

AN EXECUTIVE DECISION: WINDOWS OS VS. LINUX OS VS. HYBRID

by

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## ABSTRACT

In today's advanced IT world, corporations, large or small, must decide on what operating system best suits their needs. Although Windows is the most common operating system, competing systems, such as Linux, are providing a legitimate alternative. Windows, with its user-friendly format and off-the-shelf availability, can be found in most companies, both large and small. However, with Windows's proprietary nature, security vulnerabilities, and high total cost of ownership (TCO), organizations are seeking alternatives to reduce costs and improve operational efficiency. Linux, with its stable and secure operating environment and open-source products, is quickly becoming a popular choice among organizations of all sizes. This paper will focus on the comparison of these systems and why different sized organizations opt to Windows, Linux, or a hybrid of both systems.

## CHAPTER ONE

### INTRODUCTION

Quick information access and exchange is an integral part of today's business process. The speed and effectiveness of such information availability is based on a company's information system. This system is comprised of the hardware and software of a organization's computers and servers. Determining what type of system will best serve the organization is a major decision faced by all IT professionals.

#### Statement of the Problem

Businesses, by nature, are plagued with a myriad of decisions, and each executed decision can potentially result in a loss for the company. While some corporate decisions may pose less of a risk, others, such as choosing an organization's operating system (OS), can literally "make or break" a company. Businesses usually rely on in-house IT teams or outsourced IT consultants when faced with such a daunting task as choosing an OS for their IT infrastructure. The IT professional, whether in-house or hired consultant, must be able to comprehensively compare the needs and requirements of the business with the type of operating systems available. This will allow the professional the ability to make the soundest decision possible based upon the information available. However, making a well researched, educated decision can be extremely challenging with the overwhelming amount of resources offered today. There are numerous publications (articles, books, web sites, journals, etc.) that compare of all the existing operating systems, from software and hardware requirements to technical support, but the information is scattered at best, and is usually written by the developer of the operating system.

#### Need for the Study

Whether new or well established, corporations faced with choosing an operating system have a very daunting task ahead of them. When considering what type of operating system to base the entire corporation's operations on, there are numerous factors that must be part of the overall equation. The decision making process must be comprehensive and economically feasible for the company.

This paper, while acknowledging there are many other types of operating systems available, is going to focus on two of the most popular, Windows and Linux, as a company's choice of operating system. This paper will discuss the advantages and disadvantages associated with choosing either system. Businesses and IT professionals alike must have the ability to access a comprehensive, un-biased source of information from which they can draw a well-informed comparison decision.

## CHAPTER TWO

### REVIEW OF THE LITERATURE

#### Literature Review

Each competing OS maintains a strong support base and each has funded studies in order to prove or disprove performance claims. For example, the International Data Corporation (IDC), a Microsoft-backed research group, claims that the Windows out-scored Linux by 11 and 22 percent in money saved in the areas of areas of “file sharing, print serving, network infrastructure, and security” (Rist, 2002). Other reports authored by Windows supporters claim that Microsoft has the “lowest elapsed time between a vulnerability and the release of a fix” (Ballmer, 2004) while insisting “Linux and other open-source software will destroy the commercial industry entirely” (“Friend or Foe?”, 2003).

On the other hand, Linux supporters and developers, who, according to the IDC, “are quickly closing the price gap” (Dicarlo, 2003) with Microsoft, can find assurance in the fact that many software publishers, such as Oracle, are providing Linux versions of their products making the Windows desktop “less a necessity each year” (Miller, 2004). Rist and Bernstein predict, “Braver administrators with a keen eye for the bottom line, however, won’t be able to ignore flat licensing schemes such as Scalix’s, which can save them as much as 50 percent over Microsoft’s overall costs” (Rist, Bernstein, 2005). Predictions such as these coupled with evidence that Linux operates well on older hardware allowing for trial sessions at a limited cost, makes Linux very attractive to thrifty businesses (Stafford, 2003).

#### Summary of the Literature

These competing articles and tests focused on proving the better of the two OS, Windows or Linux, are predominately subjective and very confusing. In order for business managers and IT professionals to make timely and informative decisions on their company’s IT infrastructure, they must have the ability to consult an independent, single source of information that explicitly outlines the advantages, disadvantages, strengths, and weaknesses of each OS available. The goal of “An Executive Decision: Windows OS vs Linux OS vs a Hybrid” is to provide managers and decision makers with a consolidated, independent study outlining the characteristics of each OS in terms of their security, TCO, stability, availability, technical support, licensing, software and hardware issues, training, bugs, and virus vulnerability. This paper will also offer information on hybrids of the two OS’s and the costs involved with operating such a system. The report will focus on the business perspective and less on the technical differences of each operating system. The limitations of this report are as follows: (1) limiting study to two operating systems; (2) benefit to smaller organizations may be limited due to the high cost of hybrid systems.

### Research Hypothesis

In conclusion, this paper expects to find one of the operating systems dominant over the other from a business standpoint. A possible viable outcome is a hybrid of the two systems.

## CHAPTER THREE

### METHODOLOGY

#### Design, Participants, and Procedures

My methodology of research will be literature-based. Although, I intend to use the UMUC database library to some extent, the majority of my research will be based on information found in popular e-journals and web sites, including, but not limited to, the following: USA Today.com, CNET news.com, Eweek.com, Economist.com, Businessweek.com, Microsoft.com, Techweb.com, Itnewsweb.com, Technologyreview.com, Pcmag.com, Infoworld.com, Linuxjournal.com, and Redmondmag.com. Research information will be derived from developers and their affiliations and from information published by accredited IT and business sources. Recent electronic research results indicate that there is a great divide among developers and users in regards to Windows and Linux. While there is a plethora of information in the World Wide Web's chat rooms, the postings are primarily opinions with little or no research base; therefore, the research's pull of information will be limited to 'authorized' sources.

#### Assumptions and Limitations

To include all existing operating systems is well beyond the scope of this paper; therefore, the focus will be on the comparison of the two main operating systems, Windows and Linux. In order to compare these two systems, I will focus on the nature of each OS, closed-source vs. open-source, and the opinions of developers who favor one system over another. This paper will be written from a business standpoint, investigating the advantages, disadvantages, strengths, and weaknesses of Windows, Linux, and a hybrid of each.

## CHAPTER FOUR

### RESULTS, ANALYSIS, AND DISCUSSION

#### Operating Systems (OS)

Most anyone who has ever turned on a computer has probably been exposed to a version of Windows OS. And since “Windows OS runs over 90% of the world’s desktop computers” (“Friend or Foe?”, 2003), it is no surprise that Windows OS has the lion’s share of the PC market. However, on the server side of the house, Linux OS is giving Windows a run for its money.

A corporation’s basic IT hardware infrastructure usually consists of servers, networks, and workstations. Each of these components must coordinate their information for the system to function properly. This coordination of information is handled by the operating system. When choosing an operating system, corporation’s must take into account its expense, return on investment (ROI), total cost of ownership (TCO), availability, user interface (UI), stability, security, software and hardware compatibility, standardization, technical support, vulnerability (viruses, spyware, etc.), licensing fees, training requirements, and the longevity of the product. The purpose of this paper is to provide guidance to large corporations faced with choosing an operating system for their IT infrastructure. The following is a breakdown of the aforementioned characteristics of consideration when choosing an OS.

#### *Longevity and Standardization*

New versions of Windows OS seem to roll out on the shelves every couple of years. While the latest version seems to improve on the old, it usually requires hardware and software application upgrades. Depending on the size of the organization, such hardware and software upgrades can be very costly. On the flip side, because Windows is a propriety OS, each version of Windows OS is standardized. Windows OS has the same software on each version and is easy to install and configure because the documentation and installation process is always the same. This standardization can be a major factor in an organization’s OS decision. Familiarization with a product and its documentation puts end users at ease when upgrading to a new system, thus alleviating or greatly reducing an organization’s resistance to change. A major drawback to such a proprietary closed-source system is the limitation of intellectual draw and testing. The organization, in this case Microsoft, is only as ‘smart’ as its smartest developer.

Linux is a non-proprietary open-source OS and is developed and offered by many different distributors. The kernel of each Linux OS offered is the same, but each distributors version differs in the areas of installation process, add-on software, price, GUI, documentation, and technical support (Horowitz, 2004). The differences in documentation, configuration, and technical genre make the installation of Linux OS difficult, especially when there is an existing OS. But what Linux lacks in ease of installation, it gains in compatibility with most existing hardware platforms. What gives Linux this advantage is its optional GUI. This enables Linux to

run on various systems, such as old personal computers (e.g. 486-based machines), high-end mainframes (Z series), or computers the size of a deck of playing cards with an ARM cpu. On the server side, speed, efficiency and reliability are all increased by running a server instance of Linux without a GUI, something that server versions of Windows cannot do. Additionally, ‘the detached nature of the Linux GUI makes remote control and remote administration of a Linux computer simpler and more natural than a Windows computer’ (Horowitz, 2004). A typical Linux version usually has a choice of two GUI’s. To ease end users’ resistance to change, some versions of Linux have mocked Windows OS GUI. Windows OS GUI is inherent and only until recently (Windows XP) did it give you a choice of GUI.

### *Stability*

Developers of OS’s, to include Microsoft, are constantly trying to develop crash-proof products. Since its original version 3.0, Microsoft has been steadily increasing its OS stability. But what exactly is stability and how is it defined? Stability is the ability of an operating system platform to interact with older and current versions of itself and other applications without ‘hanging’ or ‘crashing.’ From this standpoint, Windows OS’s provide a very stable platform. Almost any previous version of Windows can run on the current OS platform, such as Windows XP, which usually includes drivers and applications. But with any existing software, there are always exceptions, so ‘patches’ and ‘fixes’ are often needed to allow for a smoother compatibility transition.

Since Linux has numerous distributors, Linux should be considered “unstable” when using the definition of “stability,” as stated above. This is due to the fact that each version of Linux is designed with different goals in mind. One version may be specifically designed for servers, another may be more geared toward PC’s, while another may be designed for the corporate environment and not for the individual user. The configuration files differ in all versions of Linux causing non-standardization of the product, as mentioned earlier. When addressing these differences in distributions, developers have to account for all the different versions of Linux to allow for their programs to run on all the varying Linux platforms. While Linux may require more work from the developer side of the house, its flexibility allows older processors to run on its platform. This provides huge cost savings for corporations who have data on back-up files and old computers with no way of accessing those files with the new OS’s and applications.

### *Bugs*

Bugs are the problems associated with programs and utilities. A program’s bugs are often confused with its stability. Linux OS is open-source software (OSS). This translates into a code that is non-proprietary allowing anyone who wants to write code for Linux with the ability to do so. An advantage to the open-source code is its unlimited exposure to developers from various backgrounds, experiences, and creativity levels. The code is posted all over the Internet for anyone to review, test, and debug. It is this exposure that has given Linux its reputation of ‘stability.’ In a study conducted by Coverity, a code analysis company, Linux was found to contain 985 bugs in 5.7 million lines of code. That is over 4000 less bugs than a typical commercial program of similar size (Lemos, 2004). Because of Linux’s Internet presence, exposed programming errors are usually found and fixed faster than its Window OS counterpart.

An attributing factor is the lack of need to go through the necessary channels to the software engineering department when dealing with Windows.

Time is another factor in the low percentage of bugs. Linux programs are, in general, devoid of business deadlines. Typically, the code is not published or released until it works, although with its increased popularity, this may soon change.

Windows OS is proprietary, closed-source software, which, as mentioned earlier, means that it has limited draw on its creativity, testing, and review. It is limited in the sense that only employees of the company have access to the code, eliminating third party review and testing, thus increasing the chances of programming errors (bugs). Business deadlines also affect the closed-source software. Timelines, not product readiness, dictate the release of certain programs. Another argument against closed-source software is lack of individual recognition on the developers' part, thereby affecting the organization's creative behavior. A study by Clarke indicated that intrinsic or internal rewards (psychological need satisfaction) are seen to be associated more with creativity than extrinsic rewards such as salary or promotion (Clarke, 1996). Programmer's of open source software are often seen as 'showing off' their programming talents. Microsoft's response to open source software: 'Linux and other open-source software will destroy the commercial industry entirely' ("Friend or Foe?", 2003).

Another example of a Windows' 'bug', or perhaps more appropriately coined, "design flaw," is its design to be used by only one person. Most computers have multiple users. Windows does offer a multi-user version, but it is not offered in its most common "store-bought" PC. To address the issue, software packages are available that adapt Windows single-user to multi-user platforms: "Databases running under Windows allow concurrent access by multiple users, but the Operating System itself is designed to deal with a single human being at one time" (Horowitz, 2004). The trade off is an increase in usability but a decrease in security, thus presenting the challenge of balancing between multi-user accessibility and the potential security problems of an open access to the root.

### *Security and viruses*

Windows OS supports the administrator class, which allows users total access to the system. Such access increases computer hardware and software issues. Unauthorized user downloads and installations are some of the main causes for computer problems, therefore, IT professionals are constantly trying to obtain the delicate balance between user access and restrictions.

To increase security, Windows introduced limited user access through account controls. Since Windows does not inherently allow multi-users, this restriction sometimes affects the software applications running under the operating system. Most software was designed with hidden assumptions for administrative privileges. In fact, most programs will either cease to run at all or are missing "key features" when run as a "limited user" (Van Eenwyk, 2005). This lack of inherent multi-user design is why Windows OS 'crashes' or 'hangs' when user restrictions are activated.

Linux is inherently multi-user. In contrast to Windows OS, which has no real log-on requirements, a user must log-on to Linux with a user id and password: "In Linux, the user with full and total access is called root, everyone else is a normal, or non-root user" (Horowitz, 2004). The non-root users have limited system privileges. In Linux, this usually relates to files and directories, although Linux makes it easy to allow "limited" users perform some administrative

tasks. In fact, many Linux programs run for limited users (Paschal, 2005). The tighter control IT professionals gain with Linux allows for more time to be dedicated to critical information or business areas and less time fixing end-user error.

Windows does have the lion's share of the OS market, but popularity and fame comes with a price. Microsoft (MS) software is targeted by more hackers than any other software. Hackers, also known as "crackers," go after MS software due to the sheer volume of affected users and the notoriety it brings (Langa, 2003). Linux, on the other hand, has not been hit with such an influx of attacks. Recent reports from a non-profit organization, called the Honeypot Project, found that unpatched MS systems were hacked within 4 minutes while the Linux systems tended to survive an average of three months. This lack of attention from hackers can be attributed to several factors, including small market share, fewer enabled services, and the change in hacker tactics (Keizer, 2004). As Linux's popularity as a viable alternative to MS rises, however, Linux's vulnerabilities will surely be put to the test.

### *Hardware and Software*

There is no doubt that MS holds a distinct advantage over Linux with its availability and compatibility of hardware and software components. There is probably not a hardware or software developer that does not make a product compatible with MS products. Most computer products come with drivers for the various versions of Windows and Windows itself has built-in software for some of the more popular devices. Another advantage to running a Windows OS is that software applications are generally more consistent and easier to install than other OS applications. Further, software for Windows is more readily available for specialized programs. However, Windows is not without its drawbacks. One disadvantage to running MS operating systems is the demand on computer hardware. By their very nature, Windows operating systems demand more operating power from their hardware, thus limiting the choice of platforms that can support their demands. In order to run the latest version of Windows, a hardware upgrade is usually required. While the single end-user may see this as a small price to pay, corporations with thousands, or even hundreds, of employees see this as a major set-back and financial loss. Other disadvantages are MS's ever-changing file format lock-in issue and the lack of support to other OS programs. Currently, Windows does not support any Linux-based programs.

While there are definitely fewer developers creating Linux compatible components, Linux appears to be holding their own in terms of hardware, software, and driver availability. Big companies are starting to jump on the Linux train. IBM, HP, Walmart, and Oracle, for example, are pushing Linux into the business world, forcing developers to take a second look at their products and create Linux supported hardware and software. One of Linux's greatest advantages over Windows is its minimal hardware requirements. Linux is capable of running on 486-based machines, as well as high-end mainframes and servers. Linux's broad spectrum of compatibility allows corporations to hang on to their current hardware, thus enabling IT departments to stay within budget. This cost savings has helped Linux gain ground in the corporate environment where the bottom line is drives decisions.

Linux-supported software is behind the power curve when compared to Windows. The majority of commercial applications are available in Linux versions, but specialized programs, such as human resource management and payroll, are not yet available. While all the latest and greatest software may not be available in Linux versions, the biggest advantage to Linux software is that it is usually available at no cost. Like Windows, Linux OS does not support

Windows programs without the aid of subsystem software, such as WINE. WINE allows a user to run Windows programs under Linux but usually limits the product's available features.

### *Total Cost of Ownership (TCO)*

Total cost of ownership (TCO) is defined as the initial cost of the operating system plus any long term costs, such as additional hardware or software requirements, licensing fees, training, technical support, maintenance, third-party software, and intangibles (e.g. system down times).

Windows is by far more expensive in terms of off-the-shelf operating system costs. For the latest desktop OS (Windows XP Pro), business users can expect to pay approximately \$150 per copy compared with Linux's free cost. On the server side, users can expect to pay around \$100 for off-the-shelf Linux software versus thousands of dollars in per client licensing costs. But Windows advocates claim that while Linux may appear cheaper, or even, free, at first glance, there are hidden costs involved. A study conducted by the Yankee Group, an international software analysis company, found that migration from Windows to Linux would be three to four times more expensive and take three times as long to deploy as compared to an upgrade to a newer version of Windows. Another organization, Equifax, an information solutions company, conducted an internal study and found that Windows would realize a 14 percent cost savings over Linux and shorten their time to market by six months (Ballmer, 2004). According to Rist and Bernstein, Linux email server software also seems to cost more in terms of third party software. Linux usually requires brand new software when integrating new programs with existing anti-virus and anti-spam software. This means not only software costs associated with commercial versions, but training, installation, and maintenance, as well (Rist and Bernstein, 2005). Another argument from Windows supporters is that Linux requires more man-hours to configure and tweak the system than Windows, which basically installs itself.

Forrester, a technology research company, conducted a study of 14 companies that were running Linux for over a year. The study found that of the 14 companies, only 5 kept detailed recordings and all 5 of those found Linux 5 to 20 percent more expensive than MS products. Also noted in the study was the fact that Linux preparation and planning took 5 to 25 percent longer than Windows, while training for Linux solutions was 15 percent more costly. Additionally, the study found that hiring qualified Linux consultants was cost twice as much as an MCSE pro (Ballmer, 2004). While Windows products are definitely the more expensive alternative, many organizations continue to employ MS products because of smooth migration, user familiarization and availability of specialized applications.

Where Linux really takes attention away from Windows is in its licensing and renewal fees. Linux vendors offer flat licensing, which can save organizations as much as 50 percent over Microsoft's overall costs (Rist and Bernstein, 2005). Another contributing factor to Linux's low cost is its availability of open-source applications. Two of the more popular Linux programs, OpenSSH and rsync, allow Linux administrators to remotely manage and secure environments from anywhere in the world. Windows administrators must physically be on-site to manage their environments. Linux supporters admit that initial configuration does take more time, but once the system is in place, it is easier to manage than Windows. Windows administrator's time is consumed with constant tweaking and configuration long after the system is up and running. Given the non-proprietary customizable nature of Linux, businesses that use

Linux solutions feel as if they are in control of the software instead of the software running the show.

Foreign and domestic governments are turning to open-source software because of its non-proprietary quality. These governmental agencies feel that open-source software is more secure because of the lack of back-door possibilities associated with closed-source proprietary software. MS Corporation has only recently agreed to allow governmental agencies to view their code. MS has concentrated much effort on security-related software issues, but ongoing security costs for Windows can easily reach 15 to 20 percent of TCO. With Linux, security costs are less than 10 percent after initial configuration (Rist, 2002).

Linux offers another cost advantage in the use of older hardware. Many organizations have aging information systems and Linux allows for increased use of those systems for longer periods of time. For larger corporations, that can amount to a substantial cost savings of over five hundred dollars per user or tens of thousands on a new server. Linux can also be used to cluster together multiple machines to create a supercomputer. Firms have been able to scrap entire rooms full of servers and replace them with one mainframe ("Friend or Foe?", 2003).

Linux also saves organizations much needed IT budget dollars in technical support fees. While some Linux vendors do charge for these services, businesses can consult the vast amount of Linux developers for free on the World Wide Web. Windows technical support fees can run tens of thousands of dollars annually and, with the loss of support for older Windows systems, that fee is only expected to go up (Dicarlo, 2003).

Windows advocates also argue that qualified Linux experts tend to be paid more than their MS counterparts and, therefore, raise the TCO associated with Linux systems. But many companies have found that their Unix employees already on the payroll are able to smoothly transition to Linux systems, thus saving the corporation thousands of dollars.

### *Hybrid*

Another possible solution to the IT professional's dilemma of choosing the best OS, in this scenario, Windows or Linux, is to use a hybrid of the two. Many businesses already incorporate more than one OS into their information automation process. Corporations running more than one OS will typically have one type of OS on their desktop units and another running behind the scenes (file, print, email, and web servers). Corporations can implement Windows under Linux, or vice versa. Given the hardware requirements of newer Windows versions, the most cost beneficial choice for larger corporations is to run Windows under Linux.

There are software packages such as WINE and Win4Lin that allow Windows programs to run inside Linux. The coexistence of the two systems provides the best of both worlds, such as having the ability to run specialized and unique Windows applications while providing the stability and security of a Linux environment. Tests have shown that running Windows operating systems and Windows software under certain Linux tools can actually increase the Windows OS speed as compared to running it under Windows.

Another strategic advantage to having Linux as the host OS is that when the Windows system crashes, it can be restarted in as little as 3 seconds (Stafford, 2005). Of course, running the Windows OS requires a licensing agreement, but corporations are able to avoid those Windows licensing fees with other Linux supported software, such as CrossOver Office. CrossOver Office is a software product that runs many Windows applications and plug-ins in Linux without actually running the Windows OS at all.

Windows was designed for a single-platform environment, in contrast to Linux, which was intended to be portable to almost every conceivable computing device. These two conflicting design differentials are why corporations tend to migrate from one OS to another instead of trying to achieve a harmonious balance between systems.

Besides system compatibility issues, there may be high costs associated with running multiple systems. Due to limited budgets, small to medium-sized businesses typically cannot afford the licensing fees, initial software purchase, and personnel required to run the systems, therefore, hybrid systems are usually run by larger corporations or governmental bodies that have resources to do so.

## CHAPTER FIVE

### CONCLUSIONS AND RECOMMENDATIONS

It is my opinion that corporations looking to get the most for their money will benefit by choosing Linux as their native OS. Its flat licensing schemes, low cost commercial software, free third-party software, and plethora of free internet-based technical support offer a very attractive bottom-line to corporations trying to stretch their IT dollars. In order for Linux to truly grab their fair share of the market (estimated to be 15 percent by 2007 (Loftus, 2004)), however, Linux vendors must standardize the implementation and configuration of each Linux component. Already, more and more developers and foreign governments are embracing Linux, presenting Linux ample opportunity to take control of its future. Linux has the potential to grow from a non-critical operation to a critical solution. As numerous software analysts will attest, Linux OS is a proven, viable alternative to Windows, and its here to stay.

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