Windows 2000 Versus Linux in Enterprise Computing

An Assessment of Business Value for Selected Workloads

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Analysts: Jean Bozman, Al Gillen, Charles Kolodgy, Dan Kusnetzky, Randy Perry, and David Shiang

IDC OPINION

Linux is widely regarded as "free" because there is no or little cost associated with software acquisition. However, after taking into account all costs, notably IT staffing, does Linux truly come at a lower cost than competing platforms, such as Windows?

IDC has completed a study of five common workloads in enterprise computing that challenges the common industry perception that Linux is "free." Our in-depth study suggests that Microsoft Windows 2000 offers lower total cost than a Linux solution in four of the five workloads common to most corporate IT environments. In these four workloads (network infrastructure, print serving, file serving, and security applications), the cost advantages of Windows are significant: 11–22% less over a five-year period.

The cost advantages are driven primarily by Windows' significantly lower costs for IT staffing, generally the largest single component of IT costs. For the fifth workload, Web serving, Linux had a cost advantage of 6% compared with Windows 2000 over the five-year period.

IDC's study confirms that low initial software acquisition costs are only one factor, not the deciding one, in determining the five-year total cost of ownership (TCO) for the two operating environments.

EXECUTIVE SUMMARY

This study compares the five-year total cost of ownership (TCO) of Microsoft Windows 2000 server environments with that of Linux server environments (from multiple Linux vendors) at 100 different North American companies. Consideration was given to the following five unique workloads:

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- Network infrastructure
- File serving
- Print serving
- Web serving
- Security applications

The bottom-line results of users interviewed in this research effort show that the Microsoft Windows 2000 environment offered a comparable, if not superior, five-year TCO advantage in four of the five workloads, the exception being the Web-serving workload. Table 1 shows the overall findings.

Table 1: Windows 2000 and Linux Server Environment Five-Year Total Cost of Ownership by Workload ($)

	Windows	Linux
Networking	11,787	13,263
File	99,048	114,381
Print	86,849	106,989
Web	32,305	30,600
Security	70,495	90,975

Source: IDC, 2002

The TCO metrics are described in terms of five-year costs for 100 users. IDC's TCO methodology, which is described at length later in this document, takes into account the costs of acquiring and supporting the hardware and software required for each of these specific workloads. Costs are broken out into six categories: hardware, software, staffing, downtime, IT staff training, and outsourcing costs.

This study strongly suggests that IT professionals who are considering deployment of the workloads evaluated should consider far more than the acquisition costs of the technologies that they are investigating. Other factors, such as strategic IT choices, company standards, IT staff skills and competencies, application availability, application deployment, and performance considerations, should be considered as part of a total platform evaluation.

IT professionals who are considering the broader strategic deployment of Linux within their IT environments, in particular, should carefully consider these findings and examine all aspects of the cost associated with Linux server systems. Many drivers of cost need to be

uncovered in such an examination and evaluation, and the "risk/return" trade-offs of Linux versus Windows may not be as obvious as they appear at first glance.

KEY FINDINGS

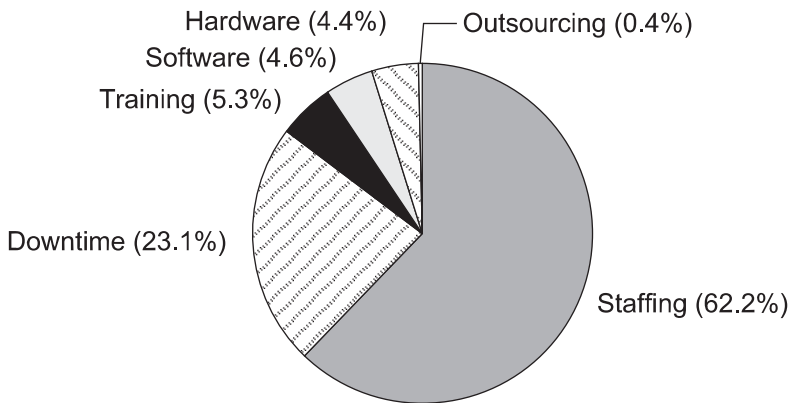
Savings of Maturity

IDC TCO studies often find that mature computing platforms have an advantage in cost measurements. This is not surprising because shrinking costs are a direct result of the experience that customers have with an existing server operating environment, associated hardware and systems software platforms, and applications and software tools. Mature environments also tend to ensure more readily available, skilled IT professionals on the open market, resulting in a depth of knowledge and expertise that cannot be duplicated by emerging platforms.

Staffing Costs Greatest Contributor to Cost

For all of IDC's workloads studies — with the notable exception of Web serving — by far the most significant cost areas were associated with staffing (see Figure 1). The largest component of total cost was not related to the initial purchase of hardware and software, but to ongoing labor-intensive support and related costs. The average cost breakdown over five years showed that staffing accounted for 62.2% of total costs, with downtime coming in second, at 23.1%. Training, software acquisition and upgrades, and hardware acquisition and upgrades claimed approximately 5% each; outsourcing amounted to 0.4%. These findings are consistent with studies that IDC has conducted in the past. In most of the workloads considered in this and other studies, software and hardware costs were relatively insignificant when considered as part of the five-year TCO for 100 users.

Figure 1: Server Environment Average Five-Year Total Cost of Ownership by Cost Category



Source: IDC, 2002

This study shows that a distinct gap exists between the support costs associated with Windows and Linux platforms, with Linux support costs exceeding those of Windows in every case. IDC believes that this differential in staffing costs is a result of the management tools available to support Linux being less mature than those used for Windows 2000. Therefore, typically more work is required to configure, program, and support Linux server environments.

Manageability Issues and TCO

Staffing costs are directly related to the routine time and effort required on the part of IT staff to manage, maintain, troubleshoot, and restore the system operations of a given server running a given operating system and workload. In this study, IDC found that the staffing costs for Linux servers were, in almost every case, higher than for systems running Windows 2000 Server.

We believe that these higher costs are, in part, related to the relative immaturity of the management tools available today for Linux systems and are possibly also due to less complete penetration of these tools into organizations deploying Linux servers today. Over time, the gap in support costs between Linux and Windows will contract. Additionally, as Linux matures and more packaged software becomes available in the Linux server market, IT professionals will become more skilled in the efficient installation, deployment, and maintenance of Linux server environments.

IDC's system management research suggests that system management tool vendors are proactively moving to support Linux. In most cases, these vendors are treating Linux like "another version of Unix." Examples of products that either support Linux today or will support Linux in the near future include BMC Patrol, CA Unicenter, HP OpenView, IBM Tivoli, and Novell ZENworks. The advantage of products from these vendors is they are typically multiplatform solutions that treat Unix, Linux, and Windows in a consistent fashion. Even such companies as NetIQ, long known as a Windows-specific vendor, have begun to support Unix and Linux. It should be noted that the tools cited here are not open source technology and, therefore, generally are not available for free.

Of course, the system management tools associated with Windows 2000 Server environments are not standing still. Both Microsoft and its independent software vendor (ISV) partner community, which produces numerous Windows systems management tools, continue to invest heavily in products that simplify the management of Windows servers. Also of course, Microsoft's base operating system continues to see significant improvement. While IDC does not anticipate another quantum leap in manageability coming from the launch of Windows .NET Server 2003 — as we did see in Windows 2000 when compared with Windows NT 4.0 — the Windows platform will continue to be a moving target.

A Workloads Discussion

Another interesting aspect of the analysis is that, as expected, a clear difference exists in the number of workloads running on each type of server system. Our study found that Microsoft servers tend to

run more workloads per server than Linux systems typically carry. This is not surprising, given the relative maturity of the Windows 2000 environment and the abundance of packaged applications ready to run on it. However, this factor is likely exaggerated by the selection of Windows 2000 servers in this study because IDC did not consider servers running Windows NT.

It is likely that this gap in number of average workloads per server between Windows 2000 and Linux servers will narrow over time as Linux applications become more pervasive, as more ISV software packages and solutions are ported to Linux, and as the scalability of Linux improves.

The Cost of System Downtime

This study quantified the impact of unplanned downtime in two ways:

- The costs for the IT staff to restart, fix, or reconfigure a malfunctioning server, which is a product of the frequency of downtime incidents, the mean time to repair, and the salary paid for the support personnel to accomplish this work
- The cost to the organization in terms of lost end-user productivity, which is a product of the hours that users are affected by downtime, the number of users affected, and the salary paid for those unproductive hours.

IDC found that, for both Linux and Windows servers, the cost of lost productivity in the form of downtime was the second-largest cost component after staffing costs — despite remarkably low downtime rates. We did not investigate the causes of downtime to determine the relative impact caused by hardware failures, software failures, inexperienced users, and poorly designed or managed networks.

Downtime impact varied significantly by workload. Highly interactive end-user applications, such as print, averaged 1.75 downtime hours per month across both Linux and Windows environments, while security applications experienced only 0.52 hours per month.

To illustrate the effects of data normalization, IDC calculated average user productivity uptime. This value is based on operational time of systems, which excludes any consideration for scheduled downtime. Note that this calculation is based on total values collected in this study and does not reflect any singular workload described herein. The value is calculated through the following formula:

$$\frac{\text{(Planned uptime x users supported)} - \text{(Downtime x users affected)}}{\text{(Planned uptime x users supported)}}$$

For most workloads, Windows servers experienced higher downtime, with an average availability of 99.995%, compared with Linux, at 99.998%. The lower downtime figures for Linux appear to be attributable to two factors. The first factor is that the Linux systems measured in this analysis tended to carry smaller numbers of workloads per system. The added complexity and interaction between applications on Windows servers could increase unplanned downtime.

The second factor is that many of the Linux sites deployed their servers in clusters, which did not decrease the incidence of downtime but did lower the impact on end users. Failover systems shield the end user from experiencing drops in availability.

Acquisition Costs and Number of Processors

Not surprisingly, hardware and software acquisition costs showed a general trend that favored Linux systems. However, IDC notes that, with the exception of the Web-serving workload, software acquisition costs remain a minor part of the total five-year costs per 100 users, accounting for less than 10% of the total. IDC also notes that combined hardware and software acquisition costs, for all workloads except Web serving, accounted for less than 15% of the total cost of the configurations examined in this study. In nearly every situation, acquisition costs for both software and systems were a distant third to labor and downtime costs.

Linux software costs were far lower than Microsoft software costs in most cases. However, since the Windows 2000 environments were, in general, shown to be more cost effective over a five-year usage period, it appears that low initial software acquisition cost is not the critical factor in swinging five-year TCO values in favor of either operating system. We examine this topic in more detail later.

IDC believes that an important reason for the lower hardware costs typical of Linux server configurations is the fact that Linux servers are usually one or two processor systems that perform relatively simple tasks on the edge of networks. Many Linux servers are purchased as "thin" servers — which are typically one or two processor systems — thus enhancing the perception of lower cost of ownership for Linux servers. In comparison, in parallel with the fact that Windows servers tend to carry greater numbers of more complicated workloads, the hardware to support a typical Windows server system had a slightly higher likelihood of being a two-way or four-way system.

However, as Linux matures as an operating system, it will likely be able to run on more scalable servers (four to eight processors, for example). If Linux software grows in complexity, it is also likely that the hardware costs to support the more complicated server platform will also increase. As a result, the average hardware cost of the typical Linux server will likely increase over time.

TCO Results Are Only One Factor in Platform Selection

Although IDC found that Windows 2000 generally had a total cost advantage ranging from 13% to 22% compared with Linux, this advantage is not always, in and of itself, a compelling reason to initiate a move from one platform to the other. IDC notes that evaluating such a move would require a return on investment (ROI) justification as well as a compelling TCO metric. Additionally, a host of other factors, some of them difficult to quantify, must be considered as part of a decision about operating environments.

Attaining a reasonable ROI during a transition from one operating environment to another can be difficult when the TCO values that are associated with each of the compared platforms are relatively close — as is the case in our comparison of Linux and Windows 2000. Therefore, where platforms are currently in use within an organization, continued use of those platforms often makes a great deal of economic sense.

PROJECT SCOPE AND METHODOLOGY

Scope of Study

This study covered Linux and Windows 2000 running on general-purpose systems. In order to make comparisons more balanced, IDC did not evaluate appliance servers, which are dedicated systems that run combinations of vendor-installed operating system software and applications. Examples of included systems are security servers, firewall servers, caching servers, and proxy servers from companies such as Dell, Sun/Cobalt, HP, IBM, and others. Users do not have to modify the system software in any way prior to deployment, eliminating the need for application development and professional staffing for application deployment.

Methodology

User Demographics and System Configurations

To obtain the TCO data used in this analysis, IDC interviewed, by telephone, IT executives and managers at 104 North American companies. The companies interviewed for this analysis generally considered themselves "late adopters" of technology — not risk takers — so their Linux workloads consisted of routine server tasks. Interviewees were selected at random from a list provided by *Network World*, an IDG publication.

IDC asked each interviewee about a specific workload (file, print, security, Web, or networking) and a specific server (Windows 2000 or Linux). In some cases, interviewees provided information on multiple workloads or multiple servers. Occasionally, IDC conducted multiple interviews within a single company. Most of the larger companies had heterogeneous environments that included Windows 2000, Windows NT, Linux, and Unix. Nearly 40% had both Microsoft and Linux servers.

TCO, ROI, and Business Value

It is important to clarify that, in this study, IDC evaluated TCO, as opposed to ROI. TCO measures cost outlays over a specific time period, and it is a primary method of weighing alternative purchase decisions. This measure is used especially to compare systems running basic infrastructure workloads. Not surprisingly, these basic infrastructure workloads also represent a highly price-competitive environment for software and systems vendors. ROI, on the other hand, measures the specific benefit that one expects to achieve by investing in a new technology, product, approach, and so on.

It is important to weigh all the factors contributing to cost when evaluating the TCO for any given system. These factors include initial acquisition costs for hardware and software, the ongoing cost of IT staffing, the outsourcing costs associated with deployment, support, or maintenance, and the cost of system downtime, which adversely affects end users' ability to access applications and data.

IDC's TCO studies frequently find that the most significant expense area is ongoing IT support costs, and this labor-intensive cost component lessens the overall impact of initial software and hardware acquisition costs as time goes by. An environment that has integrated infrastructure software and performance tools, more mature administration and operations tools, and readily available expertise would generally have an advantage over an operating environment that does not have these attributes because greater integration can have a direct, positive effect on IT support costs.

To quantify operational costs, IDC measured the total cost of creating, deploying, and maintaining a computing infrastructure to support 1,315 users of specific workloads and then projected the costs over a period of five years. We then took snapshots of the total costs at the three- and five-year marks. The total cost includes costs related to staffing, programming/development, configuration, installation, optimization/tuning, and ongoing maintenance. Both IT staffing and user productivity are included as costs. IT staff productivity accounts for the time IT staff is engaged in activities that are not contributing to the business, specifically training and responding to outages. User productivity can also be measured by studying how often the systems go offline and by measuring the effect of that downtime on end-user work.

Of course, additional factors that are more difficult to quantify are at play in any IT evaluation. IDC uses the term "business value" to take into account these factors as well as measurable TCO results. Nonquantifiable (or difficult to quantify) factors include strategic IT choices, adherence to standards, asset management, application availability, application deployment and deployment, and performance considerations. Additionally, longstanding relationships with hardware and software suppliers may carry more weight in a decision about the components of a specific, single system than would the TCO of that single system.

Major Cost Factors

IDC captured the total costs to deliver network, file, print, Web, and security applications to an environment of 1,315 users growing to 1,597 users (about 4% growth per year) over five years. The following were the major cost components:

- Hardware:
  - Purchase: acquisition of the hardware only
  - Installation: costs to initially set up the server and for annual hardware upgrades
  - Maintenance: external and internal costs to support hardware

- Software (operating system):
  - Purchase: costs of the operating system stripped out from the total server costs
  - Installation: costs to initially deploy the operating system and for annual upgrades
  - Training: external costs for initial training of IT staff, specifically on the operating system
  - Maintenance: external and internal costs to support software
- Software (applications): total costs for applications specific to each workload
- Software management: management software costs allocated across all workloads based on the IT staffing breakdowns
- Staffing: annual loaded salary, which includes cost for overhead and bonuses
- Outsourced services: IT services to support and maintain servers
- Annual IT staff training: fees for outside trainers as well as the productivity loss of staff for time spent in training
- Downtime:
  - User productivity: hours of downtime multiplied by 40% productivity factor multiplied by annual loaded salary (The productivity factor allows us to recognize that users are not 100% nonproductive during network outages.)
  - IT staff productivity: time the staff spends identifying and fixing the causes of outages multiplied by loaded salary

Normalization and Presentation

Ultimately, the value of any TCO analysis lies in its utility to the IT buyer. For it to be useful in the buying decision, the analyst must take information from very different environments and standardize it so that IT buyers can compare their own environments with the standard.

To ensure that the two server environments are compared fairly, IDC normalized all costs on a per-server basis for the average number of users and workloads. For example, in Web-serving workloads, Linux environments averaged 314 users per server, whereas Microsoft averaged 168. When comparing costs, we assumed the costs of 1.87 Microsoft servers for every one Linux server. Likewise, on a per-server basis, Microsoft servers were running 1.67 workloads for each workload run on a Linux server.

IDC presents the TCO findings on a per-100-user basis so that companies of all sizes can relate the costs and benefits of the study to their environments.

Windows 2000 Versus Windows NT 4.0

IDC focused on Windows 2000 environments using data from companies with pure Windows 2000 environments or mixed Windows environments where servers running Windows NT accounted for 20% or less of the total Windows systems. The makeup of the systems within the study sample is dominated by single and dual processor configurations. Four-way SMP systems accounted for 8% of the Windows sample.

Linux System Configurations

Linux data typically consisted of a Linux distribution (e.g., Red Hat, Caldera, and SuSE) running on standard Intel architecture servers. Table 2 shows the server configurations by operating environment.

Table 2: Windows 2000 and Linux Server Environment Server Configurations (%)

	Windows	Linux
One way	53	55
Two way	39	45
Four way	8	0

Source: IDC, 2002

A DETAILED REVIEW OF WORKLOADS STUDIED BY IDC

This section examines the detailed models for each workload. Table 3 presents the TCO values obtained for each of the five workloads, with costs broken into six categories: hardware, software, staffing (mainly full-time-equivalent personnel per 100 users), downtime, IT staff training, and outsourced costs.

Table 3: Windows 2000 and Linux Server Environment Five-Year Total Cost of Ownership Summary View for 100 Supported Users by Workload and Cost Category ($)

	Networking		File		Print		Security		Web	
	Microsoft	Linux	Microsoft	Linux	Microsoft	Linux	Microsoft	Linux	Microsoft	Linux
Hardware	1,211	1,004	5,703	3,139	1,173	2,172	1,653	2,041	7,087	3,006
Software	211	940	3,988	1,009	1,665	340	5,829	6,609	7,107	1,390
Staffing	8,392	8,201	54,030	81,204	40,247	59,080	50,609	71,056	15,102	23,015
Downtime	1,412	1,494	30,133	20,788	38,857	39,746	10,335	4,385	1,646	1,541
IT staff training	534	677	5,191	7,670	4,787	5,282	2,000	6,445	1,304	1,584
Outsourced	26	946	3	570	121	369	49	440	59	64
Total	11,787	13,263	99,048	114,381	86,849	106,989	70,495	90,975	32,305	30,600

Source: IDC, 2002

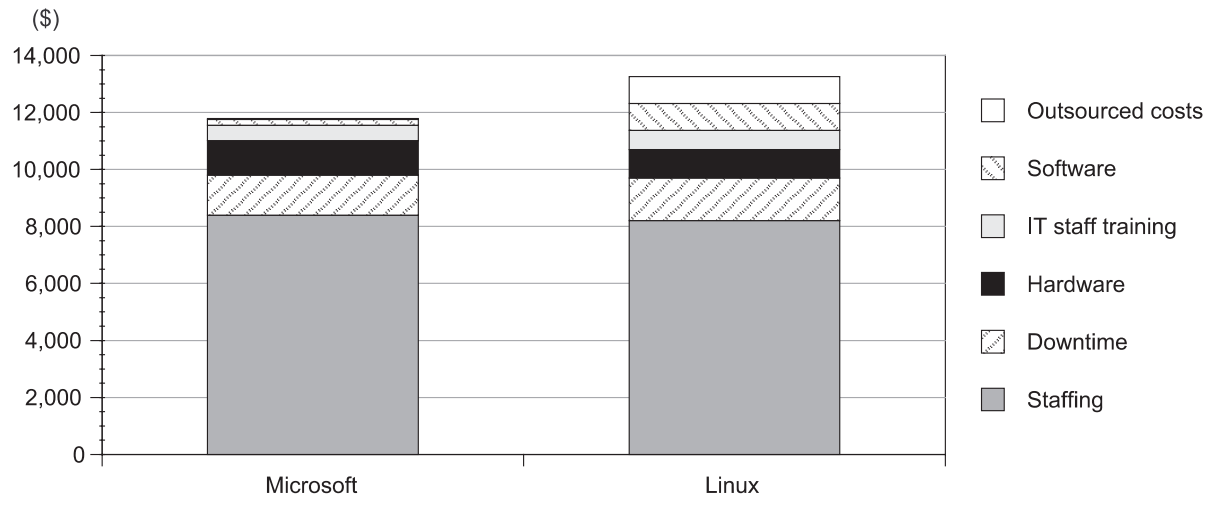
Networking Workloads

Networking workloads include systems that provide the basic infrastructure services consumed by typical business networks. This category includes solutions offering such services as dynamic host configuration protocol (DHCP), domain name system (DNS), Windows Internet Naming Service (WINS), as well as directory services and caching services. This workload also includes remote access/application sharing servers and traditional servers that are used as routers, hubs, and switches. (This study excluded devices, such as dedicated routers, hubs, and switches, that were not built on general-purpose server operating systems.)

A high-level view indicates that the five-year TCO for both the Windows and Linux network workloads was relatively low, amounting to only $12,000–13,000 per year for 100 supported users. By comparison, other workloads evaluated in this study show a cost of $30,000 to more than $100,000 per year for 100 supported users over a five-year usage period. Windows 2000 was 11% less expensive per 100 users over a five-year ownership period compared with a similar solution based on Linux. Specifically, Windows came out to $11,787, lower than the $13,263 recorded for Linux environments.

For both Windows 2000 and Linux, the number 1 cost item was staffing, which accounted for 71% of the costs in the Microsoft platform and just under 62% of the costs in the Linux platform. Other costs were effectively equal on a percentage basis between the two environments, while hardware costs were slightly higher for Microsoft environments than for Linux. Figure 2 shows the detailed breakout of specific costs involved in the network infrastructure workload.

Figure 2: Server Environment Network Infrastructure Workload Five-Year Total Cost of Ownership by Cost Category



Source: IDC, 2002

What is most interesting about the network infrastructure workload was the nature of the remaining cost categories. Software in the Linux category was 7% of the TCO value over a five-year period, while in the Windows 2000 environment, software costs only accounted for 1.8% of the TCO over the same five-year period.

Outsourcing costs (which incorporate installation at an outsourced location, upgrades, application development, colocation, and operations) showed a similar difference, accounting for 7.1% of the Linux TCO and only 0.2% of the Windows 2000 TCO. At a deeper level, this study found that operating system software costs were roughly equal for Linux and Windows, but that purchased management software and application software costs for Linux far exceeded software costs for Windows.

One possible reason for the comparably high management software costs is that, in many instances, customers custom build the software tools that are used to manage Linux server systems. Once again, the lack of maturity of the overall Linux environment, coupled with the rarity of packaged system management software for Linux, exacerbates this problem. In time, IDC expects a more mature Linux ecosystem to develop, including management tools and system management framework products ported to the Linux server environment.

This difference in application software costs between Linux and Windows servers suggests that users were deploying the Linux systems either for network infrastructure workloads, for which there was no open source application software available, or had chosen to forego open source application packages and, instead, purchase commercial software. One example of how such a scenario could play out would be for a system intended to provide directory server service. In the case of Windows 2000, this is an included feature, whereas for Linux, a user would need to deploy a commercial directory server package such as IBM's Directory Server, Novell's eDirectory, or Sun ONE Directory Server.

IDC believes that the network workload TCO benefit that Windows offers is an important factor to consider in a side-by-side evaluation. However, companies should remember that the application software cost for the precise workload deployed will have a direct and significant influence on ultimate TCO figures. Additionally, companies should keep the relative cost in perspective because this workload accounts for just a fraction of the overall five-year cost of ownership for 100 supported users for both Linux and Windows supporting other workloads examined by this study.

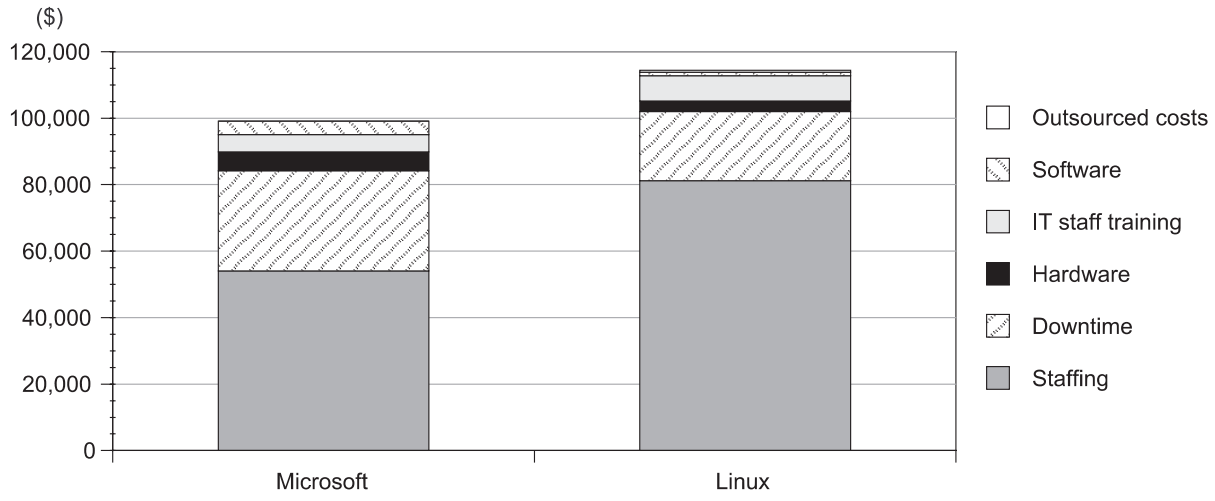
File Serving Workloads

For this study, IDC split the file and print functions into two separately measured workloads. This approach is in keeping with the practice at many organizations of utilizing separate banks of print servers and file servers, allowing each function to grow as needed without affecting the other function. This also allows file service information to be archived without requiring sophisticated procedures for excluding transient print information.

File server workloads include services such as file transfer protocol (FTP), file sharing using the network file system protocol (NFS), and file sharing using the common Internet file system (CIFS). In this study, file workloads specifically exclude network attached storage (NAS) devices because these dedicated devices generally are not built using standard server operating systems and general-purpose hardware.

For file serving workloads, Microsoft Windows 2000 server configurations showed a five-year cost for 100 users to be 13% less expensive when compared with similar solutions based on Linux (see Figure 3). From a cost perspective, the five-year TCO for Windows 2000 environments is projected to be $99,048, lower than the $114,381 recorded for similarly sized Linux environments. For file workloads, the five-year TCO for hardware, software, and outsourced costs collectively amounted to less than 10% of the total value for both Windows 2000 and Linux environments.

Figure 3: Server Environment File Serving Workload Five-Year Total Cost of Ownership by Cost Category



Source: IDC, 2002

For file serving workloads, staffing costs were the single largest cost factor influencing the TCO values achieved by this study, which found staffing costs to account for between 55% and 71% of the five-year TCO for 100 supported users. In fact, Linux staffing costs were 50% higher on a dollar basis than were Windows staffing costs. IDC believes this is another example of how a relatively new operating environment is unable to offer the same ease of management that is available for an incumbent, well-known operating environment.

For both Linux and Windows environments in file serving, downtime costs were the other big line item, with downtime costs accounting for 25% to 36%, respectively, of the five-year TCO. Taking a closer look at the data, IDC can state that, despite the vast improvements of

Windows 2000 over Windows NT, the downtime associated with Linux servers is considerably less — often well less than half the downtime that users experience with Windows 2000.

The fact that Linux file servers had less downtime than Windows file servers could relate to the trend of Linux systems' carrying smaller numbers of workloads, while Windows file servers tend to support a higher number of workloads per system. This added complexity and interaction between applications could increase the risk of planned and unplanned downtime.

Calculating the actual cost of downtime, we found that Windows 2000 systems benefited from the multiple workloads because the number of users per workload tended to be lower than with Linux systems, which were more heavily leveraged on a per-workload basis. Thus, when multiplying the number of users affected by downtime against downtime cost, we found that the higher number of users on Linux systems for file workloads narrowed the downtime costs comparison.

Interestingly, for file workloads, the five-year TCO for hardware, software, and outsourced costs collectively amounted to less than 10% of the total value for both Windows 2000 and Linux environments.

Print Workloads

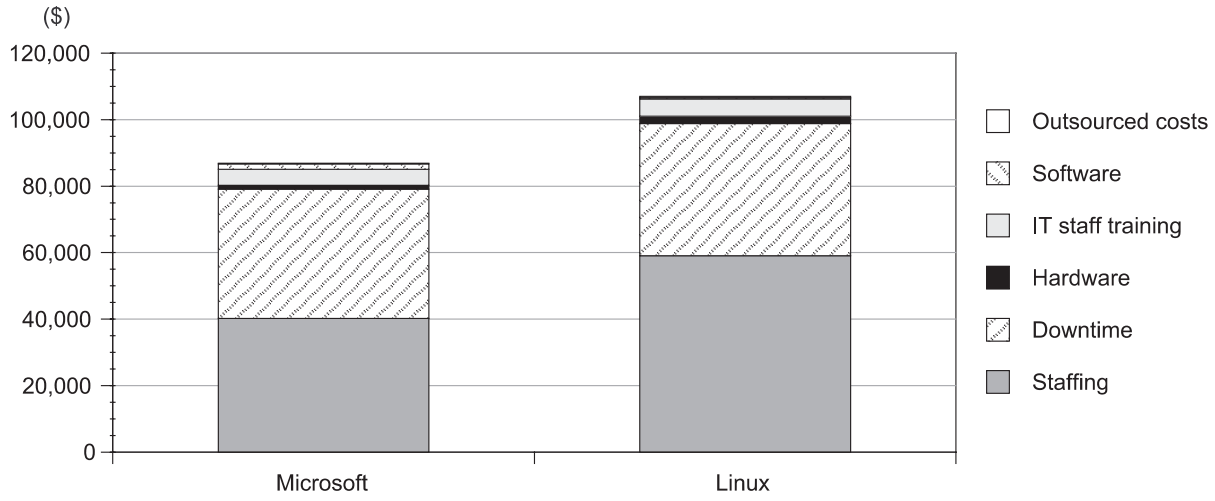
Print server workloads include print stream protocols such as Windows' native print service, Internet printing protocol (IPP), and foreign protocols including line printer daemon (LPD) for Unix and Linux clients and AppleTalk for Macintosh systems. Print servers configured with Windows 2000 achieved a five-year TCO of $86,849 for 100 supported users, compared with $106,989 for Linux, giving Microsoft a 19% lower TCO than Linux could offer.

Figure 4 illustrates the five-year TCO values for print serving workloads. As IDC found with file serving workloads, staffing and other costs (including downtime and training costs) together accounted for the vast majority — for this workload, more than 95% of the five-year TCO expense. However, unlike file workloads, for which staffing costs exceeded all other cost items by 20% or more, the print workload's major cost items were closer to being split equally between staffing and other costs.

In the case of Windows 2000 environments supporting print workloads, the "other" costs line item — for which the greatest contributor was the high cost of downtime — unseated staffing costs as the single most expensive element in a five-year usage period. In no other workload or platform did any cost item displace staffing as the single most significant component in a five-year TCO calculation.

While other costs did not displace staffing costs for Linux as the leading factor, the spread on these cost areas was far closer than on any other workload. The message here seems to be that print workload TCO is directly related to the amount of downtime experienced by supporting servers. Managing the downtime factor can have considerable influence on lowering TCO for either of these environments.

Figure 4: Server Environment Print Serving Workload Five-Year Total Cost of Ownership by Cost Category



Source: IDC, 2002

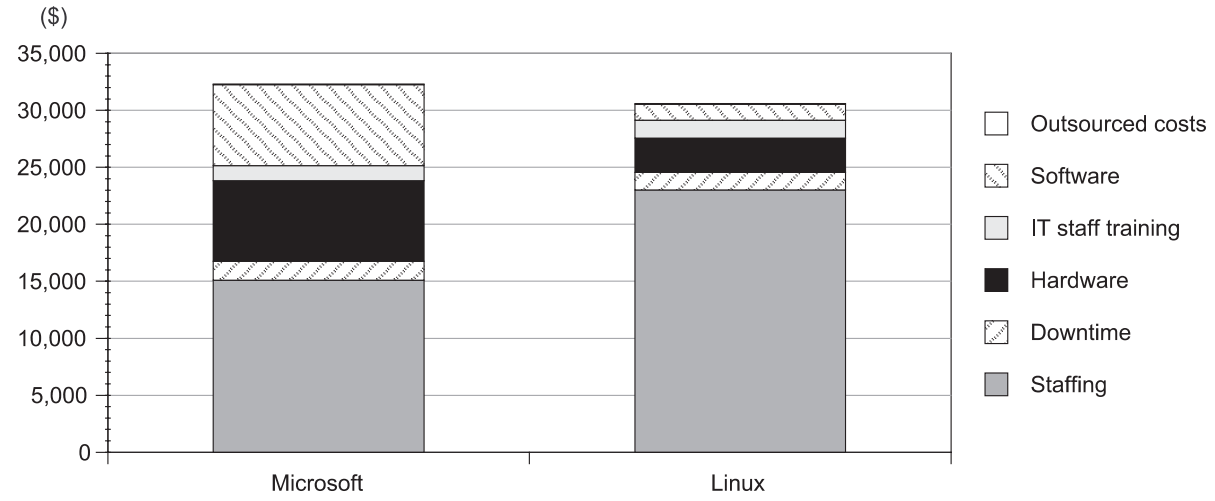
As with file serving, the tendency for Linux systems to carry smaller numbers of print workloads, while Windows file servers tended to support higher numbers of other workloads per system, likely added complexity and interaction between applications that could increase the risk of planned and unplanned downtime. Additionally, the effect of a higher average number of users connected to Linux systems raised the calculated downtime cost for Linux servers in this study.

Web Workloads

Since the category of Web server is broad enough to span many different types of deployments, for this analysis, IDC's definition of Web serving covers Internet, intranet, and extranet Web servers delivering both static and dynamic Web pages. This definition would include Web servers delivering HTML pages (generally described as static Web pages) as well as Java server pages (JSP), active server pages (ASP), PERL, and PHP pages. The analysis did not include large-scale Web hosters, nor did it include Web pages as front ends for back-end line of business (LOB) and database applications.

The Web workload was the one area in this study for which the TCO values for Linux servers were lower than those for Windows 2000 servers. This study found Windows 2000 to be 6% more expensive in its five-year TCO for 100 users compared with a similar solution based on Linux. For Web workload environments, Microsoft Windows 2000 server environments showed the cost for 100 users to be $32,305, compared with $30,600 recorded for Linux environments, over a five-year period (see Figure 5).

Figure 5: Server Environment Web Workload Five-Year Total Cost of Ownership by Cost Category



Source: IDC, 2002

The Web workload is unique beyond the fact that it was the only one in which the Linux five-year TCO was lower than that of Windows 2000. This study found this workload to also be the second least expensive workload to support overall, but it was the one with the highest relative costs for hardware and software acquisition.

Looking more deeply at these cost items, we found that software costs on Windows 2000 represented 22% of the five-year TCO total, while hardware costs represented another 22% of the five-year TCO for 100 supported users. No other workload on either platform had hardware/software costs remotely approaching this total.

The Windows software costs were largely attributable to acquisition of the operating system, which accounted for 16% out of the 22% total software cost for the five-year TCO.

Meanwhile, Linux showed a similar trend, although the acquisition costs for software and hardware were not nearly as high on either a percentage basis or a real-dollar basis. Nevertheless, the combined hardware/software costs for the Web Linux platform were among the highest recorded for all the workloads studied on Linux.

One big factor, staffing costs, was nearly 30% higher for the Linux platform than for the Windows platform. In fact, it was only because of the huge savings on initial software and hardware acquisition costs that Linux edged past Windows 2000 in this workload component of the study. IDC's interpretation of these results is that Linux acquisition costs are very low, as would be expected, but support costs for Linux are much higher than for Windows 2000. Support costs have been found consistently to be a major cost item for workloads supported aboard Linux in this study, so it comes as no surprise for the Web workload.

The question remains: Why are Windows operating system software acquisition costs relatively high for this workload? One possibility is that factors such as the tight integration between Internet Information Server (IIS) and other Microsoft technologies, including SQL Server and Active Directory, are being factored in as an operating system expense by users who see these components as part of an IIS solution — not as independent application software. A low expense for related application software recorded by this study does not allow for costs that would be incurred by using other Microsoft products to support such a solution.

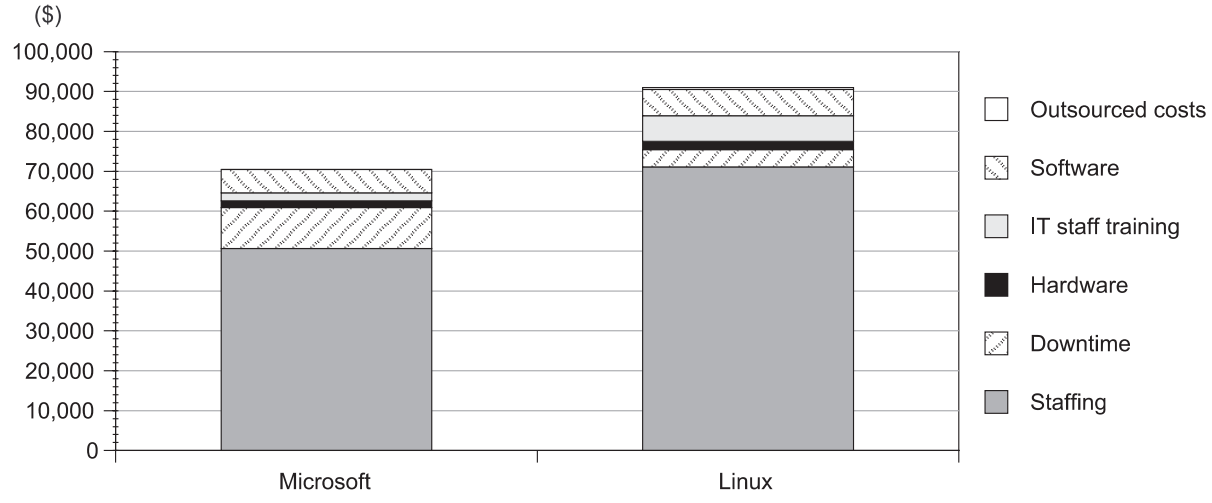
Security Workloads

One of the best examples of the subtle TCO advantages of using Windows 2000 instead of Linux is the security workload configuration. In this area, Windows 2000 servers posted an appreciable benefit over Linux servers, with a comparison of five-year TCOs for 100 supported users showing Windows costs at $70,495 and Linux costs at $90,975. This represents cost savings of 22.5% for Windows 2000 compared with Linux in this workload.

For this analysis, security workloads include servers offering a variety of services, including firewall services, support for virtual private networking (VPN), intrusion detection services, antivirus management services, authentication, access, and authorization services (including both certification and digital rights management services). This study considers those situations in which users add applications to standard server configurations for security-related functions but excludes comparisons between servers running Windows or Linux along with security application software and dedicated Linux-based security appliances in which the manufacturer installs the application software.

Figure 6 illustrates the five-year TCO values for security workloads.

Figure 6: Server Environment Security Workload Five-Year Total Cost of Ownership by Cost Category



Source: IDC, 2002

In support of security server workloads, staffing was once again the largest single component contributing to the TCO. Linux staffing costs amounted to nearly 78% of the five-year value, while Windows staffing costs were 72%. The only other cost component of the security workload that registered in double digits was cost of downtime, once again showing itself to be the chief factor for raising that cost component for Windows 2000 platforms.

In keeping with the challenges of conducting a fair "apples to apples" comparison between Linux and Windows TCOs, security server deployment, as with the other workloads studied, reflected the trend of Linux usage for single-purpose servers. IDC research from other studies confirms that the vast majority of Linux security deployments are associated with closed security appliances. Because this study did not ask about specific security hardware configurations, we cannot say exactly how many of the security servers surveyed were appliance servers. This affects the hardware pricing input to the IDC TCO model in that most appliance servers are priced less than general-purpose servers.

For security serving in particular, IDC has found that most users are typically not concerned about the choice of operating system (since the operating system is "buried" inside the server appliance). However, they do care about the products' performance. In order to decrease complexity for the end user, Linux appliance servers are configured to run with little interaction from the user, so they're difficult to compare with general-purpose servers running Windows, Unix, or another operating system. Although Microsoft offers its own appliance server that is capable of supporting security workloads, many vendors building such appliances choose such operating systems as Linux and BSD Unix (Free BSD or Open BSD) because they do not carry any royalty payments. Vendors can also optimize these operating systems for security and performance through the tuning of system software.

Major security vendors have been slow to provide enterprise software products that run on general-purpose servers using Linux. These vendors have historically concentrated on Windows or Unix operating systems. Commercial, enterprise operating systems are the preferred avenue for security software vendors because of their extensive deployment within the enterprise. Since users have a strong understanding of the operating system, security vendors don't need to concentrate as much on upgrades, configurations, and patches. Although there are many open source security packages available for Linux, few commercial security solutions exist for the Linux server platform. However, vendors are slowly rolling out Linux client security software, and as Linux moves into the enterprise, security vendors will utilize the platform that users select.

Other factors, not just cost, are considered when customers select operating systems for their security workloads. When it comes to security, some customers will select based on philosophical preferences. Many prefer to use open source–based software because they can work directly with the source code. This offers them more flexibility in hardening the operating system or in the customization of the security solution.

IDC believes that the TCO advantage for Microsoft over Linux server security workloads makes for a strong business case. This advantage should remain for a number of years because the deployment of Linux software security applications will take time. The real issue isn't so much what operating systems to use in serving security applications but instead is the replacement of servers with dedicated security appliances. It is here that the open source operating systems have the greatest influence.

CHALLENGES AND OPPORTUNITIES

IDC expects the current computing environment and the available platform choices to continue to evolve over the next several years. Neither Microsoft nor Linux advocates will stand still; both groups will address customer demands and make their products more usable and cost effective. It is entirely possible that enough cost factors will change over time to narrow the gap between Microsoft and Linux for the select workloads included in this TCO study. Microsoft's challenge will be to correctly identify the aspects of the overall Linux ecosystem that are most appealing to end customers and to create software solutions that are equally appealing and cost effective.

Packaged software for Linux will increasingly be preintegrated with the server hardware, thus reducing the need for tuning, optimization, and development going forward. This process has already begun, with packaged products such as Oracle's 9i Real Application Clusters (RACs) for Linux, VERITAS storage management software, Linux security software packages, and (soon) Sun's line of general-purpose Linux servers. These products will reduce the need for professional staffing for Linux software installation, configuration, and application development. Of course, the inclusion of commercial third-party software may represent an increase in acquisition costs for a Linux solution.

It is reasonable to expect Linux to support a more mature computing environment over the next few years, gaining better ISV support for commercial applications and packaged database products. System management tools are emerging and can be expected to expand rapidly over the next year or two in capability and installed base. It is also reasonable to expect less customization and scripting to be required for Linux computing over time, as Linux tools mature and become easier to use, thus reducing the TCO for the server environment.

In sum, IDC expects today's users of Linux technology, who are now spending significant time and resources making the Linux environment suitable for a range of business and high-performance applications, to have an easier task deploying similar workloads in three to five years. The maturation of supporting management tools is an evolutionary process that takes place with the emergence of every new operating environment. It has already taken place with Windows environments, with the operating system going through four major revisions between its launch in 1993 and 2000, accompanied by quantum improvements in Microsoft and third-party management tools. It remains to be seen whether the level of integration that

Linux solutions deliver can approach what Microsoft delivers today and whether the Linux developer and ISV communities can close the gap with a Microsoft product suite that continues to move forward at a rapid pace.

However, a major caveat to this view of an improving five-year TCO picture for Linux is that, if too many Linux variants emerge, then the open source community could become fragmented in a similar way to the fragmentation of the 32-bit Unix world in the 1990s. This fragmentation diluted the effectiveness of the Unix open systems movement that began in the late 1980s by eventually making the overall Unix development and deployment environment crowded with variants and, thus, more complex for IT management. A leading challenge for Linux — and for the system vendors that sell Linux solutions — will be to prevent fragmentation of the open source community's support for current Linux distributions and related applications, databases, system software, and middleware.

(Note: IDC has published numerous pieces evaluating the future of the Linux operating system. Interested readers may find it valuable to review the following: *Worldwide Linux Operating Environments Forecast and Analysis, 2002–2006: A Market in Transition,* IDC #27521, July 2002; *Sun Ups the Ante with Linux Software-Hardware Package,* IDC #27833, August 2002; *UnitedLinux Sets Stage for Consolidation, Competition,* IDC #27357, June 2002; and *Building the Linux Desktop: The Ximian Story,* IDC #27243, June 2002.)

CONCLUSION

The "waves" of Linux adoption in recent years have brought increasing reliability and support to the overall Linux environment. However, they have not yet succeeded in lowering the TCO for Linux servers, which require more custom software and hands-on management than comparable Windows 2000 servers, on average, according to the findings of this IDC study.

IDC found that Microsoft Windows 2000 servers were less costly to run and maintain over a five-year period than were Linux servers for four important enterprise workloads: networking, file, print, and security. This finding may be surprising because many people apparently believe that, because acquiring Linux involves minimal out-of-pocket expense, it is therefore less costly overall. Linux servers were found to be less costly in the Web space because there were more packaged software products for Linux in that space and because of the maturity of thin Linux servers arrayed in Web-centric "server farms" or tiers. However, the Windows 2000 servers studied ran, on average, more workloads than did the Linux servers, making them cost-effective platforms for IT customer sites that are also running business-critical and mission-critical workloads.

Ongoing competition is to be expected as Linux distributors and Microsoft — along with the system vendors that provide both kinds of software solutions on their hardware platforms — continue to provide cost-effective software products for the worldwide server

market. Along the way, this kind of energetic competition will benefit customers, leading suppliers to provide increasing levels of functionality at more attractive price points and driving down the cost of computing through enhanced "ease of" features (e.g., ease of installation and management).

APPENDIX A: LINUX

Linux is available from multiple Linux "distributors," including Red Hat, SuSe, Caldera/SCO, Turbolinux, MandrakeSoft, and others. Thus, a single, underlying operating system kernel is shipped by multiple distributors around the world. Each adds software modules, including utilities and middleware, on top of the basic kernel. Linux was invented in 1991 by Linus Torvalds — then a Finnish graduate student — who sought help in completing the source code from a community of open source developers via the Internet in the 1990s. Today, Torvalds publishes updated versions of the Linux operating system, but new code from the open source community is added in each new release. According to the "rules" of Linux publication, developers can create new source code for Linux, but they must publish it back to the open source community for inclusion in later releases.

This IDC study includes data about servers at user sites that are running different distributions of the basic 32-bit Linux operating system. Thus, the Linux platform studied in this IDC white paper is a generic platform rather than one provided by any single Linux distributor.

Historically, adoption of the Linux operating system has come in "waves." In the first wave, Linux was added to existing, installed-base client or server machines that were shipped without operating systems, or it replaced existing operating systems. In the second wave, system vendors began shipping Linux on new server systems, starting in 1999. These Linux hardware platforms included appliance servers and general-purpose servers from Dell, HP, IBM, Sun, and others.

Linux was also being adopted by the high-performance technical computing (HPTC) community. For HPTC applications, Linux is often deployed on Linux workload-balancing clusters including dozens of individual servers running the "Beowulf" open source Linux clustering software. In the current wave of adoption, much "custom" software development is taking place at commercial Linux sites. This requires intense IT staffing/application development related to the Linux custom application creation, deployment, and maintenance. In coming years, there will also be a wave of Linux adoption for support of Web services, which are Web-enabled applications that can link and interoperate with other Web-enabled applications via the Internet. Web services for Linux server will likely be based on the Java development environment.

These "waves" of adoption have brought increasing reliability and support to the overall Linux environment. However, they have not yet succeeded in lowering the TCO for Linux servers, which, on average, require more custom software and hands-on management than do comparable Windows 2000 servers. This is the case because custom Linux applications require optimization and tuning, achieved

at the expense of professional time from programmers/developers, system administrators, and operations personnel.

APPENDIX B: MICROSOFT WINDOWS 2000

Adoption of Microsoft Windows 2000 has been ramping up since its introduction in February 2000. Windows 2000 is available in three versions: Standard Server, for hardware platforms with two to four processors; Advanced Server, for hardware platforms with four to eight processors; and Windows Data Center, for hardware platforms with eight or more processors.

This IDC study investigated servers running Windows 2000, not looking at servers running the Windows NT Server product. This aspect of the study's methodology, which is described in the body of the document, ensured that respondents commented on the currently shipping product rather than on an older product. It also ensured that the TCO metrics were being gathered about the same Windows operating system platform.

Windows 2000 is available from one software vendor, Microsoft, rather than from multiple software vendors or software distributors, although it can be acquired indirectly through the purchase of OEM server systems. Microsoft Windows is widely available, and it is supported by Microsoft and its OEM partners, channel partners, and systems integration partners. The most scalable version of Windows 2000, Windows Data Center, is available on new servers from system vendors, which ensures that system configuration and support is delivered as part of a total solution.

Windows 2000 is now the primary version of 32-bit Windows shipping on Intel-based servers. In many cases, Windows 2000 is a follow-on replacement for earlier versions of Windows, including the widely deployed Windows NT Server 4.0, which Microsoft began shipping in summer 1996 and stopped shipping as a generally available product in early 2002.

Windows 2000 is a mature operating system product, shipping more than 1 million copies annually on a worldwide basis. Tens of thousands of packaged applications are available, including packaged databases that run on the Windows 2000 server operating system. While programmers can develop custom Windows 2000 programs, less custom development is typically associated with installing and deploying the Windows 2000 server operating environment, which serves as a platform on which to run those packaged applications.

The next wave of Windows adoption will be versions of the Windows 2000 operating system that include support for .NET — Microsoft's software technology for direct support of Web services. Microsoft expects to enhance the Windows 2000 server products with the addition of .NET versions of Windows 2000 Standard Server, Advanced Server, and Data Center Server, with additional built-in support for Web services, which are Web-enabled applications that can link and interoperate with other Web-enabled applications via the Internet, later this year.

IDC Worldwide Offices

CORPORATE HEADQUARTERS

IDC
5 Speen Street
Framingham, MA 01701
United States
508.872.8200

NORTH AMERICA

IDC Canada
36 Toronto Street, Suite 950
Toronto, Ontario M5C 2C5 Canada
416.369.0033

IDC California (Irvine)
18831 Von Karmen Avenue
Suite 200
Irvine, CA 92612
949.250.1960

IDC California (Mountain View)
2131 Landings Drive
Mountain View, CA 94043
650.691.0500

IDC New Jersey
75 Broad Street, 2nd Floor
Red Bank, NJ 07701
732.842.0791

IDC New York
2 Park Avenue
Suite 1505
New York, NY 10016
212.726.0900

IDC Texas
100 Congress Avenue
Suite 2000
Austin, TX 78701
512.469.6333

IDC Virginia
8304 Professional Hill Drive
Fairfax, VA 22031
703.280.5161

EUROPE

IDC Austria
c/o Loisel, Spiel, Zach Consulting
Mayerhofgasse 6
Vienna A-1040, Austria
43.1.50.50.900

IDC Benelux (Belgium)
Boulevard Saint Michel 47
1040 Brussels, Belgium
32.2.737.76.02

IDC Denmark
Omøgade 8
Postbox 2609
2100 Copenhagen, Denmark
45.39.16.2222

IDC Finland
Jarrumiehenkatu2
FIN- 00520 Helsinki
Finland
358.9.8770.466

IDC France
Immeuble La Fayette 2
Place des Vosges Cedex 65
92051 Paris la Defense 5, France
33.1.49.04.8000

IDC Germany
Nibelungenplatz 3, 11th Floor
60318 Frankfurt, Germany
49.69.90.50.20

IDC Italy
Viale Monza, 14
20127 Milan, Italy
39.02.28457.1

IDC Netherlands
A. Fokkerweg 1
Amsterdam1059 CM, Netherlands
31.20.6692.721

IDC Portugal
c/o Ponto de Convergancia SA
Av. Antonio Serpa 36 - 9th Floor
1050-027 Lisbon, Portugal
351.21.796.5487

IDC Spain
Fortuny 18, Planta 5
28010 — Madrid
Spain
34.91.787.2150

IDC Sweden
Box 1096
Kistagangen 21
S-164 25 Kista, Sweden
46.8.751.0415

IDC U.K.
British Standards House
389 Chiswick High Road
London W4 4AE United Kingdom
44.208.987.7100

LATIN AMERICA

IDC Latin America
Regional Headquarters
8200 NW 41 Street, Suite 300
Miami, FL 33166
305.267.2616

IDC Argentina
Trends Consulting
Rivadavia 413, Piso 4, Oficina 6
C1002AAC, Buenos Aires, Argentina
54.11.4343.8899

IDC Brazil
Alameda Ribeirao Preto, 130
Conjunto 41
Sao Paulo, SP CEP: 01331-000 Brazil
55.11. 3371.0000

International Data Corp. Chile
Luis Thayer Ojeda 166 Piso 13
Providencia
Santiago, 9, Chile
56.2.334.1826

IDC Colombia
Carerra 40 105A-12
Bogota, Colombia
571.533.2326

IDC Mexico
Select-IDC
Av. Nuevo Leon No. 54 Desp. 501
Col. Hipodromo Condesa
C.P. 06100, Mexico
525.256.1426

IDC Venezuela
Calle Guaicaipuro
Torre Alianza, 6 Piso, 6D
El Rosal
Caracas, Venezuela
58.2.951.1109

CENTRAL AND EASTERN EUROPE

IDC CEMA
Central and Eastern
European Headquarters
Male Namesti 13
110 00 Praha 1
Czech Republic
420.2.2142.3140

IDC Croatia
Srednjaci 8
1000 Zagreb
Croatia
385.1.3040050

IDC Hungary
Nador utca 23
5th Floor
H-1051 Budapest. Hungary
36.1.473.2370

IDC Poland
Czapli 31A
02-781 Warszawa, Poland
48.22.7540518

IDC Russia
Suites 341-342
Orlikov Pereulok 5
Moscow, Russia 107996
7.095.975.0042

MIDDLE EAST AND AFRICA

IDC Middle East
1001 Al Ettihad Building
Port Saeed
P.O. Box 41856
Dubai, United Arab Emirates
971.4.295.2668

IDC Israel
4 Gershon Street
Tel Aviv 67017, Israel
972.3.561.1660

IDC South Africa
Building 9, Pebble Beach
Fourways Golf Park
Roos Street
Fourways, Gauteng
South Africa
27.11.540.8000

IDC Turkey
Tevfik Erdonmez Sok. 2/1 Gul
Apt. Kat 9D
46 Esentepe 80280
Istanbul, Turkey
90.212.275.0995

ASIA/PACIFIC

IDC Singapore
Asia/Pacific Headquarters
80 Anson Road
#38-00 IBM Towers
Singapore 079907
65.6226.0330

IDC Australia
Level 3, 157 Walker Street
North Sydney, NSW 2060
Australia
61.2.9922.5300

IDC China
Room 611, Beijing Times Square
88 West Chang'an Avenue
Beijing 100031
People's Republic of China
86.10.8391.3610

IDC Hong Kong
12/F, St. John's Building
33 Garden Road
Central, Hong Kong
852.2530.3831

IDC India Limited
Cyber House
B-35, Sector 32, Institutional
Gurgaon 122002
Haryana India
91.124.6381673

IDC Indonesia
Suite 40, 17th Floor
Jakarta Stock Exchange
Tower 2, Jl. Jend. Sudirman Kav. 52-53
Jakarta 12190
6.221.515.7676

IDC Market Research (M) Sdn Bhd
Jakarta Stock Exchange Tower II
17th Floor
Jl. Jend. Sudirman Kav. 52-53
Jakarta 12190
62.21.515.7676

IDC Japan
The Itoyama Tower 10F
3-7-18 Mita, Minato-ku
Tokyo 108-0073, Japan
81.3.5440.3400

IDC Korea Ltd.
Suite 704, Korea Trade Center
159-1, Samsung-Dong
Kangnam-Ku, Seoul, Korea, 135-729
822.551.4380

IDC Market Research (M) Sdn Bhd
Suite 13-03, Level 13
Menara HLA
3, Jalan Kia Peng
50450 Kuala Lumpur, Malaysia
60.3.2163.3715

IDC New Zealand
Level 7, 246 Queen Street
Auckland, New Zealand
64.9.309.8252

IDC Philippines
703-705 SEDCCO I Bldg.
120 Rada cor. Legaspi Streets
Legaspi Village, Makati City
Philippines 1200
632. 867.2288

IDC Taiwan Ltd.
10F, 31 Jen-Ai Road, Sec. 4
Taipei 106
Taiwan, R.O.C.
886.2.2731.7288

IDC Thailand
27 AR building
Soi Charoen Nakorn 14,
Charoen Nakorn Rd., Klongtonsai
Klongsan, Bangkok 10600
Thailand
66.02.439.4591.2

IDC Vietnam
Saigon Trade Centre
37 Ton Duc Thang Street
Unit 1606, District-1
Hochiminh City, Vietnam
84.8.910.1233; 5

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