partners' silos as well). The 770 doesn't do that. It's about as open as anything you'll ever see in a handheld computer from a major manufacturer—especially a manufacturer accustomed to working through supply chains that meet customers inside the walled gardens of cell-phone carriers.

For now and the near future, the Nokia 770 is a geek tool. That is why we continue to recommend it and to salute Nokia for making and supporting it. It's also why we urge the hackers among our readers to take a look at the maemo development platform roadmap (see Resources) and to help move things along. At the time of this writing (mid-May 2006), the Telepathy IM/VoIP Integration framework is in the works. So is the Farsight audio/video conferencing framework. On the to-do list are UI development tools such as Gazpacho, and enablement for languages (Python and Java) other than C for writing UI applications. Nokia also has sponsored significant improvements to the Matchbox window manager. And, with the announced 2.0 software feature set, the 770 should be even more attractive to those looking for a way to put Linux in their pockets.

Of course, this isn't the first time a major handheld device manufacturer has attempted to leverage the Open Source Development community on behalf of a new mass-market product. Sharp did exactly that with the Zaurus, which still has an active development community, even though the device was discontinued in 2004.

Now would be a good time for the Zaurus folks to get behind the Nokia 770, and for

everybody else with time and imagination to jump on board. With a critical mass of open applications, the market will invite other large hardware players to jump into the game and defeat the walled-garden model that continues to afflict the whole cell-phone industry and to threaten the computer industry as well. (For evidence of the latter, look no further than the iPod or the Windows Media Player.)

Open Linux-based hardware products like the Nokia 770 and the Pepper Pad are disadvantaged in the short run, but advantaged in the long. Although they lack the finished gloss associated with consumer electronics, their advantage is the same unfinished nature that the mainstream reviewers find so annoying. As platforms, these hardware devices are far more open and adaptable than their proprietary competitors. And, in the long run, evolution favors the most adaptable species. ■

Resources for this article:
www.linuxjournal.com/article/9070.

Doc Searls is Senior Editor of Linux Journal.

Jim Thompson is a veteran Linux (and UNIX) hacker who has long been one of the leading figures in wireless networking.



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The Ultimate Future Linux Box

The new AM2 socket-based AMD Athlon 64 dual-core processor goes beyond 11.

NICHOLAS PETRELEY



We got our hands on an AMD rev. F Processor (FX-60 or X2-5000+), along with the ASUS M2N32-SLI Deluxe motherboard built for this processor, and we're convinced this points the way to the future of the Ultimate Linux Box.

The movie *This Is Spinal Tap* is about a fictional heavy metal band with members who aren't very bright. In one scene, a guitarist mentions that if he cranks up his guitar to volume ten, and cranks up the amplifier to volume ten, that's as loud as it gets. There's nowhere left to go. Then he boasts of an amplifier he has whose knobs are numbered up to 11. Rob Reiner, the host, asks if he couldn't just buy an amplifier that is louder at volume ten. The guitarist looks confused for a moment and then says, "But this one goes to 11."

CPUs are close to the point where they've gotten to ten, and there's nowhere left to go. AMD and Intel have been bumping up against Moore's Law for a while now. They can pump only so many Gigahertz out of a processor. Enter the dual-core processors. At this point in history, it's easier to improve performance by

adding a second core than it is to try to keep cranking up the GHz ratings (although AMD and Intel do that too).

That takes care of the processor's technology bottleneck, but it doesn't address the next bottleneck in performance: how to get the processor to talk to RAM in the most efficient way possible. So far, we've seen AMD and Intel attempt to address this bottleneck by pumping up the front-side bus frequency and by supporting newer, faster types of RAM and RAM configurations.

Fast-forward to yesterday (relatively speaking). Intel supports DDR2 RAM, but the best AMD can do is DDR in dual-channel mode—hence the need for the new AM2 socket-based AMD64 processors. The differentiating factor between the old socket 939 line of AMD64 dual-core processors and the new socket AM2 processors of the future is that the new processors include an on-die memory controller for DDR2 RAM. Otherwise, the two processors are essentially the same.

DO OR DIE

The operative phrase is "on-die". This is now the differentiating factor between AMD and Intel processors. Currently, Intel must use an onboard memory controller in order to access DDR2 RAM. Although theory and practice do not always match, this, in theory, gives AMD a big advantage over Intel in the long run.

Why? One of the biggest performance bottlenecks with respect to memory access is latency. Latency is the time the processor has to wait before it can get the information it requests. AMD has reduced latency—in theory—by putting the memory controller on the CPU itself instead of relying on an on-the-motherboard memory controller. In fact, all AMD64 processors include the memory controller on-die. The difference between the socket 939 processors and the socket AM2 processors is that the AM2-based processors have a future, because they support DDR2.

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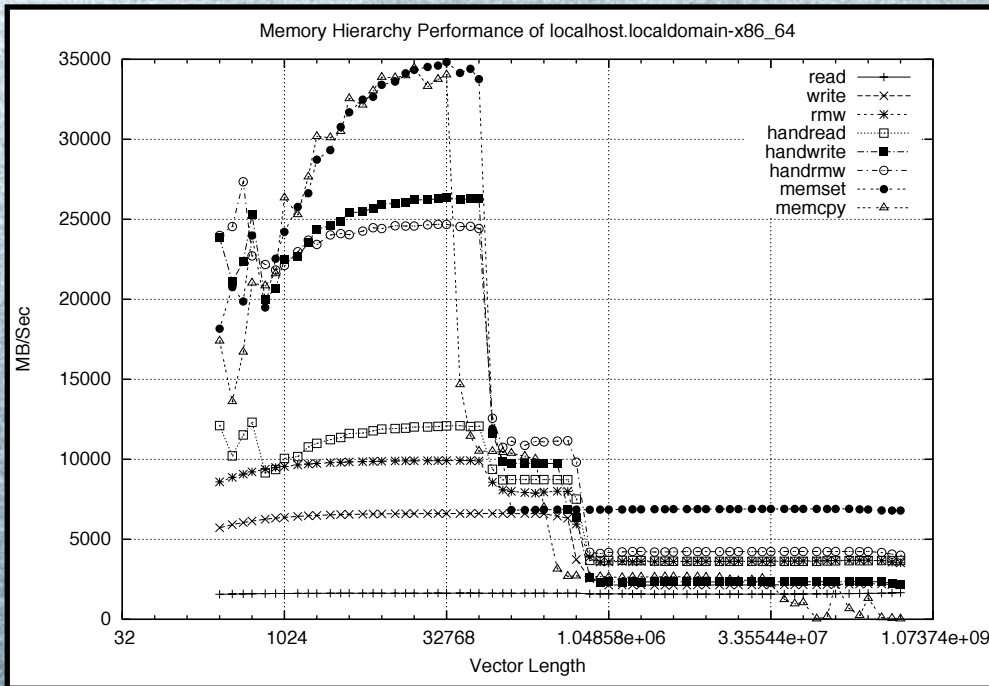


Figure 1. Memory and Cache Performance Benchmark Results for AM2

released new DDR2 memory modules at about the same time AMD released the socket AM2 processors. The timing is not a coincidence. You can't see any benefit in the socket AM2 processors without better DDR2 modules.

As it is, you can't see much benefit even with the better DDR2 modules. But that's because we're still in the early stages of DDR2 performance. Until recently, DDR2 performance has been a dog. The newest DDR modules are a lot better than the ones you could get just months ago. And DDR2 should improve steadily over time.

WHERE LIES THE FUTURE?

The question will be, which processor will best be able to exploit the performance increases in DDR2? AMD is preparing to win that battle with its on-die memory controller. Only time will tell, but I'd place my bets on AMD. It simply makes more sense to put the memory controller on-die rather than increase latency by relying on a memory controller on the motherboard, as is the way Intel processors currently work.

You've probably seen countless benchmarks of the socket AM2 processors by now, most of which show very little improvement over existing processors. We

tried the same type of comparison and found that the X2-5000+ dual-core socket AM2 processor blew away our AMD64 4400+ Athlon x2. That's not too surprising, because there's a fairly significant increase in processing speed. But, we didn't have an apples-to-apples system with which to compare the new one.

Here's the trick. AMD claims that even with DDR2 memory, speed isn't the issue, latency is. If you're familiar with how processors access memory, you'll know this is a perfectly credible statement in theory. But does it play out in practice?

We wanted to see if latency really does affect performance as much as AMD claims and reason dictates. AMD sent out a number of sample products to reviewers early on, when DDR2 modules still had high-latency issues. When AMD finally released the socket AM2 processors, it claimed we would see about a 1% performance increase over the early samples. We didn't have an early sample, so we compared the previous latency capabilities of DDR2 to the current ones by changing the latency settings in BIOS. We ran a memory/cache benchmark using the two different latency settings. You can see the performance with faster settings (4,4,4,12) in Figure 1. See Figure 2 for the benchmark results for the old latency settings (5,5,5,15).

Do you see the difference? Maybe not. Try to squint your eyes and turn your head a little and look again. If you look carefully enough, you will see some differences in performance. But we can save you the headache of trying to interpret the numbers in a moment.

First, just for fun, we wanted to show you the huge difference between these benchmarks and the same benchmark on the AMD64 4400+ (see Figure 3).

Now, back to the latency issue. There really is a performance difference between the two latency settings on the AM2, but admittedly, it's hard to see from the graphs shown here. So, we ran some Windows-based graphics benchmarks to find out if we could see the difference more clearly. We started with AMD's own nbench. We ran nbench on the ASUS M2N32-SLI Deluxe with the 5000+ processor, tricked out with two eVGA 7900GT NVIDIA video cards in SLI mode, with antialiasing and anisotropic filter settings set to application-controlled. Table 1 shows the results of nbench for the different latency timings.

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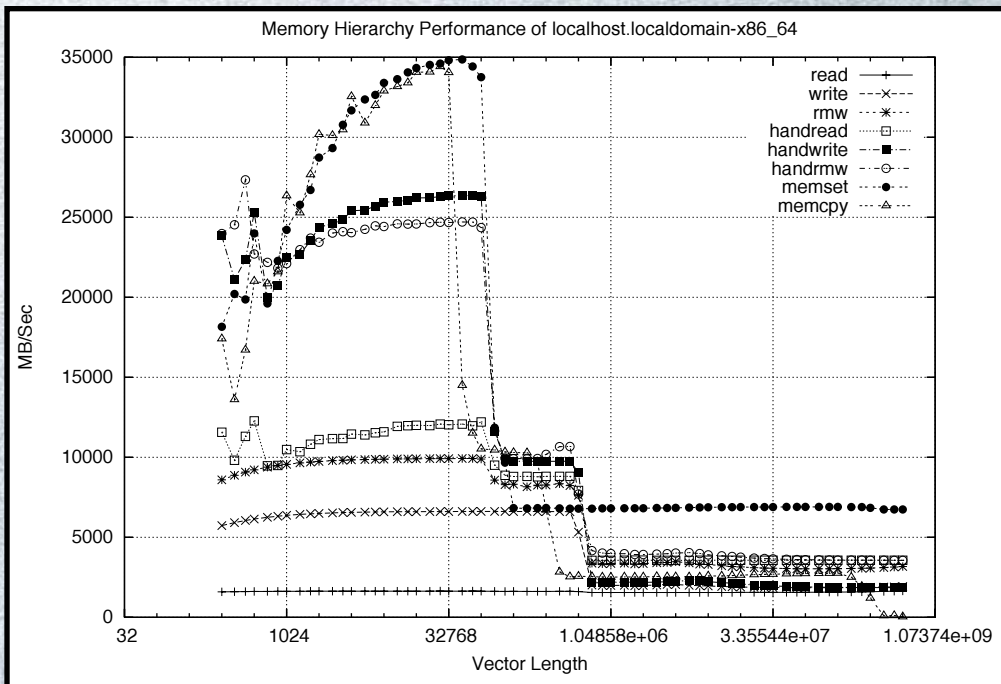


Figure 2. Memory and Cache Performance with Latency Set at 5.5.5.15

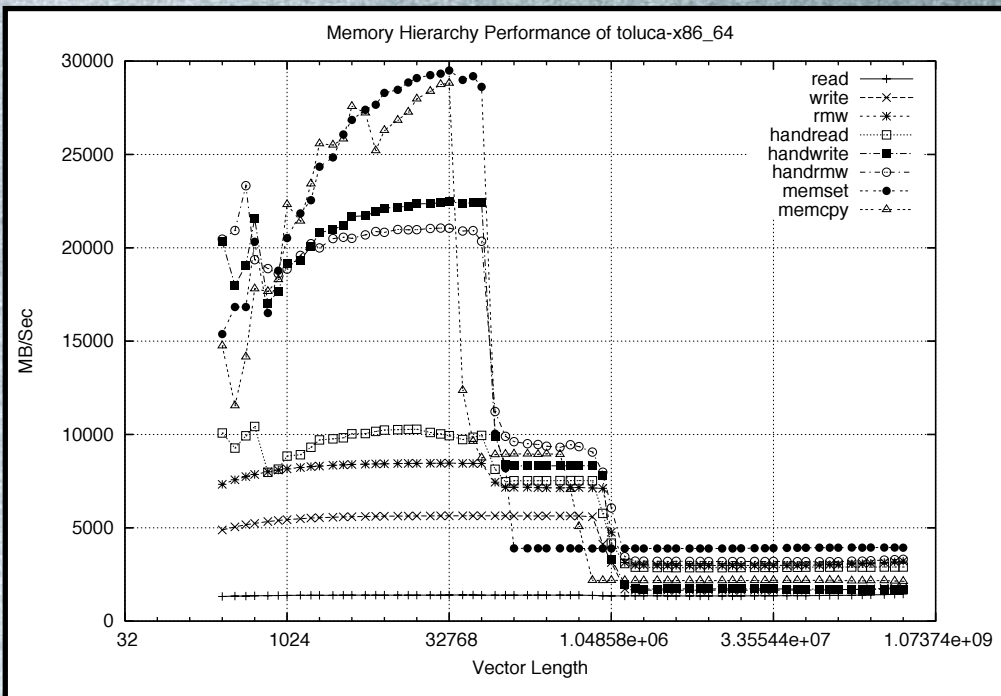


Figure 3. Performance on AMD 4400+ Athlon x2 with 4GB of Dual-Channel DDR400 RAM

We'll do the math for you. There's about a 1% difference in performance, exactly as AMD had predicted. Just for kicks, we cranked up the graphics settings to the best possible antialiasing and anisotropic filtering. Although the overall performance dropped some due to the extra work, the difference in performance between the two latency settings was about 1% once again.

The next benchmark comparison is apples to oranges, but it does show that the improvement over the AMD64 4400+ is enough to make our mouths water over the new system, regardless of where it's getting its kick. See Table 2. Even with the graphics settings entirely maxed out for best quality, the AM2 system boasted a 15% performance improvement over the 4400+ system, despite the fact that the 4400+ system had four times the RAM installed.

The problem with all these numbers is that they cannot reflect what a joy it is to behold the new system render graphics. Excerpts from unreleased games (unreleased because no current system can handle them) run like movies on the socket AM2 system, even with all the graphics settings set to the max. They don't quite run like slideshows on the 4400+ system, but the choppiness is extremely annoying, even with all of the graphics settings turned down to a minimum.

More important, the 1% difference in performance with the changes in latency settings may not look like much on paper, but it is often easy to see the improvement when you run the 3-D graphics benchmarks. This is because a 3-D scene looks best at 30 frames per second or better. When the frame rate hovers between 25 frames per second or less and 30-some frames per second, you really notice a 1% performance difference. Even a slightly more choppy rendering of a scene can be noticeably annoying.

We saw something closer to a 2% performance improvement when we ran the Windows-based AquaMark3 benchmark with the different latency settings (Table 3). This particular benchmark doesn't drop into the critical frame rates, so you don't notice the difference in performance as much as you do with other benchmarks. But you can see from the figures that the frame rates do change with different latency settings.

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Table 1.
COMPARING NBENCH WITH DIFFERENT LATENCY SETTINGS

Configuration: AM2 SLI-AC 5,5,15	
CPU overall performance	2844
3-D overall performance	3992
Overall performance	3418
Configuration AM2 SLI-AC 4,4,12	
CPU overall performance	2857
3-D overall performance	4047
Overall performance	3450

Table 2.
THE 5000+ AM2 PUTS THE 4400+ 939 TO SHAME.

AM2 SLI-MAX	
CPU overall performance	2855
3-D overall performance	4003
Overall performance	3429
AMD64 4400+ SLI-MAX	
CPU overall performance	2480
3-D overall performance	3459
Overall performance	2970

Table 3.
AQUAMARK3 RESULTS—YOU SEE A 2-6 FRAMES-PER-SECOND IMPROVEMENT WHEN CHANGING MEMORY LATENCY.

AM2 5000+, AM2 SLI with latency settings 5,5,15	
DisplayWidth	1024
DisplayHeight	768
DisplayDepth	32
AntialiasingMode	0
AntialiasingQuality	0
AnisotropicFiltering	4
DetailLevel	4
AvgFPS	97.668488
MinFPS	68.000000
MaxFPS	156.000000
AvgFPSRender	182.529037
AvgFPSSimulation	209.958633
AvgTrianglesPerSecond	29,401,354
MinTrianglesPerSecond	3,624,963
MaxTrianglesPerSecond	117,690,170
AquamarkScoreRender	18252
CPU: AquamarkScoreSimulation	10498
AquamarkScore	97668
AM2 SLI with latency settings 4,4,12	
DisplayWidth	1024
DisplayHeight	768
DisplayDepth	32
AntialiasingMode	0
AntialiasingQuality	0
AnisotropicFiltering	4
DetailLevel	4
AvgFPS	99.716568
MinFPS	70.000000
MaxFPS	158.000000
AvgFPSRender	185.784760
AvgFPSSimulation	215.265106
AvgTrianglesPerSecond	30,017,894
MinTrianglesPerSecond	3,775,542
MaxTrianglesPerSecond	122,671,018
AquamarkScoreRender	18579
CPU: AquamarkScoreSimulation	10764
AquamarkScore	99716


Sure, we'd heard about how this is only an incremental improvement over existing AMD64 Socket 939 processors and their motherboards. In fact, most opine that there's no improvement at all. As it turns out, many benchmarks show that there is minimal improvement in performance.

But, we think most reviews are missing the forest for the trees. The AM2 socket-based processors and boards aren't about delivering an exponential improvement in performance

today. This is about laying the foundation for exponential improvements in performance for the future. We can't tell you whether it is worth it for you to invest in today's socket-AM2 motherboards and processors. The risk you take is mostly dependent upon how quickly memory manufacturers can improve DDR2 and whether your motherboard will support the improved DDR2 modules.

In the long run, however, DDR2 will most definitely improve, and AMD will undoubtedly ship quad-core processors that require DDR2 and lower latency in order to exploit the advantages of quad-cores. So, although it may be frivolous to invest in a socket AM2 system today, we predict that the time is coming when the benefits will be indisputable. It is entirely possible that Intel can pull a rabbit out of its design hat and trump the AMD approach, but we don't see that happening yet. That's why we consider the socket AM2 systems as the Ultimate Linux Boxes of the future. ■

Nicholas Petreley is Editor in Chief of *Linux Journal* and a former programmer, teacher, analyst and consultant who has been working with and writing about Linux for more than ten years.



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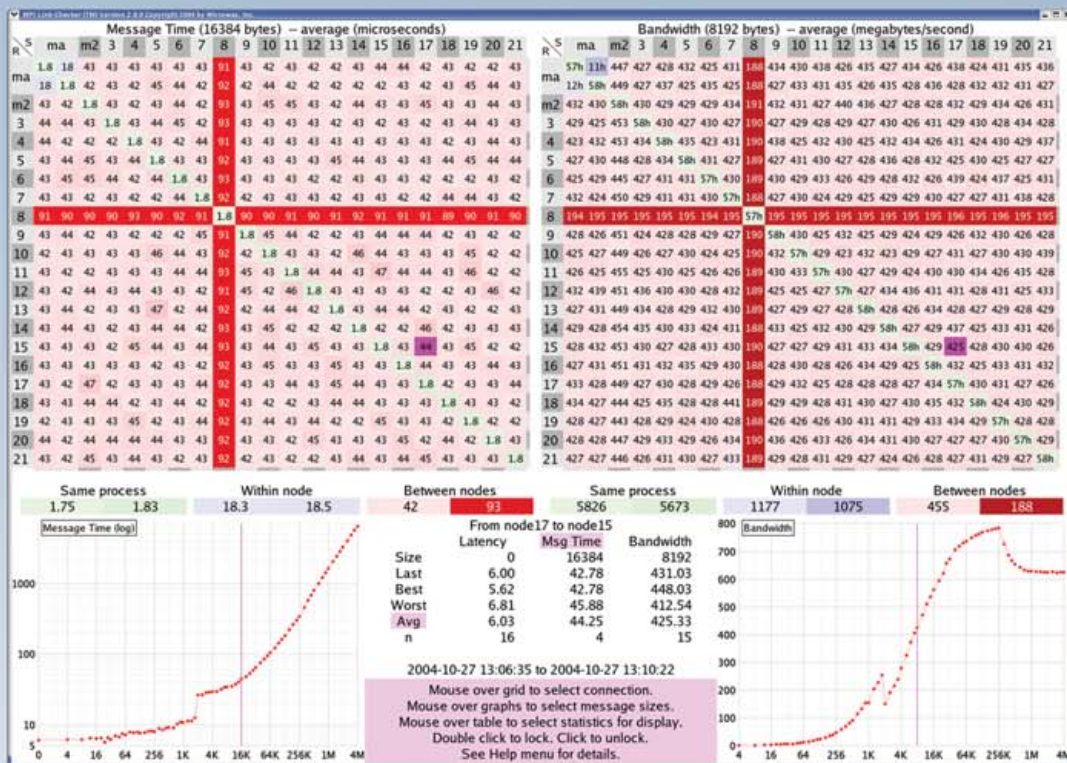
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NetDVD: Building a Network-Attached Peripheral with Linux

Use Linux to build your own network-attached peripheral. BRADFORD C. SMITH

I work in the Molecular Imaging group of Siemens Medical Solutions, where my colleagues and I develop and maintain software used to run Positron Emission Tomography (PET) medical scanners. These machines generate large amounts of patient data that our customers must archive for later retrieval and review, so our software allows customers to archive data to tape or Magneto-Optical (MO) disk. Using tape is very slow, so archiving to MO disk is generally preferred. Unfortunately, during the past few years, we've had a lot of problems with the MO hardware sporadically corrupting the MO disks, leading to expensive and tedious data recovery efforts and several replaced MO drives.

For many years, our customers have been asking for the ability to archive their data to DVD. DVD media is much cheaper than either tape or MO, and it can be read by any PC with a DVD drive. This would be useful to many of our customers, because there are free software tools they can use to read our data files on a PC. Because the MO drive vendor appeared unable to resolve our hardware problems, we decided the time was right to implement DVD archiving.

Unfortunately, we immediately hit a snag. The control consoles for our scanners are Sun UltraSPARC workstations running Solaris 2.6, Solaris 7 or Solaris 8. Customer hardware ranges from an Ultra 2 to a Sun Blade 2500. With so many different machines to support, we clearly needed an external SCSI DVD burner. But, we couldn't find a stable source for such a device, and Solaris 2.6 and Solaris 7 have little or no support for DVD burner hardware.

Because DVD burners are easy to get for x86 hardware and have been well supported by Linux for years, we decided the best solution would be to use a small Linux box with a high-quality DVD burner to do the work of reading and writing the DVDs. This would solve our hardware and OS-compatibility problems and make it easier to add support for new media types in the future. The Solaris workstations would communicate with the DVD reader/writer machine over the network, so we named our creation the NetDVD.

Finding a Vendor and Prototype Hardware

Because our business is building large medical scanners—not computers—the first thing we needed was a company to put the devices together for us and help select the hardware. I did Web searches to find appropriate companies and sent out several query letters. Few of the companies I contacted were interested in our project, and most required a guaranteed minimum number of units to work with us. We have about 700 scanners in the field, and it's likely we'll sell NetDVD devices to a few hundred of those, but I didn't have the authority to make any kind of commitment.

Thankfully, MBX Systems was very helpful. Their representative, Ed Jamison, quickly suggested some possible hardware solutions, including one using a mini-ITX motherboard in the C134 case from Casetronic, shown in Figure 1. This case is actually a bit small-



Figure 1. Prototype NetDVD in Casetronic C134 Case

er than the external MO drives we've been using, so it looked like the perfect choice. We eagerly ordered one with a 1GHz processor, 256MB of RAM, a 40GB hard drive and a laptop-size DVD burner.

Selecting the Linux Distribution

Once we had the prototype, we had to decide what Linux distribution we would put on it. My fellow developer and Linux enthusiast, Dan Duckworth, had just been reading about how great this new Ubuntu distribution was, so we decided to give it a try. We downloaded the Ubuntu 4.10 Warty Warthog CD image, and it installed beautifully. Ubuntu is based on Debian, which I've been using for several years, so I found configuring it very easy to do. It worked so well for us that we never even tried another distribution.

The NetDVD TCP/IP Protocol

While we were picking out a vendor, hardware and a Linux distribution, I was putting a lot of thought into how client machines would talk to the NetDVD. The client computer must be able to read a DVD, write to a DVD and create a copy of a DVD to provide redundant archive backups. To manage this, I decided to combine a custom TCP/IP protocol with Network File System (NFS).

To use a NetDVD, the client machine connects to it using our custom NetDVD TCP/IP protocol. If the device is already busy serving another client, it will respond with a BUSY error message and drop the connection. This ensures that only one client can control the device at a time. If the device is not busy, it will send a brief message stating the highest version of the NetDVD protocol it understands. At the time of this writing, the only version of the NetDVD protocol is 0, but we may create new versions of the protocol later to add new features.

If the client connects successfully, it immediately sends an initialization command to the NetDVD. This command tells the device both the version of the NetDVD protocol the client will use to communicate with it and what the client believes the current time to be in Universal Coordinated Time. The NetDVD sets its clock to match the client, so the machines will be in agreement on filesystem timestamps.

Also during the initialization command, the NetDVD uses NFS to export an empty directory on its hard drive with read/write permission strictly to the client's IP address. This is a working directory for the client to fill with files it wants to write to DVD. It is on a large disk partition separate from the operating system, so filling it up will not cause the device to misbehave.

To read a DVD in the NetDVD's drive, the client sends a mount command. This causes the device to mount the media in its drive and export it via NFS strictly to the client's IP address. When the client is finished reading, it can simply unmount it or unmount and eject it using an appropriate command.

To write files to a DVD, the client first mounts the NetDVD's working directory via NFS and fills it with the files and directories it wants to write to the DVD. Once finished, it sends a burn working directory command to the device and specifies whether this is supposed to be a new DVD or data appended to a DVD written previously. The ability to append data was crucial to our use of the device to archive data incrementally.

To copy a DVD in the NetDVD device's drive, the client sends a special copy command. The device then copies the directory structure on the media to a special directory on the same partition with the working directory. Once the copy is done, the client may send a burn copy command to the device one or more times to write the copied directory tree to as many DVDs as it likes. This method

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will *not* make viewable copies of video DVDs, because the data on those disks must be written in a very specific order that we don't preserve.

User Control without a Keyboard or Monitor

Although we usually had a monitor and keyboard hooked up to the NetDVD device during development, it is meant to appear to the customer as if it were a network-based peripheral, like a network printer. Because the user cannot type `shutdown -h` now to tell the NetDVD to shut down, it must do a clean shutdown when the user presses the power button.

Conveniently, modern motherboards supply the Advanced Configuration and Power Interface (ACPI). When the user presses the power button, the motherboard sends a signal to the processor. Then the processor is responsible for actually shutting the computer off. Linux has good support for this interface, so all we had to do was install the `acpid` Ubuntu package. This package comes already configured to do a clean shutdown when the power button is pressed.

But, a clean shutdown takes several seconds to complete. If the device doesn't appear to respond immediately to the power button press, a user is likely to press it repeatedly, maybe even hold it down for several seconds. This is both frustrating for the user and potentially harmful to the device, because holding down the power button forces the machine to power off immediately before the shutdown is complete.

So, we needed a way to tell the user, "I got your message. I'm turning off now. Give me a minute." As the NetDVD has no display, the natural choice was to beep using its PC speaker. For this we used the beep program written by Johnathan Nightingale. The beep package isn't part of the base Ubuntu installation, but it's still available from Ubuntu's Universe archives. Using this program, I wrote some init scripts that would make the machine start beeping once per second during boot up or shutdown and finish with an upward or downward arpeggio of beeps, respectively. This had the added benefit of informing the user when the device was ready for client connections. Unfortunately, it wasn't quite enough.



Figure 2. Second prototype NetDVD in Antec Aria Case

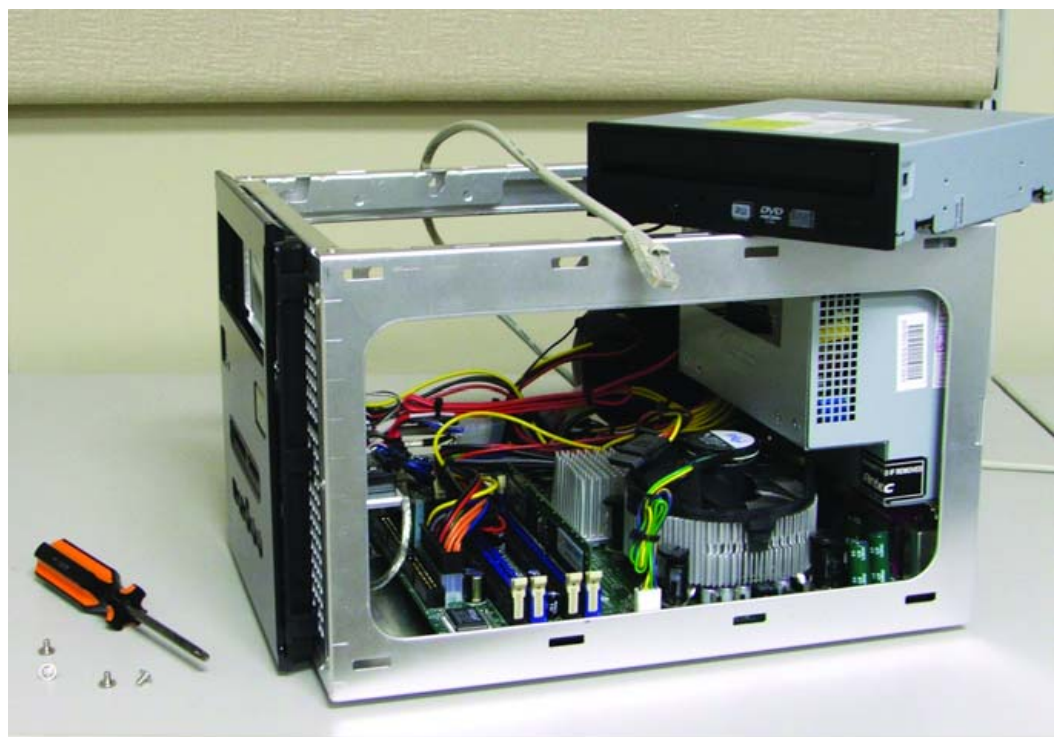


Figure 3. Inside of Case

Several seconds still would pass between the user pressing the power button and the first beep. To make the NetDVD start beeping immediately, I edited the shell script responsible for responding to the power button press, `/etc/acpi/powerbtn.sh`, so it invokes my beep-start init script immediately before running the shutdown command. With this change, the NetDVD starts beeping immediately in response to the power button press.

Handling Network Configuration

Because the NetDVD device must communicate over a TCP/IP network, the user must have some way to tell it what IP address, network mask and default router to use. This is a tricky problem, because you can't easily communicate with a machine that doesn't have its network parameters set properly. Thankfully, all machines on the same subnet can receive UDP broadcast packets even if they aren't configured properly for that subnet. So, I designed a simple protocol allowing a client machine to locate and configure NetDVD devices on its subnet using UDP broadcast.

To locate NetDVD devices on its subnet, the client program broadcasts a packet asking all NetDVD devices to respond. When a NetDVD device sees this packet, it responds by broadcasting its Ethernet MAC address and other network parameters to the UDP port specified in the request. The client program receives this information and displays it to the user. Users will know which NetDVD device they want to configure, because every NetDVD device has a label displaying its Ethernet MAC address.

To reconfigure a NetDVD device on its subnet, the client program broadcasts a packet containing the target device's Ethernet MAC address and the network parameters it should use. The target NetDVD will reconfigure its network parameters and broadcast a response back to the client's UDP port. All other NetDVD devices ignore the request.

In order to make this scheme work, I had to disable the `spoofprotect` Linux kernel feature by changing `spoofprotect=yes` to `spoofprotect=no` in `/etc/network/options` on the NetDVD device. The `spoofprotect` feature causes the kernel to ignore packets that come from the local subnet but appear to come from an invalid IP address for that subnet. If we left this feature enabled, a NetDVD with incorrect network parameters would ignore the UDP packets intended to correct them.

Hardware and OS Problems

Once we got things working and started really exercising our prototype, we began having problems with burn failures. After discussing the issue with Ed Jamison at MBX, we decided the problem was the laptop-size DVD burner. Due to their small size, these burners have more reliability problems than the full-size drives. He recommended switching to a Plextor PX-716A 16x Double Layer DVD+RW/-RW drive. Plextor has a reputation for making extremely reliable DVD burners, and this

drive is also capable of faster burn speeds than the laptop drive we were using, which our customers will appreciate.

Sadly, this meant we couldn't use the little Casetronic C134 case we loved so much. But, moving to a larger case meant we could move to hardware that was less expensive and more stable overall. As a result, we got a faster processor, a faster and larger hard drive and a Gigabit Ethernet interface. Just as important, we reduced the problems we'll have in the future due to obsoleted hardware, because desktop hardware generally stays on the market much longer than laptop hardware. Because we still were trying to minimize the size of the device, Ed recommended the Aria case from Antec shown in Figure 2.

By this time, we were using Ubuntu 5.04 Hoary Hedgehog, but when I tried to install it on the new machine, it hung while detecting network devices. After a little research, we discovered that the SysKconnect SK-98xx Gigabit Ethernet interface on the Intel D915GUXLK motherboard we were using wasn't supported properly by the Linux 2.6.10 kernel provided with Ubuntu 5.04. Luckily, a kernel patch was available from the manufacturer, so I downloaded the kernel source code, applied the patch and rebuilt the kernel.

That fixed the problem with the Ethernet controller, but the kernel also had trouble with the motherboard's ACPI. This caused a lot of boot error messages and prevented the machine from handling a power button press correctly. To fix this problem, I had to upgrade to Linux 2.6.12.2 and apply the Gigabit Ethernet driver

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patch to that. This was difficult to get right, because Ubuntu didn't have a package for that version of the kernel. I had to do a lot of experimentation with kernel parameters before I was sure I had all of the kernel features that Ubuntu relied upon.

Once the kernel problems were settled and we had the machine functioning as a NetDVD, we discovered another problem. The DVD burns actually were taking longer than they had with the original hardware, and the DVD activity light showed that the drive was frequently idle during the burn. The Ubuntu installation had not enabled Direct Memory Access (DMA) for the drive, so the drive wasn't getting data fast enough. Once we corrected this, the burns came up to the speed we had expected. It's really a tribute to the quality of the Plextor DVD drive that it successfully burned several DVDs even when it was starved for data.

When Ubuntu 5.10 Breezy Badger came out, I was pleased to find it corrected all of the problems that required a custom kernel build, but it introduced another problem I had no idea how to correct. In Ubuntu 5.10, exportfs fails sporadically, though it always exits with a 0 status. This isn't much of a problem for static exports, but as all of our exports are dynamic, it's a serious problem for us. So, we had to go back to Ubuntu 5.04.

Conclusion

In our testing, we've seen only one failure in hundreds of burns since moving to the new hardware, so we're confident that the NetDVD will be the stable archiving solution we need. As I write this, we are on the brink of installing NetDVD devices at two very enthusiastic beta sites. They've seen how it works already, and based on their reactions, I think we'll have a lot of NetDVD orders once it's officially released.

It has taken us about 15 months to reach this point, but most of that time was spent working on software that goes on our Solaris workstations and other things not related to the NetDVD. I'm extremely grateful to Ariel King and Dan Duckworth for their excellent work developing the new DVD archiving software for our workstations. That software was actually much harder to get right. I don't think we spent more than three developer-months working on the NetDVD device itself. Using Linux and other open-source software made that the easy part. ■

Resources for this article: www.linuxjournal.com/article/9071.

Bradford C. Smith is a software developer in the Molecular Imaging division of Siemens Medical Solutions USA, Inc. He has been working with Linux and loving it since 1996, and he has been known to use the ed editor just for the fun of roughing it. He welcomes your comments at bradford.smith@usermail.com.

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Developing P2P Protocols across NAT

Hole punching is a possible solution to solving the NAT problem for P2P protocols.

GIRISH VENKATACHALAM

Network address translators (NATs) are something every software engineer has heard of, not to mention networking professionals. NAT has become as ubiquitous as the Cisco router in networking terms.

Fundamentally, a NAT device allows multiple machines to communicate with the Internet using a single globally unique IP address, effectively solving the scarce IPv4 address space problem. Though not a long-term solution, as originally envisaged in 1994, for better or worse, NAT technology is here to stay, even when IPv6 addresses become common. This is partly because IPv6 has to coexist with IPv4, and one of the ways to achieve that is by using NAT technology.

This article is not so much a description of how a NAT works. There already is an excellent article on this subject by Geoff Huston (see the on-line Resources). It is quite comprehensive, though plenty of other resources are available on the Internet as well.

This article discusses a possible solution to solving the NAT problem for P2P protocols.

What Is Wrong with NAT?

NAT breaks the Internet more than it makes it. I may sound harsh here, but ask any peer-to-peer application developer, especially the VoIP folks, and they will tell you why.

For instance, you never can do Web hosting behind a NAT device. At least, not without sufficient tweaking. Not only that, you cannot run any service such as FTP or rsync or any public service through a NAT device. This can be solved by obtaining a globally unique IP address and configuring the NAT device to bypass traffic originating from that particular IP.

But, the particularly hairy issue with NATed IP addresses is that you can't access machines behind a NAT, simply because you won't even know that a NAT exists in between. By and large, NAT is designed to be transparent, and it remains so. Even if you know there is a NAT device, NAT will let traffic reach the appropriate private IP only if there is mapping between the private IP/TCP or UDP port number with the NAT's public IP/TCP or UDP port number. And, this mapping is created only when traffic originates from the private IP to the Internet—not vice versa.

To make things more complicated, NAT simply drops all unsolicited traffic coming from the Internet to the private hosts. Though this feature arguably adds a certain degree of security through obscurity, it creates more problems than it solves, at least from the perspective of the future of the Internet.

At least 50% of the most commonly used networking applications use peer-to-peer technology. Common examples include instant messaging protocols, VoIP applications, such as Skype, and the BitTorrent download accelerator. In fact, peer-to-peer traffic is only going to increase as time progresses, because the Internet has a lot more to offer beyond the traditional client/server paradigm.

Peer-to-peer technology, by definition, is a mesh network as opposed to a star network in a client/server model. In a peer-to-peer

network, all nodes act simultaneously as client and server. This already leads to programming complexity, and peer-to-peer nodes also have to deal somehow with the problematic NAT devices in between.

To make things even more difficult for P2P application developers, there is no standardized NAT behavior. Different NAT devices behave differently. But, the silver lining is that a large portion of the NAT devices in existence today still behave sensibly enough at least to let peer-to-peer UDP traffic pass through.

Sending TCP traffic across a NAT device also has met with success, though you may not be as lucky as with UDP. In this article, we focus purely on UDP, because TCP NAT traversal still remains rather tricky. UDP NAT traversal also is not completely reliable across all NAT devices, but things are very encouraging now and will continue to get better as NAT vendors wake up to the need for supporting P2P protocols.

Incidentally, voice traffic is better handled by UDP, so that suits us fine. Now that we have a fairly good idea of the problem we are trying to solve, let's get down to the solution.

Anatomy of the Solution

The key to the NAT puzzle lies in the fact that in order for machines behind a NAT gateway to interact with the public Internet, NAT devices necessarily have to allow inbound traffic—that is, replies to requests originating from behind the NAT device. In other words, NAT devices let traffic through to a particular host behind a NAT device, provided the traffic is indeed a reply to a request sent by the NAT device. Now, as mentioned above, NAT devices vary widely in operation, and they let through replies coming from other hosts and port numbers, depending on their own notion of what a reply means.

Our job is simple if we understand this much—that instead of connecting directly to the host behind NAT, we somehow need to mimic a scenario in which the target host originates a connection to us and then we connect to it as though we are responding to the request. In other words, our connection request to the target host should seem like a reply to the NAT device.

It turns out that this technique is easy to achieve using a method now widely known as UDP hole punching. Contrary to what the name suggests, this does not leave a gaping security hole or anything of the sort; it is simply a perfectly sensible and effective way to solve the NAT problem for peer-to-peer protocols.

In a nutshell, what UDP hole punching does already has been explained. Now if it were only that, life would be too simple, and you would not be reading this article. As it turns out, there are plenty of obstacles on the way, but none of them are too complicated.

First is the issue of how to get the private host to originate traffic so we can send our connection request to it masquerading as a reply. To make things worse, NAT devices also have an idle timer, typically of around 60 seconds, such that they stop waiting for replies once a request originates and no reply comes within 60

seconds. So, it is not enough that the private host originate traffic, but also we have to act fast—we have to send the “reply” before the NAT device removes the “association” with the private host, which will frustrate our connection attempt.

Now, a reply obviously has to come from the original machine to which the request was sent. This suits us fine if we are not behind another NAT device. So, if we want to talk to a private IP, we make the private IP send a packet to us, and we send our connection request as a reply to it. But, how do we inform the private IP to send a packet to us when we want to talk to it?

If both the peer-to-peer hosts are behind different NAT devices, is it possible at all to communicate with each other? Fortunately, it is possible.

It turns out that NAT devices are somewhat forgiving, and they differ in their levels of leniency when it comes to interpreting what they consider as reply to a request. There are different varieties of NAT behavior:

1. Full cone NAT
2. Restricted cone NAT
3. Restricted port NAT
4. Symmetric NAT

I won't go into the details and definitions of these here, as there are numerous resources explaining them elsewhere. Symmetric NATs are the most formidable enemy for P2P applications. However, with a degree of cleverness, we can reasonably “guess” the symmetric NAT behavior and deal with it—well, not all symmetric NATs, but many of them can be tamed to allow P2P protocols.

First, how do we tell the private IP that we are interested in connecting to it at a particular instance?

Implementation Details of the UDP Hole Punching Technique

This problem can be solved by joining the problem, rather than fighting it head on. In order to achieve peer-to-peer traffic across NATs, we have to modify our P2P mesh model slightly to make it a hybrid of a traditional star model and modern mesh model.

So, we introduce the concept of a rendezvous server, or mediator server, which listens on a globally routable IP address. Almost all peer-to-peer protocols have traditionally relied on certain supernodes, or in other words, in P2P, all nodes are equal but some are more equal. Some nodes always have acted as key players in any P2P protocol. If you have heard of a BitTorrent tracker, you know what I mean.

A rendezvous concept is nothing new in the P2P world, nor is the star model totally done away with in P2P.

Coming back to our original NAT problem, private IPs obviously can browse the Internet through NAT devices, and thus they can talk HTTP through port 80 or through a proxy HTTP port over TCP. So private IPs can almost always open TCP connections to global IP addresses. We use this fact to make the private IP connect to a mediator or rendezvous server through TCP.

Our solution relies on the fact that all the P2P nodes are constantly in touch with a rendezvous server, listening on a global IP address through a persistent TCP connection. Remember that P2P nodes are both client and server at the same time, so they can originate connections as well as serve connection requests simultaneously.

It is through this TCP connection that we inform a particular P2P node that another node wants to talk to it. Then, the target node

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sends a request following which the peer sends the connection request as a response to the request.

Because the private machines behind a NAT device do not have a routable IP address, the only way for us to access them from outside the NAT device is through the mapping that the NAT device maintains for the machine to talk to the external world. For each connection originated from the private IP, a unique port is assigned at the NAT device. For us to talk to the private IP, we have to send our packets to that particular port assigned for the private IP's connection to the external world. Now, we know that there is no notion of connection in the UDP world, so NAT assumes that if a reply doesn't come for a UDP request in about 60 seconds, the connection is deemed non-existent and closed.

So now we have another problem—that of determining the port assigned at the NAT's public interface for the private IP connection. This can be inferred by inspecting the source address of the UDP datagram that reaches any global IP.

So far so good. If we are not behind NAT, we can use the previously mentioned technique to initiate communication with a private IP using the rendezvous server.

However, reality tells us that P2P peers are more likely to be behind a NAT than otherwise. So, this solution is not enough. We want to initiate a P2P connection from behind a NAT device ourselves. So, now we have two NAT devices in the picture, one behind each P2P node.

Now the real fun begins. First, let's redefine our goal in the light of

this new twist to the problem and attack it step by step. What we want to do now is use the rendezvous server and inform the target P2P node to send us a request, but we are behind a NAT.

So, for any external party to talk to us, we should have a global IP/port combo that exists at the NAT public interface. First we have to create one for ourselves. Only then we can receive communication requests coming from outside the NAT network.

We can create a mapping for us by sending a packet to a global IP. The global IP can then figure out our mapping by inspecting the from address. But how do we inform our P2P node of this address? For that we can use the TCP connection with the rendezvous machine. But, only the global IP to which we send the packet knows our association, so how do we figure that out? It's simple. The global IP can send that information to us as a reply in the packet payload to us.

Assuming that we somehow obtain a public IP, port pair and figure that out, we tell the mediator that we are listening at that public IP/port pair and request the P2P target node to initiate a request to us. Subsequently, we can connect to it as a reply to that message.

But, then we cannot receive packets from the P2P target node, because NAT is not expecting a reply from that global IP. In fact, some NATs that show full cone behavior allow packets to come from any IP, but most NATs do not—back to square one.

Consider this: if both P2P nodes behind the NAT send packets to each other's public IP/port, the first packet from each party is discarded because it was unsolicited. But subsequent packets are let through because NAT thinks the packets are replies to our original request. And voilà, the hole is punched, and UDP traffic can pass through directly between the P2P nodes.

Unfortunately, NATs also differ in their behavior of assigning public ports for different destination IPs. Most NAT devices fortunately do not change public ports between requests to different destination IPs, so we can safely assume that.

So first we send certain probe or discovery packets to two different IPs and figure out the behavior of the NAT. If it is found to be consistent, our approach will work. In the unlikely case that we bump into symmetric NAT behavior that varies the port between requests, we can figure out the delta by which the port number varies. And, using this we can guess the port assigned for a particular request.

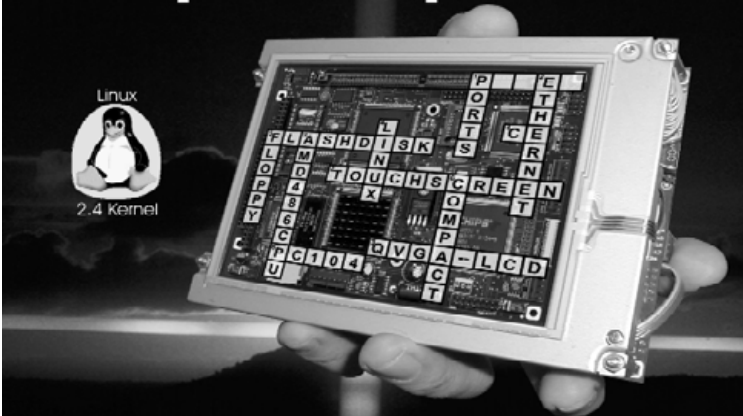
The reason we are so particular about this is because the first packet to our P2P destination behind NAT is dropped by NAT. So, all we can do is guess. In practice, however, it works fairly well. This is why it is important that the P2P nodes keep the source and the destination ports the same for communication.

Once this hole punching procedure is performed, the two P2P nodes can communicate with each other without the help of the rendezvous machine. So the rendezvous machine is useful only for informing a P2P node about an incoming connection and informing each of the communicating peers about each other's public addresses. Subsequently, the communication happens directly without the intervention of the rendezvous server.

Now we have to apply some ingenuity and introduce appropriate headers in the packets to inform the peer whether it is sending a reply meant for the P2P client or whether it is sending a request meant for the P2P server. Once we are able to differentiate between the two, we are set. We also need to differentiate between hole punching traffic and regular traffic, because hole punching traffic needs to be bounced, and regular traffic needs to be processed.

Of course, if we stop sending and receiving, the association at the NAT device at both ends will expire. So we either can send keepalive traffic or rerun the hole punching technique. You can choose whichever technique is suitable depending upon your needs.

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This technique will not work if both the P2P nodes are behind the same NAT device. So, we also have to figure out whether we can communicate directly using the private IP address itself. Thus, our hole punching has to try the private interface along with the peer's public interface. And, it can happen that our private network has the same private IP as the peer's private IP. So we have to guard against getting spurious responses.

It also can happen that another P2P node in the same private network as ours has the same private IP as the P2P node we want to talk to in another private network. Then we have to do additional validation against the peer's identity to make sure we really are talking to the interested node.

In the unlikely case that you run into brain-damaged NAT devices at both ends, this technique obviously will fail, because we should be able to predict the public address assigned to us. In that situation, the only way is to make the rendezvous server act as a relay for the traffic. So peer-to-peer traffic goes through, but it is no longer peer to peer with the rendezvous machine acting as server. If you run into such situations, you need to think of implementing that as well.

Now, for the Real Dope, the C Code for Achieving the above

Due to their long length, the listings for this article are located on the *Linux Journal* FTP site at <ftp.ssc.com/pub/lj/listings/issue148/9004.tgz>. I leave out unnecessary detail and glue code and focus purely on the nontrivial aspects of UDP hole punching.

If you need more information on implementing your own hole punching library, you always can refer to the above design constraints and design a solution appropriately.

Please note that I have consciously left out the rfc and NAT discovery techniques, such as STUN and frameworks like ICE. UDP hole punching is already complicated, and we don't gain anything by making it even more bloated without adding any real value. So, the technique as it stands works as good or even better than other NAT traversal mechanisms.

First, take a look at the rendezvous code (Listing 1). Note that we use `select()` to serve multiple sockets. We could as well use `kqueue()` on *BSD, or better, use the `libevent` abstraction (see Resources). But, I stuck to `select()` because performance doesn't matter so much to us. We talk to the mediator server only for establishing peer-to-peer connections, not otherwise.

The hole punching implementation is given in Listing 2 and the P2P client in Listing 3.

Using this method, you should be able to develop your own peer-to-peer protocol. You easily can develop your own instant messaging protocol along with some GUI code. You can transfer files either using `nc` or using code for that directly. You can develop certain applications, such as transferring voice via a microphone and speaker. In other words, you can develop a hobby VoIP application with this.

Several possibilities exist. You can add some reliability on top of UDP in case you are paranoid about your data reaching you safely.

One very useful tool that helped me immensely in this endeavor is the Network Swiss-Army knife, `netcat`.

You can see hole punching in action by using this simple command. At each end, type:

```
$ nc -u -p 17000 <peer public IP> 17000
```

With only the peer public IP different, you can start communicating if you are lucky, because most NAT devices try to assign the same

private port as the public port.

If you want to test TCP hole punching, try this:

```
$nc -l -p 17000
```

at one end and this:

```
$nc -p 17000 <peer public IP> 17000
```

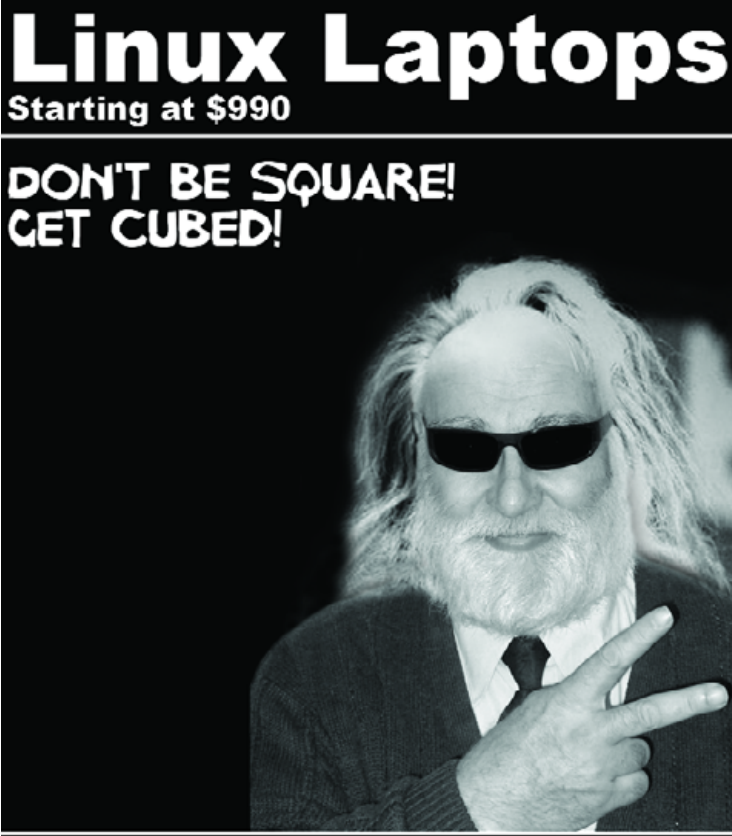
at the other end.

Future Work

Rather than having one rendezvous server, you can have a few of them for failover and geographical distribution. However, if you are behind two levels of NAT, sometimes this may not work. You also could listen on multiple virtual and real interfaces and attempt hole punching on all of them. You can add TCP hole punching on similar lines and try that first, and then attempt UDP hole punching. ■

Resources for this article: www.linuxjournal.com/article/9072.

Girish Venkatachalam loves to play with open-source operating systems, such as OpenBSD, FreeBSD and Debian GNU/Linux. He also likes to go cycling when not hacking. He can be contacted at girish1729@gmail.com.



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Mobile Phones: the Embedded Linux Challenge

An overview of the suitability, viability and liability of Linux on mobile phones. BILL WEINBERG

Although mobile handset manufacturers are embracing Linux as an emerging platform for next-generation smart phones, development and deployment of those devices still face key technical challenges. In particular, mobile phone OEMs must deliver devices with power management, fast boot up, integrated radio (GPRS) interfaces, advanced multimedia capabilities, attractive small form-factor GUIs and differentiated PIM application sets (browser, phone book and so forth)—all integrated and running in a modest memory footprint. This is a particular challenge for embedded Linux developers because, unlike PCs, phones aren't built to a standard architecture.

This article examines various technical challenges that face developers of Linux-based mobile phones. It addresses availability and maturity of key enabling Linux capabilities and also of open-source projects that support phone application development. In addition, it discusses technical and economic challenges presented by the stringent and numerous requirements of mobile network operators.

Linux and the Mobile Phone Marketplace

The global mobile phone market is growing at an explosive pace. Industry analysts at IDC report that in Q2/2005, the handset market grew 34%, as almost 700 million handsets made their way from device OEMs into people's hands and onto the global voice and data networks. Analysts at Gartner predict that by 2009, the global installed base will number more than 2.6 billion mobile phones.

For the Linux-centric segment of the IT industry, these numbers are tantalizing—orders of magnitude greater than total Linux shipments and installed base for servers, and far greater in volume than the worldwide desktop market. As such, the mobile phone market represents both an opportunity to "break out", reaching significant market

share in client devices and to complement the already significant presence of Linux in the communications infrastructure (based on carrier grade and other versions of enterprise and embedded Linux).

Why and Whither Linux?

In the past few years, Linux has made significant gains as a mobile phone platform OS. Device manufacturers LG, Motorola, NEC, Panasonic and Samsung today ship two-dozen smart phone models based on Linux, complemented by Chinese brands like Datang, e28, Haier, Huawei and ZTE. Nokia and others also are beginning to ship Linux-based wireless VoIP clients.

Device OEMs, large and small, are choosing Linux as the strategic platform for their smart phones for a mix of technical and economic reasons. On the technical side, OEMs look to Linux for performance, robustness, "gold standard" TCP/IP networking (especially routing) and flexibility. On the economic front, Linux offers OEMs lower development and deployment costs, more choice of vendors (including "roll your own"), a larger open and commercial technology ecosystem, and an opportunity to unify the divergent and costly product lines and engineering efforts needed to support multiple product tiers (smart phones, feature phones and entry-level devices), network types (GSM, CDMA, analog and Wi-Fi) and carrier requirements.

For all of these strong technical and economic benefits, Linux phones account today for between 1–2% of the total market. On smart phones, the fastest-growing segment, Linux enjoys a stronger position. Smart phone share is growing at 85% per year, and Linux owns 25% of the smart phone segment (Q2/2005 Gartner), far ahead of Windows Mobile and others, but behind SymbianOS by a factor of two or more.

Table 1. Mobile Phone Market Tiers

Tier	Price Point	Capabilities	CPU	OS
Top Tier "Smart Phone"	\$200 US and up	Telephony, often Wi-Fi/VoIP, full e-mail and browsing, multimedia (MP3, video), SMS/MMS, games and voice commands	ARM9, ARM11	SymbianOS, Linux, WindowsMobile, PalmOS, RIM
Mid Tier "Feature/Enhanced" Phone	\$49–\$199 US (usually subsidized by subscription)	Telephony, messaging, limited Internet, color display, games, voice dialing	ARM7, ARM9, some SH, M32/M100	Nucleus, older SymbianOS, Brew/REX
Low Tier "Entry/Basic" Phone	\$0–\$49 US (often free with subscription)	Basic telephony, phone book, text messaging	ARM7, legacy regional CPUs	Legacy RTOS (Nucleus, iTRON, etc.)



Figure 1. Mobile Phone Segment Shares (Gartner Q2/2005)

Pick Your Phone

Categorizing phone types is not an exact science, nor even an exacting marketing exercise. Features that once differentiated phones strongly (like e-mail or imaging) are now commonplace across tiers and price ranges. Moreover, what is smart today may be a common feature in six months. Feature phones for which you pay good money at the holidays can end up as entry-level giveaways toward the end of their market lifetime the following spring and summer.

The Smart Phone Trap

Although delivering Linux-based smart phones is no mean feat, it is still easier and more viable than putting the open-source OS on lower-tier phones. Why? Because smart phones, with higher prices and more ample margins, have more room in the BOM (Bill of Materials)—room for hardware dedicated to key phone functions (multimedia, display control, baseband RF and so on) and for software to enable that hardware. Often the application OS (Linux, Windows Mobile and so on) runs on a dedicated application processor, with additional CPU and DSP cores handling voice, multimedia and RF functions. Smart phone buyers are also typically early adopters, eager for the latest technology and more tolerant of some marginal behaviors, especially of shorter battery life in technology-rich devices.

Smart phones, however, represent only about 6% of the total phone market. If the Linux industry and developer communities want truly ubiquitous phone-based deployment, a Linux phone platform also must be able to support the technical and economic requirements of the broader middle tier or feature phone space. These handsets don't sport all the technical goodies of smart phones, and the underlying hardware doesn't come with all the support hardware either. A cost-down BOM means that Linux on the application CPU is directly exposed to



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the vagaries of software support for voice, data, RF and graphics. Place that burden on a single CPU running between 0–200MHz as needed for energy management, in a much more modest memory footprint, and Linux can't make the middle tier cut.

Social projects aimed at bridging the digital divide also envision open-source phones for low-income populations in developing countries (think tiny Ubuntu). But just as the \$100 desktop is proving elusive, so likely will the free Linux-based cell phone.

Over time, the specs for middle- and even low-tier phones might rise to meet Linux base capabilities, but margins also get much thinner on these same devices. Battery technology is not improving at an appreciable rate, meaning that applications can't make up the difference with faster clocks either. So, if Linux is going to break out of the smart phone trap, it must acquire a series of new capabilities and enhance and unify many existing ones to meet the challenge.

Technical Challenges

OSDL kicked off a new initiative (see the OSDL MLI sidebar) to foster Linux adoption on mobile telephony handsets. As its first order of business, MLI is cataloging gaps and requirements to make Linux a more apt phone platform OS. The following list and discussion is representative of input from MLI participants and other interested parties, especially handset manufacturers and phone silicon suppliers.

Power Management

Today, if a portable device manufacturer wants to offer a Linux-based and power-managed device, he or she faces a boggling choice among variously divergent paradigms (Table 2).

OEMs can look to the desktop where notebook-centric schemes like ACPI and APM dominate, and indeed occupy most discussions of Linux power management on the kernel mailing list. For non-x86/IA-32 notebook hardware, OEMs can turn to PMU for Apple PowerPC hardware. Embedded OEMs deploying ARM-licensed silicon can leverage the ARM Ltd. IEM framework, or work with the various power

management schemes present on silicon from dozens of ARM licensees (FreeScale, Intel, NEC, Samsung, TI and others). There also exist unique and further divergent energy conservation protocols from MIPS and MIPS licensees, from FreeScale for its CPU lines, from IBM for Power Architecture, from Renesas and Hitachi, and so on across the silicon supplier universe. OEMs also can choose schemes like MontaVista's DPM and other embedded Linux supplier solutions.

Although choice is a good thing, too much choice can lead to fragmentation. In response to this power management smorgasbord, members of OSDL MLI and other embedded industry consortia have expressed a desire to see either a unified cross-processor power and energy management scheme, or a mainstream high-level "umbrella" that covers embedded, desktop and even blade-based thermal management.

Radio Interface

Motorola has been building radio sets for nearly a century. They and other handset manufacturers like NEC, Nokia and Panasonic leverage their hard-won RF know-how to build their popular phone product lines. New entrants and also new designs from existing suppliers, however, must overcome a range of designs challenges before they can build handsets that meet the requirements of carriers, operators and regulators, and do so cost effectively.

In today's crop of Linux-based smart phones, the GPRS interface resides in an encapsulated "modem" device that can contain an additional CPU core, a DSP and RF hardware to support wireless communications. It really behaves like a modem—many smart phones communicate with these embedded processors via AT modem commands over a dedicated serial port. Offloading the radio function makes it easier to build a smart phone, but it impacts costs by adding components to an already heavy BOM.

Some experimental designs today remove the modem and expose the baseband interface to the application OS (as with Nucleus in mid- and low-tier phones), but doing so exposes Linux to hard real-time requirements that stretch beyond the limits of recent advances in Linux

Table 2. Available Power Management Schemes

APM—Advanced Power Management	The most widespread technology for Linux, but not 100% compatible with more ubiquitous ACPI.
ACPI—Advanced Configuration and Power Interface	The most ubiquitous x86/IA-32 notebook power management scheme (backed by Intel, Toshiba and Microsoft). Very BIOS-dependent.
PMU—Macintosh PowerBook Power Management Unit	Power management scheme very specific to G3/G4 PowerPC systems from Apple.
Longrun	Mostly transparent hardware-based power management specific to Transmeta Crusoe.
DPM—Dynamic Power Management	MontaVista Software framework for driving ARM (especially TI OMAP and Intel XScale) CPU clocks and operating voltages among "operating points" in response to policy and system events.
IEM—ARM Intelligent Energy Management	ARM Ltd. Power management scheme for ARM core licensees with dynamic voltage and frequency scaling (compatible with but different from DPM).

real-time (preemption and open-source real time—see below). GSM and also CDMA wireless protocols predicate signal frame times in the 800–900 microsecond range. For x86/IA-32 and PowerPC processors with 500MHz–1.5GHz CPU clocks, submillisecond worst-case response is now commonplace, but with clock-scaled ARM processors running at 0–200MHz, hard real-time interrupt response and preemption are still marginal.

A separate challenge arises from the use of legacy telephony stacks ported “as is” to Linux. This software was written and optimized for legacy phone OSes like Nucleus and REX. These proprietary multilayer stacks were implemented with unique thread contexts for each layer, and when ported to Linux can exhibit 20–30 microsecond context switch latencies layer to layer. As such, just traversing the stack with a single packet can consume a large portion of available compute time, leaving few CPU cycles for other tasks.

If Linux is going to participate in cost-down mid- and low-tier phone designs, it will need both more spritely context switching and/or optimized and open native ports of key GPRS and CDMA protocol implementations.

Real Time

During the past five years, Linux has progressed toward offering significant native real-time responsiveness. Today, Linux is replete with native real-time options, including capabilities like the preemptible kernel, O(1) scheduler, FUTEXes and the recent Open Source Real-Time Linux

Project (now merged into preemption patches maintained by Ingo Molnar—see the on-line Resources). There also exist dual kernel and virtualization technologies like RTLinux, RTAI, Adeos and proprietary Jaluna OSware that offer RTOS-like responsiveness by virtue of embedding an actual RTOS into the Linux stack.

OSDL MLI members and others in the community would prefer to see native Linux solutions do real-time response. For exposed RF interfaces, and time-sensitive and QoS capabilities like multimedia and voice processing, the consensus is that Linux needs continual nudging in the direction of native RTOS-like responsiveness. In mobile designs, Linux must meet deadlines and switch context with agility in systems whose clocks can scale erratically to conserve battery power, jumping from 200MHz peak performance down to 40MHz (or even 0MHz) and back in response to system policies and peripheral inputs.

Small Footprint

Today’s smart phones can ship with 128MB of Flash and 64MB of RAM. However, a phone OS need not seek to occupy every last byte of available storage. Every byte used by the OS and middleware is a byte not available to OEMs for value-added content. On the plus side, embedded Linux can theoretically deploy in a footprint of 1MB or less; real phone configurations are much larger.

Embedded developers, platform providers and maintainers of the Linux kernel itself provide a range of configurations and tools to shrink the platform footprint:

Expert Included.



Kui-Ho is passionate about quality and continuing improvement in the servers he produces. Making sure the right parts are included and the wires are connected is just the beginning: there are hundreds of small details to understand, document, check, and double-check so that no server leaves until it is ready for its intended purpose. Kui-Ho likes the Rackform iServ R240 with two Dual-core Intel® Xeon® 5100 series processors because he knows that it takes advantage of Intel’s proven reliability, while providing more performance in less space than previous Intel generations. Add improved memory performance, increased I/O, and reduced power consumption, and even Kui-Ho is impressed.



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- **Linux Tiny:** this build option/patch set was introduced during 2.6 and results in otherwise mainstream kernels with footprints well under 2MB. Linux Tiny also features other space-saving patches, like SLOB, a space-efficient replacement for the SLAB allocator; tools for tracking memory allocation, counting in-line function use and for comparing function sizes across builds; and kgdb configurations for systems without serial ports (see Resources).
- **ARM Thumb and MIPS16:** embedded CPU architectures like ARM and MIPS offer special execution modes and small word instruction sets that shrink application size by generating and executing smaller code and data. These methods and modes are best employed to shrink user-space code, but in doing so require special mode/size-specific library and system call versions to accommodate 8/16-bit instructions and operands where standard implementations expect a full 32 bits. More recently, silicon suppliers and maintainers of appropriate architecture trees of the Linux kernel have begun building and maintaining special versions of their trees to accommodate these hyper-efficient execution modes. Even if mainstream kernel builds do support such execution modes, such support will likely be all or nothing, making it difficult or impossible to support mixed mode systems and integration of prebuilt (binary) third-party code. To learn more about ARM Thumb or MIPS16, see Resources.
- **XIP—Execute in Place:** if you have truly parsimonious RAM requirements and can spare a little Flash (and perhaps more performance), you can configure the Linux kernel and/or individual applications to run directly out of Flash. Instead of copying compressed images from NOR Flash (or other types of ROM), there exist several schemes to support execution of uncompressed program images directly in place (XIP). Note that because Flash access cycles are usually slower than those for DRAM, XIP programs can run much more slowly than with RAM-based execution; although, kernel XIP can be used to speed up boot time by removing the need to copy and decompress the kernel image to RAM. To learn more about about User Space XIP with CramFS and on raw NOR Flash kernel XIP, see Resources.

Other Ways to Shrink the Kit

There are myriad methods, tips and tricks for reducing the user-space memory burden. These include using uClibc instead of glibc as a standard library, deploying BusyBox and TinyLogin instead of standard shells and multiple utilities, and using compressed filesystems like CramFS and YAFFS.

Carrier and Operator Requirements

Phone manufacturers, however innovative they wish to be, cannot simply build the phone of your dreams—or of theirs. Rather, they must respond to the expansive and exacting requirements presented to them by their customers, the mobile carriers and operators (think Cingular, Vodaphone and others), predicated by the networks those companies build and maintain, which are highly regulated by national governments and even some international bodies. These requirements come in the form of phonebook-sized tomes, comprising 5,000 or more distinct specifications, and many of these specs are themselves highly complex and multifaceted.

The Once and Future Open Phone

Governments, especially the US Government, jealously guard their control of the electromagnetic spectrum. The US Federal Communications Commission (FCC) auctions and doles out grants of radio spectrum use and has very particular ideas about bandwidth, signal strength, security and as we've (re)learned in the last six years, about content on the "public" airways. Other governments and regulatory bodies around the world are similarly disposed toward open and free uses of radio frequencies. Devices that do not conform to these (overlapping) regulations and do not pass regulatory muster (homologation) do not earn approval and are not licensed for sale. Violations carry nasty fines and even criminal penalties.

Mobile carriers and operators, in response to these regulatory regimens, are understandably reluctant to experiment with open device architectures. Ditto for their suppliers, at least on the "thin" end of the wire (carrier-grade Linux and other implementations are today powering a growing share of wireless infrastructure). Carriers and operators are not completely averse to openness, but tend to think only in terms of secure delivery of value-added services. By establishing careful sandbox environments and limiting API sets on the technical end, and by even more careful political negotiations, the chain of manufacturing, deployment and regulation have begun to crack the lid on otherwise closed handsets. As such, mobile phone users and market watchers have seen a handful of "can openers" emerge during the last five years, principally Mid-P Java and BREW, with mixed results, especially in performance. More recently, a slew of native applications has emerged for



phones based on SymbianOS and on Windows Mobile 5.0.

Linux-based phones offer up the promise of further prying open the clamshell by leveraging the OS to provide a secure application programming environment (in user space); it also comes with a well-established community of skilled developers. Whether Linux-based handsets will be truly open platforms, remains an open question. Phone deployed so far, although based on a Linux kernel and many familiar OSS components (like versions of Qt), are by no means open devices. Hackers cannot (easily or at all) rebuild the kernel, OS and application components, or even add functionality to the stack. These devices are not designed to accept logins, let alone reflashing. The "can opener" for these Linux-based mobile devices, like those based on proprietary OSes, is Java, even if you can download source code for the OS and portions of the application stack.

There do exist after-market resources to support hacking Linux-based phones. One such project is Harald Welte's Open-EZX (see Resources). This project, still in its early stages, strives to build a 100% open phone stack for Motorola mobile phones like the A780 and e680. The project's wiki is replete with warnings about rendering your phone unbootable and losing regulatory approval,

but also with useful information on how to get a shell and how to cross compile for these devices (they're based on Intel XScale Architecture PXA processors).

Motorola's chief phone architect definitively disavowed support for such efforts. Why? Principally, liability issues stemming from its customers' concerns for the integrity and security of their mobile networks and the complex burden of supporting millions of devices with potentially divergent versions of the Open-EZX software stack. Then why call it Open-EZX? Because device OEMs like Motorola do want to encourage the evolution of developer communities around their devices and platforms. They just need to foster that evolution in a way that is amenable to carrier, operator and regulatory sensibilities. Today, that means offering SDKs to hand-picked ISVs.

Hopefully soon, through educational efforts and persistence, this very conservative and careful audience of network operators and government regulators will be more comfortable with mobile phones as computing platforms, not mere mono-function radio devices. ■

Resources for this article: www.linuxjournal.com/article/9073.

Bill Weinberg brings more than 18 years of open systems, embedded and other IT experience to his role as Open Source Architecture Specialist and Linux Evangelist at the Open Source Development Labs, where he participates in OSDL initiatives for carrier-grade, data center and desktop Linux.

OSDL MLI

To bolster the nascent adoption of Linux by mobile phone manufacturers, OSDL is creating an initiative called MLI (Mobile Linux Initiative) to bring together mobile chipset manufacturers, Linux-based platform suppliers, ISVs, handset manufacturers, integrators, carriers and operators, and open-source developers. In Beijing during October 2005, OSDL hosted the first meeting for this new initiative. Although the ultimate requirements and development efforts will be driven by the members of this new initiative, MLI has the general goal of addressing a mix of technical and economic challenges, from the kernel up, to accelerate Linux adoption on mobile phones and other converged voice and data devices. When MLI met for the first time in October 2005, the new body appointed interim governance and immediately got down to the job of requirements gathering and gap analysis. The first likely deliverables are use cases and marketing output. The most important deliverable, as with Carrier Grade Linux, will be the instigation of the new open-source project work to fill the gaps it identifies and to bring currently divergent technologies (like those in this article) into the Linux mainstream. To learn more about MLI, see Resources.

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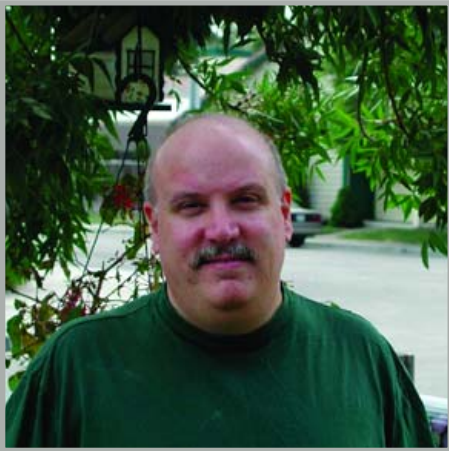


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Postscripts on the Ultimate Linux Boxes

Some final words on the Ultimate Linux Boxes, including a contender for the Ultimate Notebook.



Nick Petreley, Editor in Chief

It's too bad we didn't get enough notebook computers to choose an Ultimate Notebook this year, particularly because so many people have problems installing and using Linux on many notebook computers. If it is any consolation to you, I've had great success with my ABS Mayhem G4 A78 notebook (www.abs.com). It has been replaced by the G4 Revolution since I bought it (and the price has dropped significantly, naturally). The key to the G4, or any other notebook you consider, is to pick one with Linux-supported hardware. Most notebooks come with either an NVIDIA display or ATI. The G4 A78 has an NVIDIA display driver, and I've always had good luck with NVIDIA, so that was a driving factor in choosing this notebook. It also has an Intel M-PCI PRO Wireless Chip, which works out of the box even with distributions like Kubuntu. The only manual work I had to do to make it work was add a line to my configuration file to specify my WEP security code. All in all, I installed and configured Kubuntu on this notebook faster than I was able to get the pre-installed Windows

XP to work properly. The Windows wireless driver couldn't connect to my network unless I advertised the network name (SSID). It didn't matter that I typed in the SSID manually. Linux had no such trouble.

The bottom line is that the Mayhem G4 A78 is a great performer and very Linux-friendly. The problem is that the latest Mayhem notebooks have slightly different hardware. ABS is going with the Intel WM3B2915ABGNAX Mini PCI Wireless Adapter now (can they add any more letters to that item number?). I'm not at all confident that most Linux distributions will work with this chip out of the box, but then I haven't tried it.

Here are some postscripts about the Do-It-Yourself Ultimate Linux Box. We offered some advice on how you can get a little wiggle room on price, but you might benefit from some common-sense tips on what not to do. One of the biggest mistakes you can make is to opt to go with a dual-card NVIDIA SLI configuration without getting any real benefit for the price. For example, don't compromise big on the price of your processor in order to invest in a dual-card NVIDIA SLI configuration. If you don't have enough CPU power, you won't get what you want from the display cards. Likewise, there's no point in doing SLI if you're going to connect it to a monitor that can do only a 1024x768 resolution. With a monitor like that, you probably won't see any improvement in performance or quality compared to a single card.

Oh, and here's something you need to know. You can't use dual monitors and SLI mode at the same time. You can switch between dual monitors and SLI mode without making any hardware configuration changes, but you can't have your SLI cake and eat your dual monitors too (whatever that means).

Here's a do-as-we-say-not-as-we-did tip. If you are a do-it-yourself type, you probably

have several computers and play the hand-me-down game. When you upgrade your own video card, you hand down your existing card to the computer your kids use (or vice versa, if they get the premium stuff, first).

If you are going to hand down your CPU, be very careful when removing the CPU from one motherboard to transfer it to another. We transferred a CPU several times in order to test the various motherboards, and there was one time when it stuck to and popped out while removing the heat sink.

Here is where I'll personally take the blame and switch from the editorial we to I. I bent a few pins while prying the CPU loose from the heat sink. Try as I may, all my efforts to get the pins back into position just made things worse. I was never able to re-insert that CPU into a socket. Dual-core AMD64 CPUs don't come cheap, so that was a painful lesson to learn, more painful than leaving a piece of my thumb in the CPU fan on the Aberdeen server.

I guess the lesson here is that if you are as clumsy as I am, get someone else to do the tricky work for you.

Finally, we made mention of a number of benchmarks that weren't fit for publishing because they didn't provide useful information. In one case, we're referring to a benchmark called 3DMark 06. The numbers didn't add anything to what we'd already found, and we couldn't publish the results anyway, because our copy of the benchmark is not for commercial use. But if you dual-boot Windows, I recommend you have a look at this benchmark for yourself. You can download a copy from www.guru3d.com. If your hardware is good enough to render the tests well, you'll be blown away by the test scenes. ■

Nicholas Petreley is Editor in Chief of *Linux Journal* and a former programmer, teacher, analyst and consultant who has been working with and writing about Linux for more than ten years.



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