

# Green computing

Want to save cash while doing your bit for the world? Going green does all that and more – **Paul Hudson** shows you what Linux can do to make a difference...

**U**ntil recently, computing has been split firmly into two camps. On one side are people who care about maximum performance, where programmers produce software that demands high-end machines confident in the knowledge that Moore's law will lead to machines powerful enough to run it all easily. On the other side are people who care about size and battery life, where advances rarely produce more speed, but more commonly result in smaller, less battery-intensive hardware.

A few years ago, when 3.8GHz Pentium 4 chips were nestled under 8-inch heatsinks and monster fans abounded, these two computing worlds couldn't have looked much further apart, but

**“Most computer desktops spend their lives sitting virtually idle.”**

with the environmental message of doomsday climate change finally being accepted by even the most stubborn, "green computing" is the buzzword on every sysadmin's lips. But don't think that going green is something you can ignore if you're a home user. In fact, home users stand to save just as much money as sysadmins as a percentage of their costs, because most computer desktops spend their lives sitting virtually idle. If you're using even a low-end desktop computer you're likely to have a 300W power supply, but if you're running multiple graphics cards

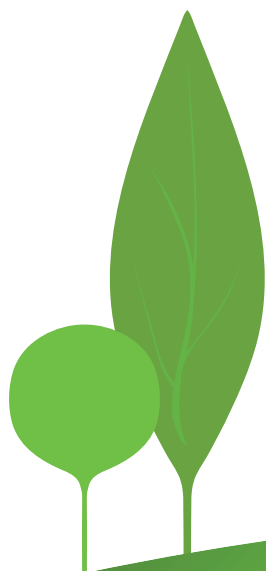
and multiple hard disks along with a multi-core CPU you may well have something over 1,000W – the top-end PSUs of today even reach 1,500W, which is a mind-boggling amount of power.

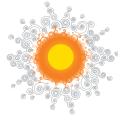
## The cost of cooling

All this power adds up to a lot of expense beyond just buying the hardware – in the US alone, the cost of powering and cooling data centres is the equivalent of the electricity bill for six million US households. According to the US Environmental Protection Agency, that adds up to \$4.5 billion dollars – and is set to grow to over \$8 billion in the next five years.



› The Ultimate Linux Box from LXF92 had a 1kW power supply, but that's a maximum – once the power saving was set up correctly, the machine draws only about a tenth of that.





Let's break down the cost of computing in average company. Computers add up to about half of all electricity costs, but that cost isn't evenly weighted – servers account for two-thirds of that, with desktops and other user hardware accounting for the remainder. Of course, that doesn't include mobile devices such as BlackBerrys or other phones, but they aren't easy to measure.

In the server room, part of the problem is that components are easy to price up, whereas cooling – if it is to be efficient – needs to adjust dynamically to load, and so is rather hard to price in advance. That said, a good rule of thumb is that you should add 50% to your hardware costs to estimate the cost of powering it all, of which half is for cooling alone.

There are several basic ways you can cut this cost:

- 1 Use less cooling
- 2 Power down unused computers
- 3 Use fewer computers

They sound obvious, but only the first one is easy enough to do – whereas most data centres run at a chilly 15 degrees Celsius, you can save money by cutting the cooling to raise the ambient temperature to somewhere between 22 and 24 degrees. In an ideal world you'd be able to pipe the excess heat somewhere useful rather than trying to cool it, but we're a few years away from there just yet.

The other two solutions take an increasing amount of effort, but are where the real cost savings lie. Let's take a look at how you can start saving money today...

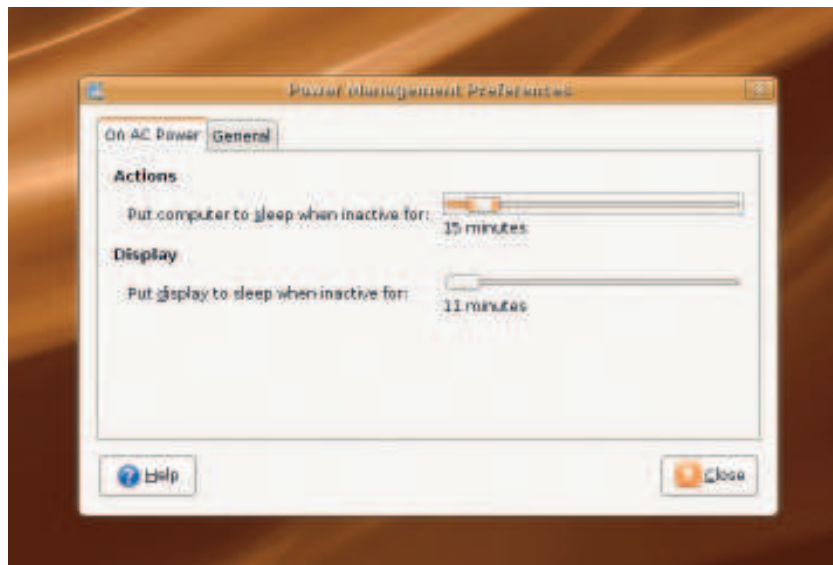
## Fully automatic

Forcing machines to power down when they are unused might sound wasteful, but you don't have to go all the way to off if you don't want to. After extensive testing, Google found that you can measure approximate power usage entirely from CPU usage. That's not to say the other parts of the computer don't chew through their own power – of course they do – but when the CPU is idle, the other components usually are too. So, if you want to power down the machine without actually turning it off, you need to make these components sleep.

Thanks to the technologies such as ACPI and SpeedStep/PowerNow, your computer may well do a fairly good job of scaling back its power when system resources are unused. This is especially true if you have a laptop, where aggressive power saving settings are the norm. But if you fire up your desktops power management tools (look for System > Preferences > Power Management under Gnome, and *KPowerSave* on KDE) you'll find it's very easy to have your computer automatically shut off essential services when it's idle. *KPowerSave* even comes with an easy-to-use set of power schemes that you can switch to straight from your panel – the easiest way to get in shape is to enable power saving mode like this.

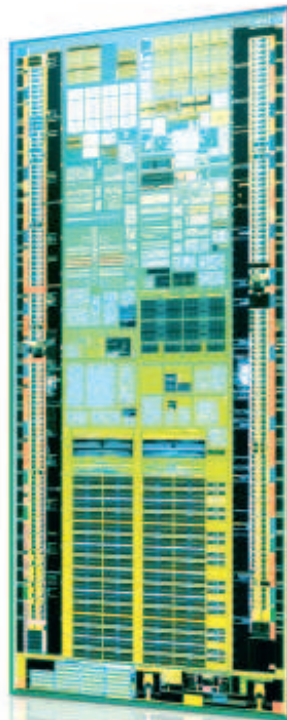
If you don't find the standard Linux power management tools make any difference, it's possible your BIOS isn't configured to allow power-saving settings – that wouldn't be a huge shock, to be honest, because many motherboards simply come pre-configured for maximum performance regardless of power usage. The easy way to tell whether this is the case is just to listen to the fan on the PSU: if it blasts out the same amount of air whether you're playing *Unreal Tournament* or typing into the command line, chances are you have no power saving enabled. The Ultimate Linux Box we built for **LXF92** was just like this, and we had to tweak the BIOS settings to have it run at anything less than 100% power.

When you're looking at buying a computer, it's very easy to get suckered into thinking you need two or even four cores along with heaps of RAM and terabytes of hard disk space, but do you? Put simply, you can make all the power-saving tweaks you like on a »



» Gnome doesn't offer much functionality for saving power, but you should take advantage of what there is – laptop owners will doubtless agree.

## Smaller, faster, smarter

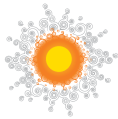


Both Intel and AMD are working to reduce power consumption in all their CPUs, but it's clear that this is an area where Intel has an increasing lead. Intel's Pentium 4 plan was to ramp up the clock frequency as fast as possible, and that paid off for a long time – at least until Athlon 64 came along, and showed that you can do just as much with less clock speed and smarter design. Intel then surprised everyone by dropping the NetBurst architecture from P4 and switching to Pentium M, which was an extension of the older Pentium III architecture. Since then, the Core architecture has continued to use comparatively low clock speeds while adding more cores, thus keeping overall power needs down.

Not content with ruling the mobile roost, Intel has recently announced its Atom processor – an all-new architecture designed for super-small laptops and pocket devices. Amazingly enough, the Atom is an x86-64 chip with SSE3 support and hyperthreading, running at 1.8GHz and requiring a maximum of just 2.5 watts. When idle, that dips down to 0.1W, which is far below what even the Core 2 architecture can achieve. With such an astonishing power/performance ratio, it's no surprise that sub-notebook manufacturers such as Asus are looking for ways to get the Atom into new laptops as quickly as possible – it seems that the new 9-inch Asus Eee 900 will almost certainly come in an Atom edition in just a few months.

But Intel wants to go even further – work is already underway to produce the Atom's successor, which may well include an integrated graphics chip while retaining the same power efficiency.

» The Intel Atom CPU maxes out at around 2.5 watts (compared this with the latest Core 2 Duo chips that max out around 35 watts) – it's no wonder they can fit 11 of them into a space 19mm across!



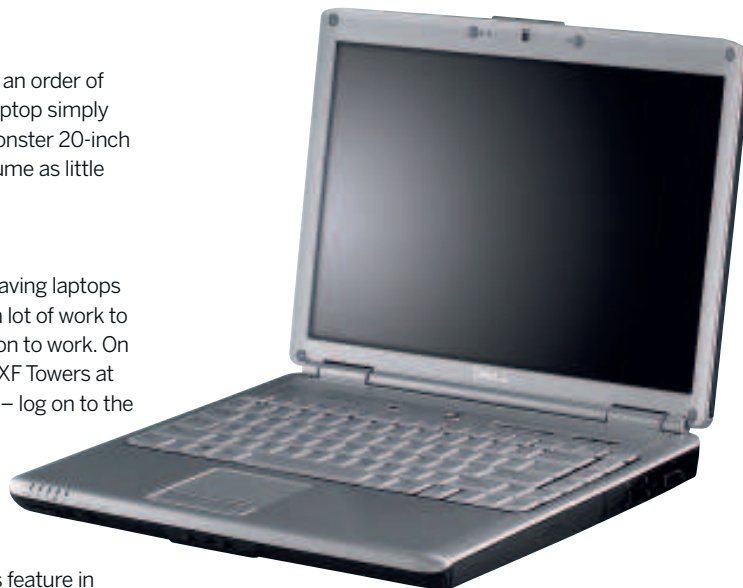
## Green computing

- » dual-core desktop machine, but it's still going to be an order of magnitude more energy-hungry than an average laptop simply because every part of a laptop (except for those monster 20-inch desktop replacement terrors) is designed to consume as little energy as possible.

### Hibernate vs suspend

But everyone knows there are two problems with having laptops everywhere: expense, and the fact that it can take a lot of work to get simple features such as suspend and hibernation to work. On the expense front, we're always surprised here at LXF Towers at just how cheap you can get a laptop for these days – log on to the Dell site, for example, and go to the Small Business laptops section and you'll find low-end laptops for £180 plus tax and delivery, and surprisingly that includes a dual-core CPU!

The other problem is something we've covered extensively in the past, most recently in our laptops feature in **LXF105**. In theory, suspend and hibernate are quite simple things: suspend leaves the computer on, but halts the disk and puts the CPU to sleep; hibernate saves your computer's RAM (and thus the precise system state) to disk, then switches the computer off entirely. These have historically been problematic with Linux, but the very latest distro releases do a good job of getting it right out of the box – with the occasional exception of Ubuntu with certain hardware. If you find you simply can't get software suspend to



» **Desktop power savings are easy to achieve if you don't mind switching to laptops – even high-end laptops handily beat their equivalent desktops for power savings.**

application, the accepted method of ensuring that they don't tread on each other's toes is to run them on their own servers. So essentially you would have one server dedicated to a web server, one dedicated to a database, another dedicated to your email, and so on. This is where the waste comes in: if your database server is running at 99% capacity while your web server is kicking its heels in boredom, there's nothing you can do to help balance the load.

Aggressive consolidation means forcing those individual servers into a single machine so that they can be load-balanced properly. Of course, that rather muffs up the app certification, which is why the solution is virtualisation: bring all the systems together on to one server, but run them in complete isolation using virtualisation. The speed loss is minimal, and it means you can bring together several idling machines. Even better, if one of those virtual machines end up maxing out the machine, it's a cinch to live migrate it to a different physical computer.

To put this all into perspective, 10% of all computers in American data centres are owned by or run on behalf of the US government. With \$4.5 billion spent each year on powering data centres, the government's share of that is \$450 million, and if they can remove even 80% of those machines using virtualisation then that's \$360 million saved every year.

### Going the other way

Building smaller and lighter chips is one solution to the problem, but IBM has quite a different solution: consolidating all your servers into a single one. Yes, the word "mainframe" is back, and not just as a word used in science fiction movies – mainframes are designed to be black-box computing solutions, meaning that you plug them in and they work. To help distribute the load, virtualisation ships as standard in these machines, giving you the ability to create and run hundreds of virtual machines on a single box.

The advantages of mainframes remain much the same as they were years ago: they offer consolidation of resources, easier administration, a single point of support contact, and precision engineering. But that last part has taken on extra importance in the green computing debate, because any sysadmin who builds a hodge-podge of servers from different manufacturers has to take a guess as to how much cooling they need – and the chances are that whatever they come up with will be suboptimal. But with a single, all-in-one machine you know exactly what it needs and can cool it efficiently.

**“Just a small change can make a big difference to the environment.”**

work, try installing the userspace software suspend tool from <http://suspend.sourceforge.net> (this is in the Debian repositories as *Uswsusp*, so it's easy for Ubuntu users to install), and you'll probably find that does the trick.

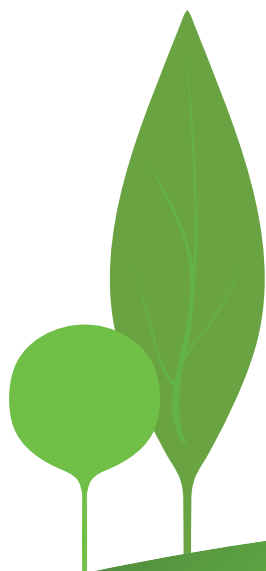
### Virtualisation to the rescue!

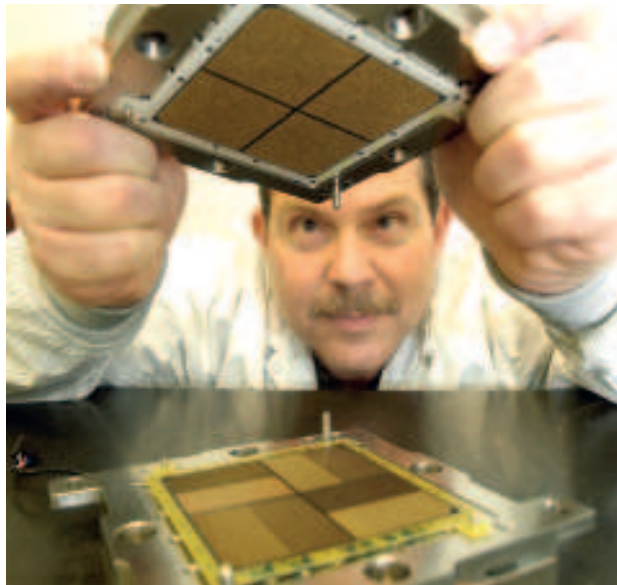
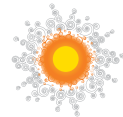
Let me throw in a tasty bit of buzzword for you to chew on: "aggressive consolidation". This particular bit of management jargon came about through various statistics about the average compute load in today's server rooms. Some people will tell you that the average server is busy only 20% of the time; others – presumably somewhat more pessimistic – have reported figures as low as 5%, which means that 95% of the time those machines are doing nothing at all.

The reason for this is application compatibility: when you want to get one certified application to talk to another certified

### Why dual-core works

Intel's Core 2 Duo chip has done wonders to reduce power usage for CPUs because it has moved the focus from high clock speeds (which traditionally waste a lot of power) to having slower, smarter, multi-core machines. One of the real innovations here is that each core in a multi-core machine has its own idle state, which means that one core can be working at 100% usage while the other one is powered down, sitting idle. That usually works out better from an energy-saving standpoint than having both cores running at 50% usage, which means the OS has more flexibility when balancing tasks – if it needs the second core, it can power it up and balance the load appropriately.





› IBM's new z10 server is as powerful as 1,500 conventional servers, but uses 85% less power and 85% less space.

There are lots of ways you can go green with your computing, and technologies such as virtualisation are bringing a new focus to Linux as the operating system that *enables* sysadmins rather than leaving them to weigh up licensing costs against potential green benefits. But going green with your computing is rather like going green with your household: you don't need to go from filament light bulbs and 300-watt TV sets to having insulated walls and composting. Instead, just a small change can make a big difference to the environment and to your bottom line.

Putting that into real terms, what it means is that even if you virtualise only half of your data centre, or change a quarter of your desktops to use lower-powered hardware, then you're already going to see sizeable savings – enough, hopefully, to convince you to go even further!

## Have a go green

Thanks to the growing market for green computing, some companies are even offering out-of-the box solutions to cut power consumption. In the UK, Boston has produced a range of climate-neutral servers and workstations: the servers are designed from scratch to be power-efficient everywhere, and when they reach the end of their lifespan Boston will take them back for recycling free of charge. What's more, the servers have a guaranteed maximum energy usage, and Boston will carbon offset it all, so you save money and feel good all at the same time!

So you see, going green doesn't have to be a lot of work, and neither do you have to hit 100% perfection to make a real difference. Even if you leave your existing infrastructure in place and just commit to buying green hardware when you expand, it's a great start, and can only get better with time. **LXF**

## Roll it out

If you're running a network of Linux desktops, you can effect an immediate change in power usage by rolling out a power-saving policy across them all. It doesn't have to be too aggressive to see a marked difference – even shutting off the monitor after 5 minutes of inactivity will help, particularly in offices where it's common for people to leave computer monitors on overnight.

## Sysadmins go where it's cold

A curious thing about the world's largest data centres is that they are often in warm parts of the world. This is nearly always just down to local need – California has a disproportionately large number of servers, but that's to be expected given that it also has a disproportionate amount of tech companies.

It makes a lot more commercial sense to put your machines where there isn't much heat, and where there aren't tech companies vying for space, and that's where countries such as Canada and Iceland are cashing in – they have lots of space and lots of cold, which means you can let the climate help out with your cooling costs. With Iceland, you even get the added bonus of geothermal energy on tap, so it's possible to run your entire server farm with a zero-carbon footprint.



› Iceland: cold.

Photo: Bob Jagendorf.



› Boston's Igloo 1000: a rack-mounted server that uses just 90W at full load.

