

# Get the Truth on Linux Management

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A Research Report Prepared by EMA  
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ENTERPRISE MANAGEMENT  
ASSOCIATES

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## Executive Summary

In various older studies, Microsoft and some analysts claimed Linux has a higher Total Cost of Ownership (TCO) than Windows. They attributed the difference mainly to higher system management costs, and concluded that the higher TCO outweighed the much lower license and acquisition costs for Linux.

However, in a new study of over 200 Linux enterprises, Enterprise Management Associates (EMA) found that this perception is no longer accurate. Sophisticated management tools now allow Linux management to be fast, effective, and inexpensive. With far lower acquisition costs, Linux is now a cost-effective alternative to Windows.

EMA analyzed the cost factors cited in previous studies and found the following results:

- Provisioning – 75% of administrators using sophisticated tools can provision a system in less than 1 hour; one third can provision a system in less than 30 minutes.
- Patch management – most Linux administrators spend less than 5 minutes per server per week on patch management. Sophisticated management tools reduce this effort even further.
- Configuration management – supporting multiple versions of a given distribution has no discernible impact on Linux management. In some cases, respondents actually had more versions of Windows than Linux.
- Reliability – most respondents reported 99.99% or higher availability for their Linux systems. A significant number (17%) report no downtime at all.
- Problem resolution – in over 60% of cases, when problems occur in Linux environments they are diagnosed and repaired in less than 30 minutes, over 8 times faster than industry average.
- Management and support – 88% of enterprises with Linux and Windows spend less effort managing Linux; 97% believe it is, at worst, the same for both systems. Respondents with sophisticated management tools all report Linux management is the same or easier than Windows management.
- Storage management – enterprises with sophisticated management tools did not find any significant difference in storage management effort or utilization for either Windows or Linux.
- Resource costs – most administrators, for either Linux or Windows, earn under \$60k. Salaries for combined Linux/Windows administrators are only marginally higher than for Linux-only administrators. Linux skills are readily available.
- Consulting and training costs – 79% of enterprises spent nothing on Linux consulting, and 63% spent nothing on training. Only 4% spent over \$10K on consulting or training.

In addition, this research found the following in areas not adequately addressed in previous studies:

- Acquisition costs – for similar environments, Linux acquisition costs can be almost \$60,000 less per server than Windows in software costs alone. Windows also incurs higher hardware costs.
- Productivity – Linux tends to be more productive, as Linux administrators tend to manage more servers than Windows administrators, and Linux systems tend to handle greater workloads than Windows systems.
- Security Management – 75% of Linux administrators spend less than 10 minutes per server per week managing security. With sophisticated management tools, this goes up to over 85%.
- Virus and Spyware Management – 95% of Linux administrators with sophisticated tools spend less than 10 minutes per server per week managing viruses and spyware. Respondents strongly endorsed Linux as inherently less vulnerable. No administrator reported spending more time on Linux than Windows.

## Introduction

In various older studies, Microsoft and some analysts compared the Total Cost of Ownership (TCO) of Linux and Windows servers. These studies concluded that Linux had a higher TCO, predominantly due to higher management costs.

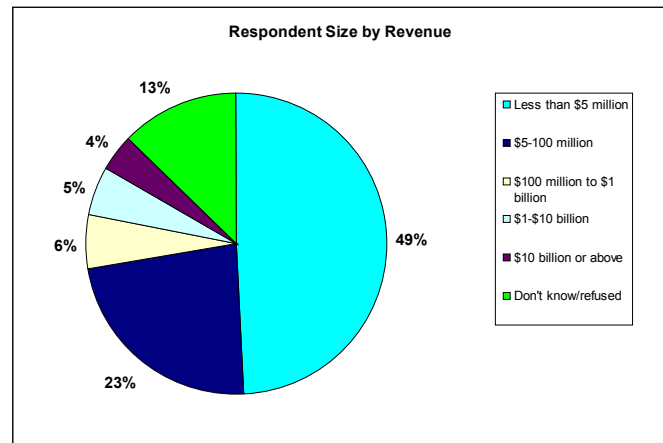
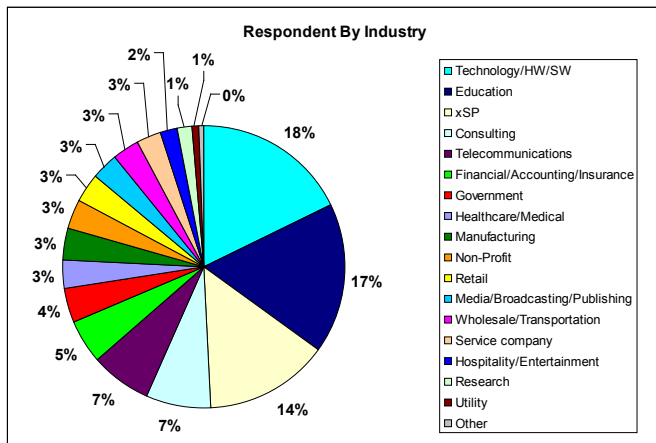
These findings contradict EMA's recent experience with Linux management, which has been getting easier over time. Sophisticated management tools have become increasingly available for Linux, covering patch management, provisioning, software distribution, security administration, storage management, virus protection, and more. Cross-platform management vendors have extended their tools to support Linux. Linux distributors and niche vendors have delivered quality point solutions. Other solutions provide sophisticated Linux management through the same tools that manage Windows - Microsoft Systems Management Server (SMS) and Microsoft Operations Manager (MOM).

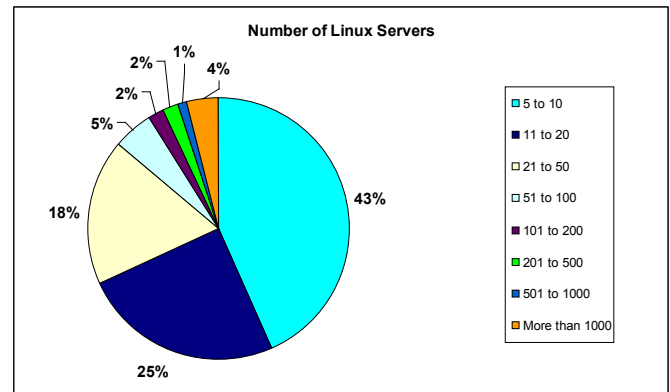
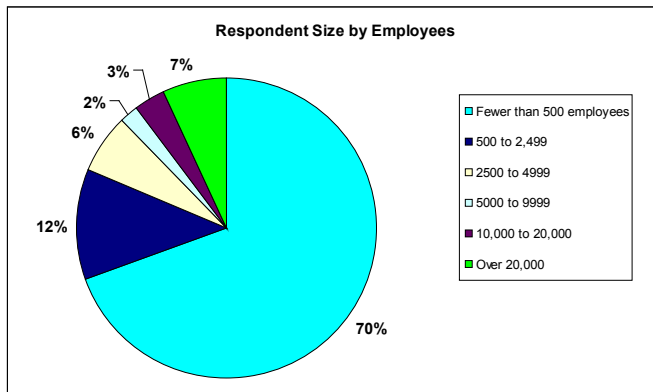
EMA therefore undertook a new research study to determine the effect of sophisticated tools on Linux management. Levanta, a leader in Linux management and data virtualization, sponsored this research paper. However, EMA conducted all research and analysis independently. Levanta had no influence on either the research or any of the subsequent findings detailed in this paper.

## Survey Methodology

EMA investigated whether Linux server management was a significant barrier to cost-effective Linux operations, by analyzing the current state of Linux management and its associated costs. This study did not set out to compare the TCO of Linux directly against the TCO of Windows, but concentrated primarily on management effort in the Linux environment, particularly where sophisticated management tools were in use. Where the data is available, however, the analysis highlights general comparisons between the two environments.

This multi-faceted research study consisted of a telephone survey using a random sample of several thousand IT organizations, a web survey of self-selecting respondents, and in-depth interviews with CIOs and MIS Managers in 13 enterprises with Linux environments. Overall, the study netted over 200 responses.





Respondents represented a range of industries. The majority of responses came from Technology and Service Providers (32%), Education (17%), Consulting (8%) and Telecommunications (7%). Most organizations were Small to Medium Enterprises (SMEs), earning less than \$5M in revenues, but a significant percentage (27%) had revenues over \$100M. Most respondents had fewer than 500 employees, but almost 20% had more than 2500 employees.

Respondents represented organizations of differing sizes, from small (<20 servers) to very large (>1000 servers) enterprises, with most having fewer than 20 Linux servers. While most respondents came from the USA, responses came from many geographies, including the United Kingdom, Germany, Canada, South Africa, Australia, Russia, New Zealand, and Singapore. Respondents also represented a cross-section of management maturity, with a variety of sophistication levels, from manual management to automated with purchased utilities and tools.

## Key Findings

This research study has resulted in some very significant findings, including:

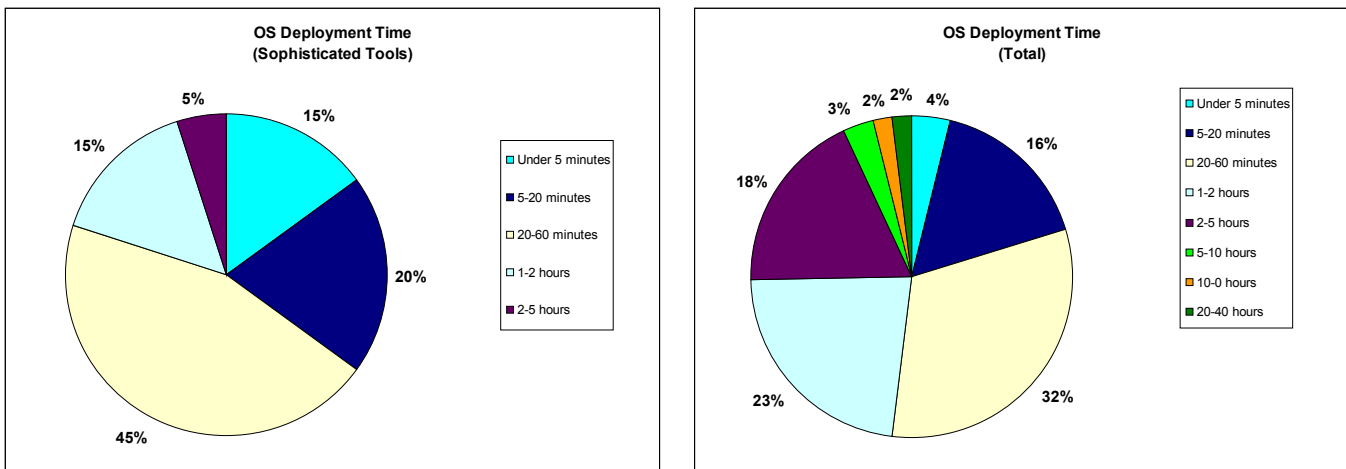
- **Provisioning** – Deployment and provisioning of Linux systems and applications can happen very quickly. Over half of surveyed enterprises can provision a Linux system in less than 1 hour. This process is even more efficient with sophisticated management tools.
- **Management** – Most respondents spend less than 5 minutes per server per week managing Linux systems – including patch management, system migration and repurposing, security management, and virus/spyware protection. Most respondents manage their Linux systems centrally, many use sophisticated management tools, and across the board, these tools made Linux system management easier and faster.
- **Reliability** – Linux environments are extremely stable, in many cases more so than many proprietary environments. Many enterprises experience 100% uptime for their Linux environments, and most experience greater than 99.99% availability. When problems occur, Linux administrators repair them quickly, in most cases faster than industry averages.
- **Storage Management** – Sophisticated storage management technologies such as SAN and NAS have made storage management and utilization a platform-independent discipline. In these mature environments, most Linux administrators spend very little time managing storage, yet have high utilization rates.
- **Support** – Customization and support of multiple versions does not have any discernible impact on the management effort for Linux systems. In many cases, administrators use the same management tools across many versions of multiple heterogeneous systems including Linux, UNIX, Windows, and z/OS.
- **Ease of Management** – Over 90% of respondents believe that the time and effort required for managing Linux servers is the same or less than managing a Windows environment.

- Resource Costs – administrator salaries are only marginally higher for Linux than for Windows. However, Linux administrators tend to be very experienced, and Linux consulting and training costs are very low. Linux systems also appear to handle more users, and to require fewer administrators, than Windows. Therefore, overall Linux resource costs on a per-server or per-user basis appear to be lower than for Windows. In addition, Linux skills appear to be readily available.
- Acquisition Costs – Initial acquisition costs for Linux are very low across the board compared to similar proprietary environments. For example, when including the cost of hardware, operating system, database, web server, and a development environment, a Linux-based system suitable for running a high-volume web application may cost almost \$60,000 less than a comparable Windows-based system.

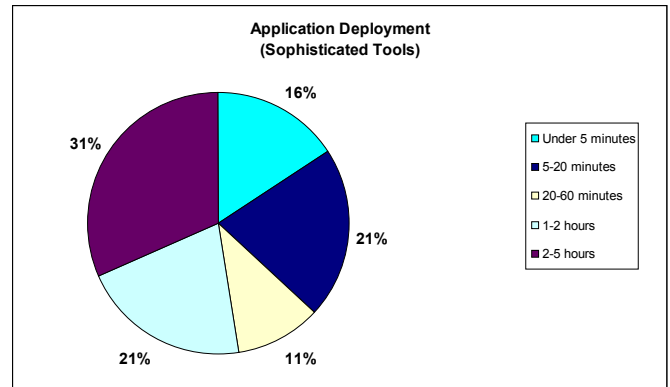
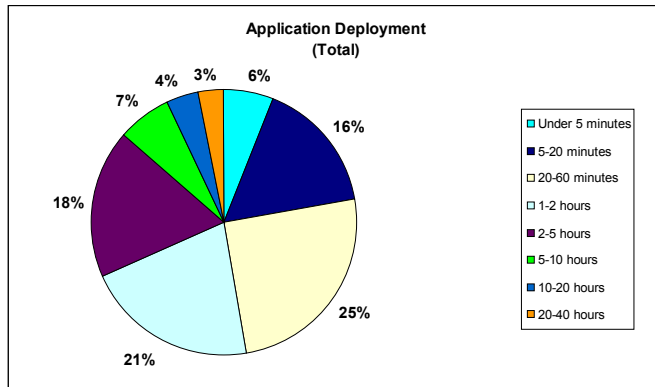
## Management Costs

### Deployment and Provisioning

A major part of managing any environment, especially a complex server environment, is setting up the operating systems and applications. Provisioning, migration, and repurposing can generate significant costs if not properly managed. However, the sites surveyed can provision and deploy their Linux systems and applications very quickly. Organizations with sophisticated management tools are especially efficient in deployment and provisioning.



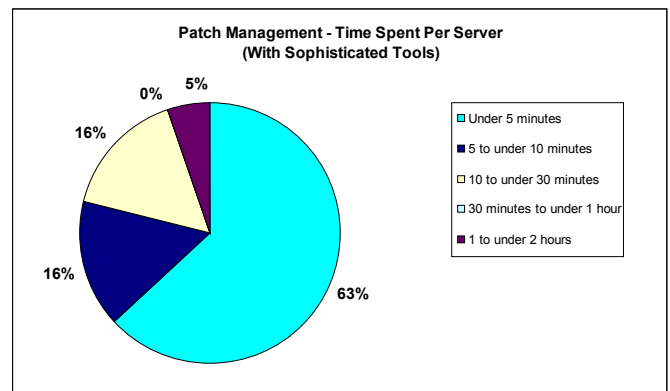
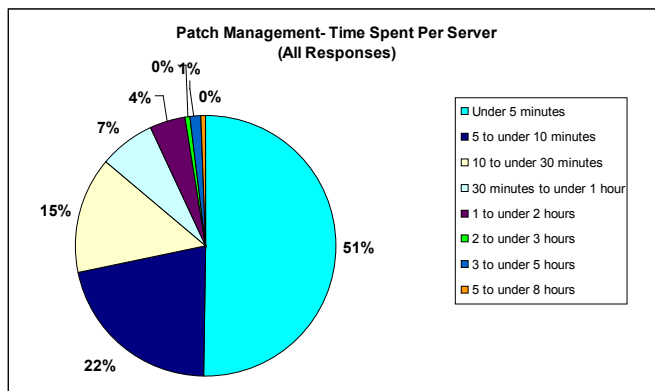
Over half of the respondents can provision a new Linux server in less than 1 hour, and 20% can do so in less than 20 minutes. For sites with sophisticated tools, over 75% spent less than 1 hour to provision a new Linux system and one third could provision the OS in less than 20 minutes. None took longer than 5 hours.



Application provisioning took slightly longer – just less than 50% of respondents provisioned applications in less than 1 hour. Sites with sophisticated management tools were again faster – one third were able to deploy applications within 20 minutes, and none took longer than 5 hours. 15% of sites without such tools took over 5 hours for application deployment.

### Patch Management

Effective patch management is essential to ensure systems have the latest updates to correct bugs, close vulnerabilities, and add essential functionality and security fixes. Patching can be laborious and resource-intensive if not properly managed. However, this research has found that patch management takes a limited time for the average Linux administrator, and even less for those with sophisticated management tools.



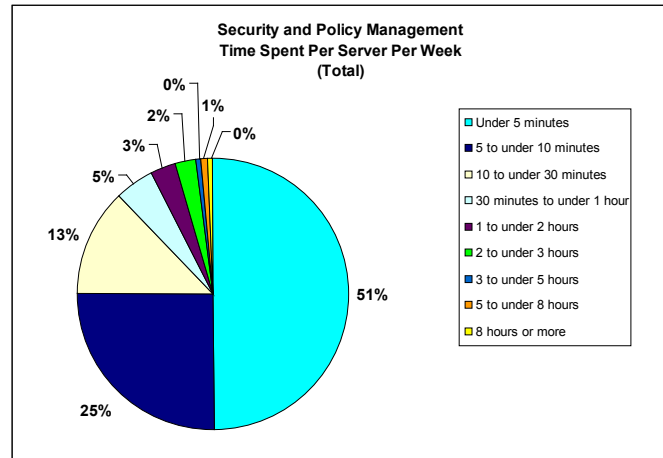
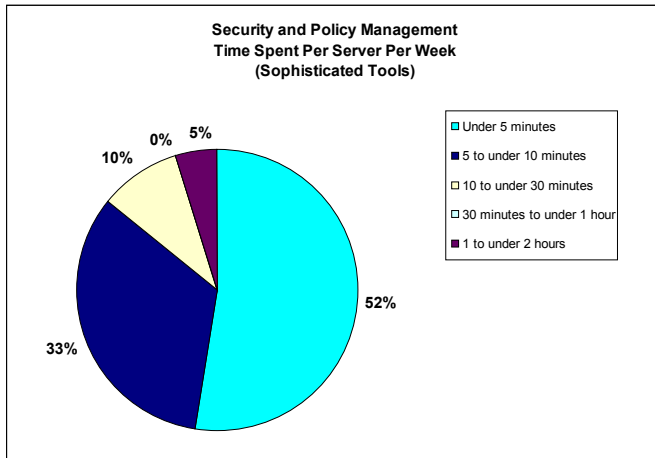
Half of all respondents spend less than 5 minutes per server per week on Linux patch management; 85% spend less than 30 minutes. When sophisticated management tools are used, the percentage of respondents spending less than 5 minutes per server per week rises to 63%. No respondents with sophisticated tools spent more than 2 hours per server per week on patch management. Sophisticated management tools clearly make patch management more efficient.

Most MIS managers interviewed used the same process for server provisioning, migration, repurposing and propagating major changes. A large city university using sophisticated management tools was able to repurpose a Linux server in less than 5 seconds – “from anywhere, even the airport or at Starbucks, I can bring up the [administration] GUI, and find an available blade that meets the requirements. I shut down the low-powered server, unbind the [Linux operating environment] with a drag and drop, rebind it to the new hardware, and reboot.”

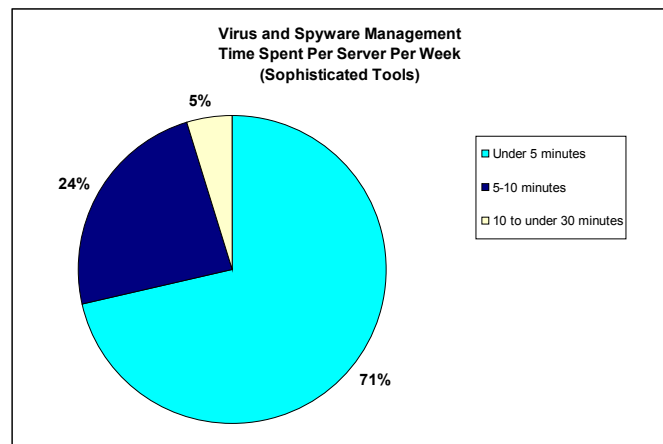
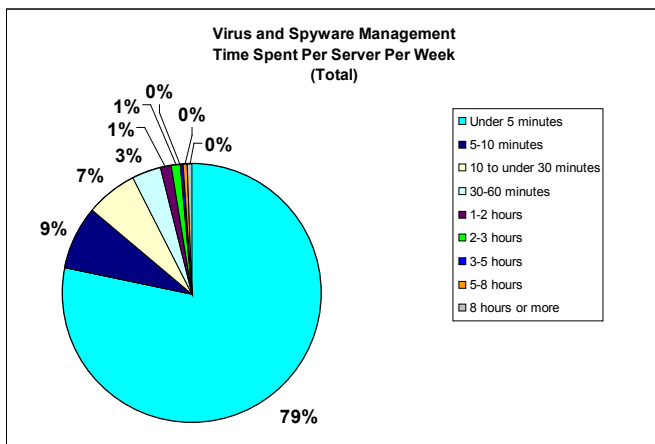
Another organization “had do this with Windows, and it was just a nightmare – not just a case of moving a disk to a new machine. With Linux it is easier, but with [our management tool] it is child’s play.” A major bank added, “Windows is definitely a lot more involved, due to the frequency of Microsoft updates. We also need to reboot [Windows] boxes just about every week for some critical update. On the Linux side it just requires stopping and restarting a service.”

## Security Management

Security and policy management (managing users, access rights, etc.), and protecting against viruses, malware and spyware, are a critical part of ensuring a safe operating environment where users can get to the applications and resources they need to do their job.



Linux administrators spend very little time managing security and policies. Half of all respondents spend less than 5 minutes per server per week, and 75% spend less than 10 minutes. When management tools are used, the effort goes down even further – 52% spend less than 5 minutes per server per week, and 85% spend less than 10 minutes.



## Virus and Spyware Detection

Enterprises also spend minimal effort protecting against viruses and spyware. In total, 88% of Linux administrators spend less than 10 minutes per server each week managing viruses and spyware. When sophisticated tools are in use, 95% of administrators spend less than 10 minutes per server per week, and no administrator with sophisticated tools spends more than 30 minutes per server per week.

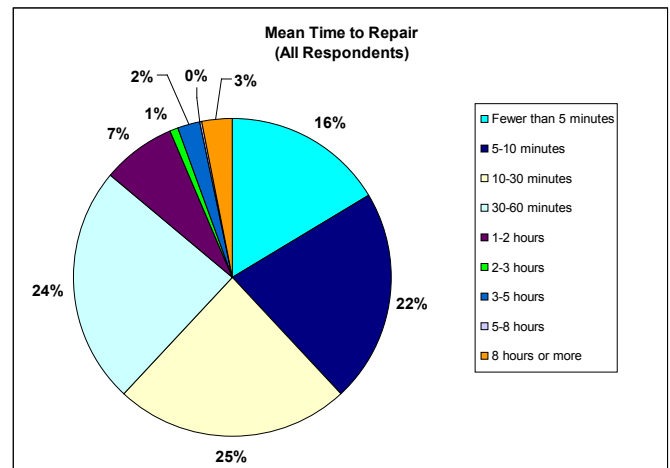
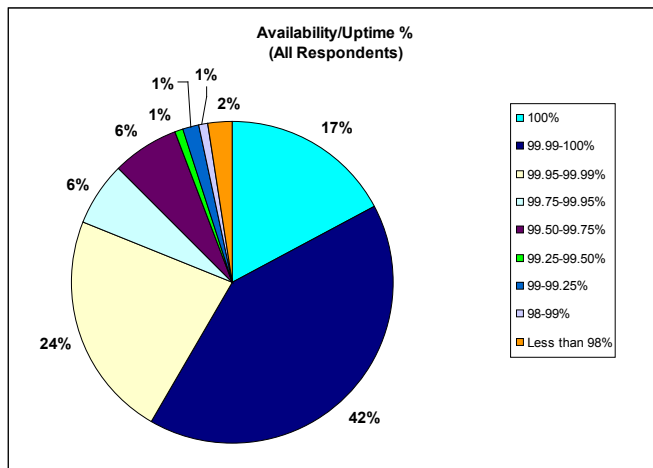
When asked to compare security management between Linux and Windows, the interviewees strongly endorsed Linux as easier to manage, and inherently less vulnerable. Only a small minority spend the same amount of time managing spyware and viruses on Linux and Windows. None reported spending more time on Linux than Windows.



One administrator who handles both Linux and Windows for a large entertainment software group said, “I see way less [virus] traffic for Linux than for Windows.” Another administrator for a major US bank spends twice as much time on virus and spyware protection for Windows than for Linux. A large peripheral manufacturer spends 10% of their virus and spyware management effort on Linux, and 90% on Windows, noting that they are “constantly running checks on Windows,” whereas for Linux they “have a lot less out in the wild to worry about.”

## System Availability

Older research claimed Linux has lower reliability and availability, specifically citing longer repair times caused by less skilled resources and difficulties with problem diagnosis, documentation, and repair. However, our research showed that Linux environments were extremely stable, with high availability and short problem resolution times.



Some organizations had exceptional uptime, with 17% of respondents reporting 100% availability. Over half of all respondents (58%) reported availability of over 99.99%, and 89% reported availability over 99.95%. At the other end of the scale, only 2.5% of respondents reported availability worse than 98%.

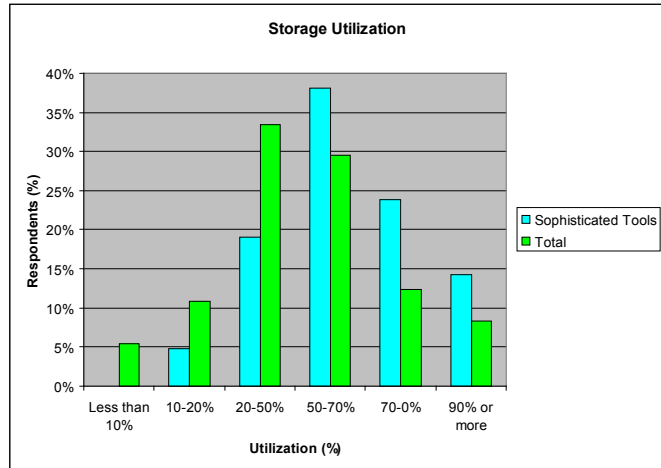
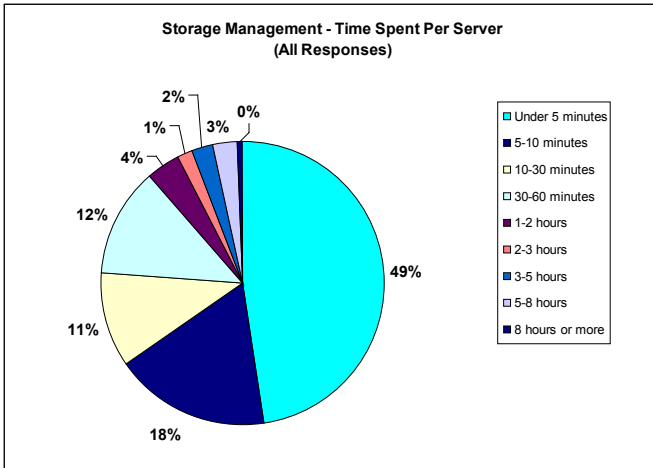
A large international bank with over 1500 Linux servers reported the only downtime in 2 years was from a CPU failure, and was not even software-related, adding that their Linux environment “just runs and runs and runs.” A large hosting site reported 100% availability across 230 managed servers since October 2001. A large city university reported 100% availability for systems with sophisticated management tools (across both Intel and z/Series), with unplanned downtime only affecting a handful of unmanaged Linux systems.

When problems do happen in Linux systems, they are quickly resolved. The average time to fix a server reporting a fault (i.e. Mean Time To Repair, or MTTR) for over 60% of respondents was less than 30 minutes. This is well below the average found in a separate EMA study, which showed most enterprises averaged MTTR of around 4 hours.

A large city university using a sophisticated provisioning solution keeps all their data on NAS, so they can simply switch out a failing system and diagnose it later, resulting in MTTR of around 5 minutes. A large financial institution running Linux on IBM z/Series hardware reported effective MTTR of 0 minutes, because they have “never run into any bugs from Linux,” noting this as “one of the reasons we can support it with so few people – that and the reliability of mainframe hardware.” Comparing Linux to Windows and Sun Solaris, a global computer peripheral manufacturer reported that for problem diagnosis and resolution, “Windows is the most problematic; Linux and Sun are the least.” However, this was not true for all organizations. A large hosting facility with both Windows and Linux reported that the MTTR for Windows was “mostly same as Linux, maybe a couple of minutes more.”

## Storage Management and Utilization

Previous studies have found that storage on Linux servers is hard to manage and ends up underutilized. This study found mixed results on this topic.



The research showed that the vast majority of Linux administrators spend less than 30 minutes per server per week managing storage. Almost half of all Linux administrators spend less than 5 minutes per server per week; 65% of respondents spend less than 10 minutes.

Enterprises with both Windows and Linux systems did not find any significant difference in the time they spent managing storage on either platform. Where organizations had deployed a Storage Area Network (SAN) or Network Attached Storage (NAS), storage management was generally enterprise-wide, and independent of platform. A large national bank noted, “Multi-gig databases are connected to the SAN, and managed by the storage team. They use the same tools across the SAN, regardless of the OS.” This not only reduces the storage management cost, but also improves overall storage utilization, regardless of operating system.

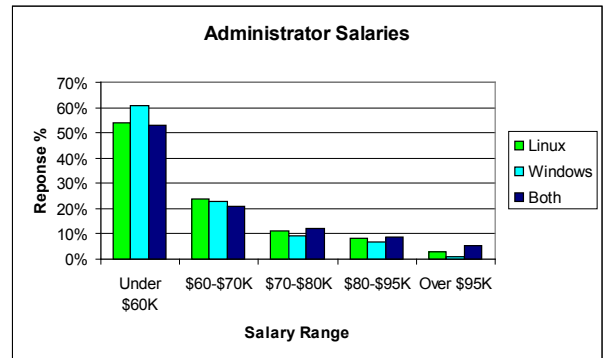
Almost half of all respondents had fair storage utilization, with room for peak use, at between 50-90% utilization. 16% of respondents were using less than 20% of their available capacity, and 8% had less than 10% of their capacity available for overhead and peak usage. Organizations with sophisticated management tools were better at maximizing their storage utilization across the board – only 23% of these respondents were under 50% utilization, compared to 52% of respondents without sophisticated tools, and almost twice as many respondents with tools (38%) as without (18%) are using between 70-90% of their available storage.

## Resource Costs

Earlier studies found that the cost of Linux administrators, including salaries, consulting, and training costs, was significantly higher than for Windows administrators. However, this research finds that Linux administrator salaries are very close to Windows administrator salaries. Older studies also assume the same number of administrators and servers are required for any given workload. However, this research finds that Linux administrators handle more servers, and Linux servers handle more users. Overall, this study therefore finds that the total resource cost for Linux is likely to be significantly lower than for Windows.

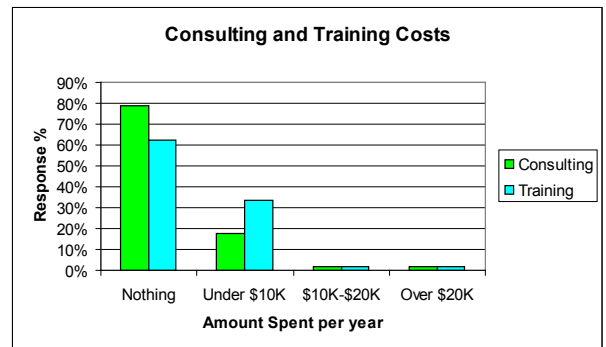
## Administrator Salaries

Salaries for Linux administrators are only marginally higher on average than for Windows administrators. More Linux administrators (22%) earn over \$70K than their Windows counterparts (17%) do. However, most Linux administrators (52%) and Windows administrators (60%) are on a salary of less than \$60K. At the top end of the scale, very few Linux administrators (3%) or Windows administrators (1%) command over \$95K. In addition, administrators who manage both platforms cost only marginally more than Linux-only administrators do. Over half of these multi-skilled administrators command a salary of less than \$60K, while only a quarter earn over \$70K.



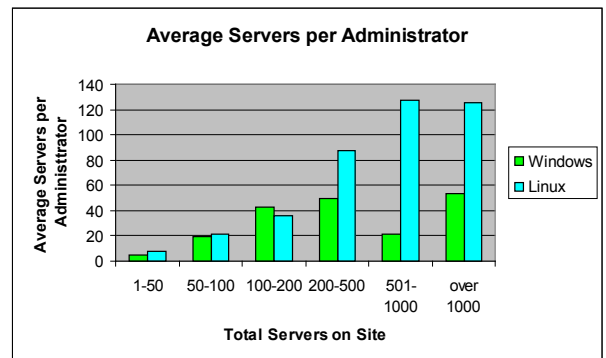
## Resource Availability

Growing maturity, wider deployment, and availability of skilled resources for Linux helps explain this closing salary gap. A cursory search of resumes posted on popular US job search websites Monster.com and Careerbuilder.com turned up literally thousands of relevant, qualified, and experienced job seekers with Linux administration skills. Salary expectations ranged from under \$45K to over \$100K, with many in the mid-range at around \$55-75K. Resources were available nationwide.



## Consulting and Training

Widespread availability of skilled resources may explain the low expenditure on third-party support for Linux system management. In a vast majority of enterprises, employees administer Linux systems with very little additional consulting or training. According to the research, 79% of respondents spent nothing at all on Linux consulting over the last year, with 96% spending less than \$10,000. Training costs were only marginally higher than consulting costs. More organizations spent at least some money on technical training for their Linux administrators, with 34% spending up to \$5K annually. Yet only 4% spent over \$10K, and over 63% spent nothing, validating the opinion of a large city university that stated simply, “We don’t need any consulting in our Linux environment.”

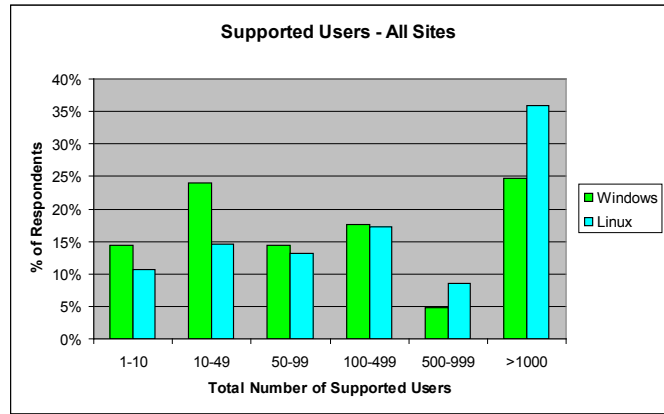
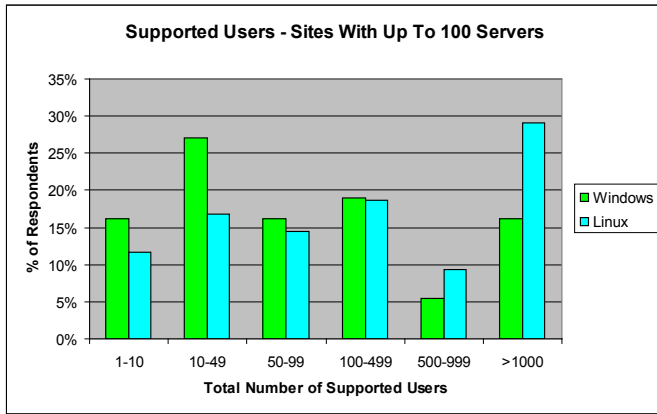


## Administrator Productivity

One of the more interesting findings in this research is that Linux administrators tend to manage more servers than Windows administrators. In sites with up to 100 servers, (representing over 85% of respondents for each platform), each Linux administrator managed on average 15 servers, and each Windows administrator only 12. This strongly indicates that Linux requires fewer administrators in these small- to medium-sized environments. Across all respondents, each Linux administrator manages 68 servers, while each Windows administrator manages only 32 servers. However, the number of respondents with more than 100 Windows servers was not sufficient to draw a definitive comparison with Linux in these large-scale enterprises.

Nevertheless, if even marginally fewer administrators were required for Linux, as the research data suggests, this would help to balance out any marginal salary difference between Linux and Windows administrators.

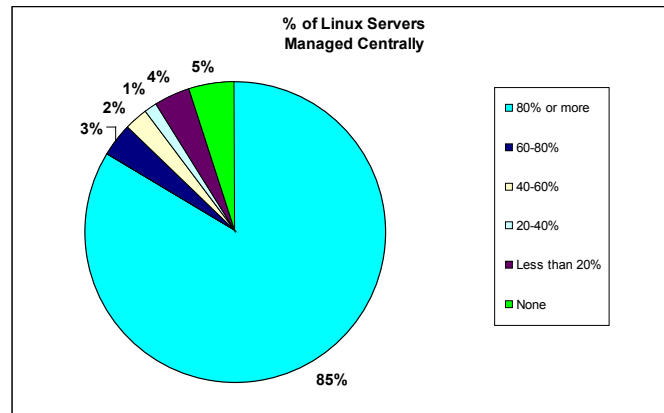
## Server Workload



The survey results also indicate that Linux often handles a greater workload than Windows. In sites with up to 100 servers (85% of respondents for each platform), over a third of the Linux respondents supported over 500 users, compared to less than a quarter of Windows respondents in this group. In the same group, 29% of Linux respondents supported over 1000 users, compared to only 16% of Windows respondents. Across all respondents, 44% of Linux servers supported over 500 users, while only 30% of Windows servers supported the same workload. However, the number of respondents with more than 100 Windows servers was not sufficient to draw a definitive comparison with Linux in these large-scale enterprises.

## Centralized Management

Centralized management now appears to be the norm for Linux environments, which indicates that this is no longer an issue, even for large enterprises. According to the research, 84% of all organizations, and 95% of organizations with a sophisticated management tool, manage the vast majority (80% or more) of their Linux systems from a central location. At the other end of the scale, only 12% of organizations still have substantially decentralized Linux systems management, managing 40% or fewer of their servers from a single location. Most organizations avoid the additional resource cost and performance problems associated with decentralized system management.



## Non-Survey Cost Findings

### Hardware Costs

Any evaluation of TCO should evaluate the differences in hardware costs between Linux and Windows servers. The minimum requirements for the high-end x86 versions of the major versions of enterprise Linux and Windows operating systems are as follows:

	Processor	Hard Disk	Memory (RAM)
<b>Red Hat Enterprise Linux AS 4.0</b>	Any Pentium class	800 Mb	256 Mb
<b>SUSE Linux Enterprise Server 9.0</b>	Unstated	500 Mb	256 Mb
<b>Microsoft Windows Server 2003 Datacenter Edition</b>	400 MHz	1.5 GB	512 Mb

This comparison is not particularly exhaustive. For example, there are many alternatives on each platform, and each system provides different functionality. Minimum specifications are also relatively meaningless compared to recommended specifications or actual deployments. However, these versions provide a reasonable high-level comparison, representing the most powerful and scalable x86 offerings from each vendor (with support for 4-way processors, 64-bit, and Itanium class CPUs, etc).

In this comparison, Windows requires 2 to 3 times as much disk space, and twice the memory as either of the major Linux distributions. Historically, Windows has required more and better hardware with each version. Microsoft critics refer to this as ‘bloatware,’ and claim it unnecessarily drives up hardware costs. Supporters respond that every new release takes advantage of hardware advancements to deliver more and better functionality. However, it remains a fact that Windows requires more substantial hardware than equivalent Linux distributions, with a corresponding increase in base hardware acquisition cost.

### Licensing Costs

Software and licensing costs are at the very heart of the debate concerning the TCO of Open Source software. Critics of Linux maintain that ‘Open Source’ does not mean ‘free,’ and to an extent, they are correct. However, software acquisition costs for Linux-based systems are significantly lower than for similar proprietary systems.

Additional expense comes with platform products, such as databases, application servers, web servers, development tools, Client Access Licenses (CALs), etc. For example, the following table compares the software acquisition costs for a high-performance web application server, consisting of a base operating system, web/application server, database, and development stack, running on a 4-way x86 processor, with 5 developers and 100 direct end users:

	<b>Windows</b>	<b>Cost</b>	<b>Linux</b>	<b>Cost</b>
<b>Operating System</b>	Microsoft Windows Server 2003 R2, Enterprise Edition (Includes 25 CALs)	\$3,999	Red Hat Enterprise Linux AS 4.0	\$1499
<b>Web Server</b>	Microsoft ISA Server 2004 Enterprise Edition (\$5999 per processor)	\$23,996	Apache/JBoss	\$0
<b>Database</b>	Microsoft SQL Server Enterprise Edition (“Processor License”, unlimited users)	\$24,999	MySQL Network Platinum	\$4995
<b>Development Environment</b>	Microsoft Visual Studio 2005 Professional Edition (\$799 per user)	\$3,995	PHP/Perl (e.g. Visual Eclipse)	\$0
<b>Client Access</b>	4 Additional Server CAL packs (\$799 for 20 CALs)	\$3,196	N/A	\$0
<b>Total</b>		<b>\$60,185</b>		<b>\$6,494</b>

Again, this is not a definitive pricing analysis. Major vendors offer discounted volume licenses. Different components vary in functionality. Conversely, the Linux and MySQL prices include support contracts (often including 24x7 telephone support), whereas the Microsoft costs are product licenses only. It also assumes that other third-party software is not installed (on either platform), such as IBM WebSphere, BEA WebLogic, Oracle database, etc. However, this provides a reasonable comparison, and shows that a Windows/Microsoft stack has significantly higher software acquisition costs compared to an equivalent Linux/open-source stack.

## Support Costs

Previous studies have implied that Linux incurs additional management costs due to the supposed difficulty in managing and maintaining multiple versions, handling operating system modifications, and the additional cost of server management tools. However, any equivalent environment will incur similar (if not higher) costs.

Maintaining different versions of any operating system will always increase management effort, whether it is Linux, UNIX, Mac, or Windows. For example, a large city university is maintaining multiple Windows operating systems, and “the PC group tries everything – including SMS and MOM – but they are just killing themselves, because they need to support everything from Windows NT to Windows 2003.” Supporting multiple versions and service packs of any operating system is problematic; this is not a justifiable differentiator for Linux TCO.

It is also possible to modify the Linux operating environment significantly more than proprietary platforms, at a much more fundamental level. However, this research still shows that Linux management effort is not significantly high despite this flexibility. As has been noted, the effort to propagate patches and changes to Linux systems is low across all the organizations surveyed and even lower when sophisticated management tools are used.

Similarly, the drivers for deploying additional management tools are not unique to Linux. This research study has found that sophisticated management tools certainly reduce the time and effort of managing Linux. However, it has also shown that many organizations manage Linux effectively even without such tools. The same is likely to be true for proprietary operating systems. For example, some Windows sites may be very efficient, but others will need additional management tools such as Microsoft’s SMS and MOM, or one of many other products from Microsoft Systems Management partners. In the case of Linux, however, many management tools are available under open source licenses, without any additional cost.

## Additional Qualitative Findings

### Major Challenges

Enterprises looked for Linux management solutions for several reasons. Many specifically needed solutions for provisioning and patch management. For example, a large city university acquired 56 blades, with basic provisioning software, but according to the MIS Manager, “the management tool for these blades was overly complex and never worked well.” With a sophisticated provisioning system, they can now “provision remotely wherever we want ... and not have to do it multiple times – if you want to provision 1 or 1000 blades, it is no work at all, just a matter of dragging and dropping an icon on a screen.” They use the same solution for security and patch management, configuring each patch once, and then pushing it out to all their Linux systems. A large entertainment developer with over 1000 Linux servers found that a sophisticated solution “helps provisioning significantly” by allowing them to deploy new application code to multiple servers from a single system image.

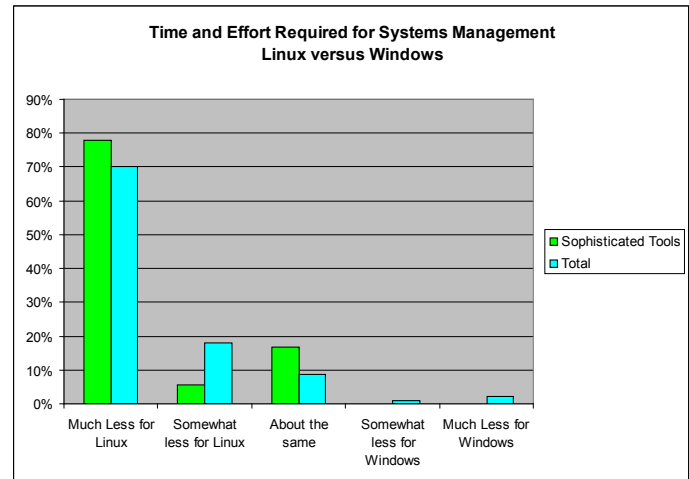
A large microchip manufacturer running both Linux and UNIX reported that sophisticated tools have greatly improved their Linux asset and inventory management. They previously could not see which sites were out-of-state, in both hardware and software inventory, resulting in remote sites that could not handle application upgrades. Using a centralized inventory and software distribution solution, they can now ensure their remote Linux systems have appropriate hardware, and can automatically update the application software worldwide. This eliminated a need for additional Linux administrators for each of their 10 remote sites, and improved their chargeback efficiency.

These initiatives have all occurred in the last 2 years. In both cases, the products that solved these management problems did not even exist 2 years ago. Maturing management solutions for Linux enable enterprises to address these problems, and to reduce Linux management and operation costs significantly.

## Overcoming Linux Systems Management Shortcomings

Participants in this study have deployed a variety of solutions to manage their Linux systems efficiently and cost-effectively. Most use the tools available from the Linux distribution vendors Red Hat and Novell. Others have purchased management tools from Linux management vendors such as Levanta or SWSoft, or from large enterprise vendors such as CA and IBM. In most cases, there is some additional scripting or in-house development.

According to our research, 88% of enterprises expend less effort managing Linux than Windows, and 97% believe it is, at worst, the same for both systems. Where sophisticated management tools are in place, 100% of all respondents report Linux management to be the same or easier than Windows management. The in-depth interviews reinforced this finding. Two sites that used the same tools to manage both Linux and Windows rated the ease of management to be identical. Other interviewees with both platforms consistently rated Windows as harder to manage than Linux.



Security and vulnerability are major issues for Windows management. A large peripherals manufacturer noted, “Windows vulnerabilities take a lot more time. Linux is easy. Windows is a pain primarily because it is so flawed.” A large hosting site noted, “out of the box, a Linux system is inherently more secure, and has less setup work to do than a Windows system.” The MIS Manager at a large city university with equal numbers of both platforms said, “It is a constant battle to get the Windows servers to work.” The MIS Manager at a large state university stated simply “anything you need to do on Windows just takes more time than the same thing on Linux.”

These results contradict previous findings that Linux is harder to manage than Windows. In fact, most participants with both Windows and Linux find Linux inherently easier to manage.

## Increasing Maturity of Linux

Linux maturity continues to evolve. It has clearly reached a level of maturity that organizations of all sizes can run mission-critical applications with minimal management effort, especially enterprises that utilize sophisticated management tools. Large IT organizations have proven this, overcoming many of the hurdles associated with early adoption. This study shows that even Small and Medium Enterprises (SMEs) should no longer be apprehensive of the costs of deploying and managing Linux systems.

Linux has grown from an enthusiast’s operating system to a viable enterprise platform. It has strong support from mainstream hardware vendors such as IBM, Hewlett-Packard, Sun, Intel, AMD, and Dell. It supports widely adopted technologies such as J2EE. It is also at the forefront of deployment of web services and Service Oriented Architecture. These factors make for exceptional portability across mainframes, servers, workstations, desktops, appliances, blades, grids, and even portable devices.

Most large management software vendors now support Linux, with solutions available from Oracle, Sun, BMC, Symantec, Intel, CA, and Quest. Linux-specific solutions are available from vendors such as Levanta, Emu Software, Aduva, and others. Free, open source solutions are also available, and the Linux distribution vendors provide very functional management tools such as Novell SUSE’s YaST (Yet another Setup Tool), YOU (YaST Online Update), and Yellowdog Updater Modified (YUM); Red Hat’s RHN (Red Hat Network) and RPM (Red Hat Package Manager); and Debian’s APT (Advanced Packaging Tool). Microsoft even supports Linux as a guest operating system with its latest release of Virtual Server 2005, and promotes technologies that integrate Linux management into standard Microsoft tools such as SMS and MOM. This wide, mainstream support has been a tipping point for ease of use and ease of management.

Many government and education environments are being mandated or strongly encouraged to move to Linux. This has been true in Europe and Asia for some time (e.g. Germany, Korea), and is starting to appear in the USA (e.g. Commonwealth of Massachusetts). Equivalent-sized Small and Medium Enterprises (SMEs) have not adopted Linux as strongly, likely put off by dated perceptions that Linux administration skills are scarce and expensive, that the system itself is hard to deploy and manage, and that there is too high a risk associated with Linux.

However, this study shows that Linux has matured, and management solutions help to make it simple and economical. Skilled administrators are readily available, including professional services consultants from IBM, Novell, Red Hat, HP, and many smaller firms. Linux salary costs are not appreciably higher than for Windows, and an administrator skilled in both systems is unlikely to cost more than a Linux-only administrator. Linux administrators also tend to manage more systems, and Linux systems tend to handle larger workloads.

Certified training programs add further confidence to Linux resourcing. Administrators can attain certifications like Novell's Certified Linux Engineer, Red Hat's Certified Technician/Engineer, and Linux Professional Institute Certified. In addition, there is a large, knowledgeable, enthusiastic, and mostly free community to turn to for education and assistance. This community is available worldwide, day and night, to provide education, support, samples, documentation, case studies, patches, bug fixes, enhancements, and other technical assistance. Linux skills and training are now so mainstream, even the "Linux for Dummies" book is in its second edition.

SMEs do not need to undertake wholesale conversion to Linux to reap the benefits. Through outsourcing, hosting, and co-location, SMEs can enjoy the advantages of Linux with almost none of the perceived risk. Of the service providers polled, 90% run Linux (only 59% run Windows), and in many cases charge less for Linux hosting than for Windows. SMEs should also investigate "out-of-the-box" Linux solutions such as certified application stacks and zero-administration offerings from Red Hat, SpikeSource, Sage/Net Integration, and others. Linux also underpins many single-function appliances and blades, so even SMEs can easily rack a new Linux system with minimal effort.

Critics vastly overstate the openness of Linux to hackers. As open source software, anyone can inspect Linux code to look for vulnerabilities. However, in practice, many more vulnerabilities, exploitations, viruses, and spyware target Windows than Linux. Open source software also has a huge development community to close any exposure quickly. Enterprises do not need to wait for slow, unmotivated vendors to acknowledge and patch vulnerabilities.

Also overstated is the risk of litigation arising from SCO's contract and copyright claims. Some case studies use disingenuous 'blue-sky' accounting to show million-dollar cost savings based on this risk. However, proprietary vendors have fought and lost some of the largest and most disruptive litigations in the history of technology, both in the US and in Europe. More importantly, Linux vendors including Red Hat and Novell offer comprehensive indemnification to protect Linux customers from copyright infringement claims.

## Conversations and Case Studies

EMA interviewed MIS Managers and Administrators at Linux sites in three different categories – hosting companies, enterprise IT departments, and sites with sophisticated management tools – to gain a more in-depth, qualitative view of systems management in a Linux environment. They provided a deeper insight into real-world Linux issues and solutions. Summaries of these interviews are included below.

### Hosting Companies

The hosting companies interviewed range in size from 90 to 5000 Linux servers, with an average of 1800 servers under management. Two organizations also manage a significant number of Windows systems. The number of end users varies, and is difficult to pinpoint due to the nature of hosting, where end users may be customers of customers of customers. Estimates range from 500 to several million. Some other indicators of workload from these companies include:

- 6-8000 emails a day
- Half a T1 in network traffic
- 95-100 network sessions established per second



These companies are predominantly running email and web servers, but several run many application and database servers. The Linux distributions include Red Hat Enterprise Linux, Fedora, and Debian, all on x86 processors. Only one site has more than one version of Linux in production. Apache is the favored web server across the board, and all run MySQL database, with two sites also running PostgreSQL. One site running Windows has both Windows 2000 Server and Windows 2003 Server (in both Standard and Enterprise editions), with Microsoft ISA as the web server, and a combination of Microsoft SQL Server, Oracle 8.x, Oracle 10.x, and IBM DB2 databases.

These hosting sites use a variety of management tools, including HSPComplete, Virtuozzo, Nagios, RPM, YUM, APT, YaST, and RHN. Two sites also use custom-developed software, including some scripting. On average, these sites reported 75% automation of their systems management, with as high as 95% for one site. Each site administers Linux entirely from a single location, although the physical servers are in up to nine different locations. The sites running Windows report the same level of centralization and automation as for their Linux environment. All the enterprises are satisfied with the efficiency of the tools they have. One of the larger sites notes, "Updating [Linux] is fairly easy. A system like YUM does almost as well as a fully automated system." Even the smallest site, running free or low-cost management software, believes "The tools we have work quite well for what we have to do."

The smallest host runs 90 servers with a single administrator; the largest runs 5000 servers with a pool of 32 people. Availability for the Linux systems is very high across the board, with uptime ranging from 99.9% to 99.999% (not including downtime due to customer-written, owned, or managed application code). Across all sites, the average MTTR is no more than 1 hour, with two sites reporting MTTR as 30-40 minutes.

The average salary for their administrators is less than \$60K, with the highest salary being \$72K, and the lowest being just \$35K. The average administrator has 7 years' experience managing Linux. In total, these enterprises spend only \$1,000 annually on training and consulting, yet each administrator manages on average 129 Linux servers.

The main management issues for these companies are software deployment, including patch and upgrade management. Several also cited security management, with one company specifically noting vulnerabilities arising from poorly developed customer code as a significant problem. Across these sites, 57 administrators spend 28 workdays per week managing patches, security, policies, storage, viruses, and spyware for over 7000 Linux servers – less than two minutes per server per week. On average, each administrator spends only seconds per server per week. Provisioning a new system takes on average just over 1 hour. Repurposing an existing server takes less than an hour. Migrating a system to a new server takes less than half an hour.

Where a SAN, NAS, or RAID array is used, storage utilization is as high as 90%, and according to one enterprise, "maintenance is not that intensive." Due to the nature of system hosting, where customers are allocated storage to use and manage (or not) however they decide, several of the sites have significant spare capacity. However, one administrator notes, "Drives are so large these days it tends to be a non-issue. It is more an issue of throughput – using multiple spindles provides a lot of space but allows higher throughput."

Most sites consider patch management to be the primary security issue. One site running many email servers is primarily concerned with spam, and only one site was significantly concerned with intrusion detection. As a smaller Linux-only host notes, "85% of illegitimate traffic is trying to break into Windows. I see a lot of worms trying to hit Windows ports, but that doesn't bother me, because I don't have Windows." None of the sites spends significant time dealing with Linux viruses or spyware.

## Enterprise IT Departments

The enterprises interviewed include a major national US bank, an entertainment and gaming developer, a large state university, a multinational computer peripheral manufacturer, and a European microchip manufacturer. Several are publicly listed companies, and total revenues are between \$3bn and \$30bn per annum, averaging almost \$16bn. They range in size from under 100 Linux servers to over 1600, with an average of 700 Linux servers under management. The number of supported users ranges from 3000 to several million. All except one enterprise also runs over 300 Windows servers.



These enterprises run a wide range of applications on their Linux systems, including online banking, email, game servers, distribution applications, student services, and engineering applications. All run various versions of Red Hat Linux, with two enterprises supporting multiple versions simultaneously. A variety of databases and web servers are in use, including Apache, JBoss, WebSphere, Oracle, MySQL, and PostgreSQL.

One site has a highly automated management environment, using software they have developed in-house. Management tools in use at other sites include RHN and YUM, and third-party software includes IBM Tivoli, CA-Unicenter, Semantec/Veritas, and Opsware. On average, these enterprises automate 90% of their Linux system management, and centralize 100% of their management effort, even though all the enterprises run Linux in multiple physical locations. Availability is very high, with the majority reporting 99.999% availability for their Linux systems. MTTR is as high as 4 hours for one organization, with the others reporting between 30-60 minutes on average.

The average salary for their Linux administrators is \$76K. The highest (at two different sites) is around \$95K, and the lowest is \$52K. The average administrator has over 7 years' experience managing Linux, and each manages 85 servers on average. One site has just one administrator for 150 Linux servers. Only the peripheral manufacturer spends anything on training, budgeting around \$25K annually. The other enterprises spend nothing on either training or consulting. The state university justifies this on the basis that, "There's so much stuff on the web. If you need to find out something ... you can just look it up. There are so many users – you can just Google anything. We don't have to pay for anything."

Their main management issues are provisioning, software distribution, and patch management. Two enterprises also cite application and performance management as issues. Across these sites, 33 administrators spend 7 workdays per week managing patches, security, policies, storage, viruses, and spyware for almost 3000 Linux servers – less than 2 minutes per server per week. On average, each administrator spends only seconds per server per week. Provisioning a new system takes on average just over 2 hours. Repurposing an existing server takes less than 25 minutes. However, migrating an existing system to a new server takes on average almost 3 hours.

The peripherals manufacturer "would not be able to manage without systems management," and several enterprises echoed this opinion. The state university is highly automated, and the administrator can "just watch the logs to see what got patched and updated." The major bank only does updates once per quarter, with four full time staff completing the updates across 1600 servers in 2 weeks.

According to the entertainment company, which has a very heterogeneous environment, "Linux is a more generic platform [than Solaris], it is easier to understand. It is not completely different ... but management is probably 10-20% less intensive." Comparing Linux to their Windows system, the peripheral manufacturer sees very little difference, saying, "Linux is normally more stable, we get fewer alerts generally, but setup and management is about the same." However, they are troubled by the frequency of Windows patches, claiming to do "about 1 patch on Linux for every 50 on Windows," adding, "patches for Linux and Solaris are very controlled, and managed on a precise clock, whereas Microsoft is all over the place, you never know what's coming."

At the large bank, the administrator is also concerned about Windows' disjointed approach to patching, and the resulting impact on availability, saying, "Windows management is incredibly frustrating. Whenever you do updates, you have to check for updates to the updates, and reboot, taking the service down for several minutes on enterprise iron." Stability is also a concern for the state university, where "for some reason, a Windows system will just start acting crazy – you need to shutdown the application and reboot. That never happens on our Linux servers."

Storage utilization varies from 65-90%, with the highest utilization coming from the peripherals manufacturer who has a "very tightly managed" SAN.

Again, security is not a significant issue. The peripheral manufacturer has significant investment in perimeter security, watching for viruses and attacks, but claims "the reason that's there is because we have Windows – without Windows, I wouldn't bother." The state university sees Linux as inherently more secure than Windows or Solaris, saying, "We don't have our systems broken into. When we ran Sun boxes, they were broken into regularly."

Overall, the peripheral manufacturer believes "Windows gets a lot more expensive due to all the things we need to do to keep it safe, protected." The state university reinforced this saying simply, "If cost is a concern, you go with Linux."

## Sophisticated Tool Users

The research also included interviews with several IT managers using sophisticated Linux management tools. The companies interviewed include a large US financial organization, a large US city university, and a national US retail company. One is a public company with over \$30bn in annual revenues. These companies run between 42 and 95 Linux servers, averaging 75 per organization, supporting between 5000 and half a million end users.

Each enterprise runs multiple versions of Linux, both Red Hat and SUSE, in some cases on multiple hardware platforms including both x86 and z/Series hardware. For example, one enterprise is running SUSE Enterprise Linux on z/Series, and Red Hat V2 and V3 on x86. Another enterprise supports three different versions of SUSE Linux ES (V7, V8, and V9) on their z/Series hardware. Other system software includes JBoss, WebSphere, Tomcat, WebLogic, Oracle, and DB2. The applications in production include web portals, email, and point of sale.

The sophisticated management tools in use include Levanta Intrepid M, Velocity Software's ESALPS, HP/OpenView, CA-Unicenter, Semantec/Veritas, and IBM/Tivoli. The enterprises have automated between 90-100% of their Linux systems management, and 100% is centralized. At least one site still relies on some scripting for critical functionality. The smallest site manages 42 servers with a single administrator. Others require as few as one administrator per 63 servers, with the average being one administrator for every 43 servers. Availability ranges from 99.99% to 100% – one site has not had any unplanned downtime since they first installed Linux in their z/Series environment. This same site therefore reports their MTTR as 0 minutes, while the other sites average MTTR of less than 20 minutes.

The average salary for their administrators is around \$75K, with the highest salary being \$95K, and the lowest being just \$42K. The average administrator has 7 years' experience managing Linux. Each administrator manages on average 35 Linux servers. In total, these enterprises spend only \$2,500 annually on training and consulting. The financial institution explains this, saying it is “easier to figure out problems in Linux than UNIX – you can always go and Google, and find someone who has had the same problems.”

Provisioning and patch management are the primary Linux management issues for these organizations. Across these sites, 35 administrators spend 7 workdays per week managing patches, security, policies, storage, viruses, and spyware for over 225 Linux servers – around 15 minutes per server per week. However, this includes most of a full-time resource managing storage across IBM mainframes, Solaris, Windows, and Linux systems at the large city university. Provisioning a new system takes 45 minutes on average. Repurposing an existing server takes less than half an hour. Migrating a system to a new server takes just over one hour. However, the city university, for example, takes no more than 13 minutes each for provisioning, migration, or repurposing.

Sophisticated management solutions greatly simplify Linux provisioning, patch management, and software distribution at all these enterprises. The city university is very happy because they can now “provision remotely wherever we want to be, and we can do it once, and not have to do it multiple times,” adding, “If you want to provision 1 or 1000 Intel blades, it is no work at all.” The nationwide retailer is impressed that it takes only minutes to apply large-scale changes, such as new FTP binaries. “It's very very quick ... because you can apply changes to whole groups of servers – you are not really installing a new FTP server, you do that ahead of time and simply point each virtual server to the new software. For simple changes, like binaries, just change your pointers and bam, you have it. [The management tool] takes care of everything.” The management tool reduces replication effort for the financial institution by standardizing widespread changes. “That saves us quite a bit of time, especially in backing up and applying patches,” but still allows them to set up unique servers – “sometimes when you cookie-cut servers, you get the whole kitchen sink – [the management tool] enables us to customize our environment.” The MIS manager from the city university declared that some of the more sophisticated features of their provisioning toolset were “really indistinguishable from magic.”

Storage utilization averages 75%, although the city university has only 50% utilization, because it has reserved a large proportion of their SAN for an impending deployment of a major new ERP application.

Security management effort varies. The city university spends less than 5 minutes a week in total. The financial institution, however, spends 10-15 hours per week (mostly managing user access manually due to their high turnover of contractors). None of these enterprises spends more than 10 minutes per week managing viruses and spyware.

## EMA's Conclusions

This research study shows, and in most cases quite clearly, that the resource costs and management requirements for Linux systems do not lead to a higher overall TCO for Linux environments. Many enterprises show great efficiency in managing Linux. Enterprises can improve their efficiency significantly by using running sophisticated management tools. In most cases, this study shows Linux is a highly cost effective alternative to Windows

This study found at worst a marginal difference in base resource costs between Linux and Windows. However, Linux resourcing becomes significantly less expensive when taking into account the ability of Linux to support larger numbers of users, and the additional productivity of Linux administrators. Linux resources are easy to find, and tend to be highly experienced. Overall, resource costs for Linux environments are therefore likely to be lower than for Windows. In addition, administrators who can manage both Windows and Linux command around the same salary as Linux-only administrators, bring added efficiency to mixed environments.

Acquisition costs of Linux are, without doubt, very low. For example, the difference in acquisition costs for a typical Linux-based web application stack, including both hardware and software costs, is over ten times less than for an equivalent Windows-based environment.

This study also found that Linux availability is very high. The cost of downtime is not a significant differentiator. Error recovery, when required, is also very efficient. The above-average response times for troubleshooting and resolving problems contributes to the high availability and reliability of Linux systems.

Management practices – including deployment, provisioning, patch management, software distribution, security administration, and storage management – do not add significant time and resource costs to Linux environments. Where enterprises use sophisticated management tools, these processes were substantially more efficient. Many such tools are available, and are in use at various Linux environments. Most Linux enterprises can benefit from the lower TCO these tools deliver.

Other potential TCO issues such as risk management, consulting costs, transition costs, vendor viability, and resource availability, are largely insignificant, due to the evolving maturity of Linux, and to the pioneering efforts of large-scale Linux users. Other enterprises, including Small and Medium Enterprises, should no longer perceive these as significant issues when contemplating deployment of Linux for their enterprise.

However, this study is not exhaustive, and does not mean that Linux is the best or correct choice for every implementation, application, or enterprise. The choice of platform must account for many more variables than just resource costs, management effort, or even TCO. Windows in particular has many available and proven applications. On the server side, Windows has made good inroads on UNIX, and has an opportunity to become a true enterprise platform. UNIX, while it has lost ground to Windows, remains a strong contender on the server, with proven stability, scalability, and application durability. Mainframe operating systems also continue to defy their critics, and IBM's z/OS in particular maintains a stronghold in the large enterprise server category with massively scalable architecture and applications. Enterprises should examine their specific needs and use this data as a starting point before deciding on an enterprise platform.

However, EMA's research and analysis has found that average resource costs for Linux are no longer significantly higher than for Windows. The effort required to manage Linux systems, especially where sophisticated management tools are used, is of minimal concern when considering the overall TCO of Linux systems. In many cases, Linux is likely to be a significantly less expensive platform to acquire and maintain than Windows.

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