DESKTOP LINUX TECHNOLOGY & MARKET OVERVIEW

Open Source Applications Foundation
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FOREWORD

For several years now, many people involved with computing and the Internet have harbored hopes that Linux might become a viable end-user operating system for a broad population. There has been great frustration with problems and limitations of commercial offerings, especially to the extent that the original goals of computers as tools of empowerment for individuals seem to have lost momentum. In turn this frustration has fueled the wish for an alternative which could evolve through the inclusive and open-ended dynamics of open source development.

At the same time, it is an undeniable truth that while Linux-based server software has matured to become an integral and vital component of the global information infrastructure, as yet Linux on the desktop has remained on the periphery. Recently, I initiated a project on behalf of OSAF to take a careful look at the state of Linux on the desktop, and asked Bart Decrem to spearhead a short-term research project to assess the current situation and trends.

As you can read, while we do not believe a revolution is in the offing, there is a great deal of good news about what has already been accomplished, and even more about what is very likely going to be happening with adoption of desktop Linux, especially considering the situation outside the U.S. A further piece of good news is that, by and large, there do not appear to be intractable obstacles to the continuing growth of adoption of Linux as an end-user OS.

I hope readers will find this report timely and valuable. I encourage your feedback, which may be sent to desktop-linux-report@osafoundation.org.

Mitch Kapor,
Open Source Applications Foundation
July 10, 2003

CREDITS

Thanks to the numerous individuals who agreed to be interviewed as part of the research for this document. Their insights and contributions have shaped this document, but the opinions expressed here and any inaccuracies are of course the sole responsibility of the author.

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The most recent version of this document is available at
http://www.osafoundation.org/desktop-linux-overview.pdf.
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1   EXECUTIVE SUMMARY

"Our clients are not asking us to replace all of their Windows desktops. They're asking us to help them figure out how they can reduce the number of Windows desktops."

A few years ago, after several high-profile Linux desktop efforts failed, people were quick to proclaim the still-born death of Linux on the desktop. Just months later, new commercial Linux desktop ventures sprang up, the major open source desktop projects (KDE, GNOME, OpenOffice and Mozilla) all achieved important milestones and the Linux desktop was born again.

This report gives an overview of the state of Linux on the desktop, both from a technology perspective and in terms of marketplace developments. It concludes that, while much work remains to be done, desktop Linux is now "good enough" for significant classes of users. We believe that claims about Linux' fitness or unfitness for desktop use have both been overblown. It is true that Linux is unlikely to achieve significant adoption by knowledge workers and mainstream consumers, especially in the United States, over the next few years. It is also true that Linux is already in use by millions of users around the world, and is likely to find a home on tens of millions of desktops over the next few years, outpacing the Macintosh OS as the number two desktop operating system.

We believe that initial deployments of Linux on the desktop will focus largely on highly technical workers, students and transactional workers. The public sector, especially outside of the US, will also be a major driver of desktop Linux adoption. Massive deployments, ranging for 14,000 government desktops in Munich to 80,000 PCs for students in Spain, are already under way. Thanks to the unique nature of open source software, the lessons learned from these initial deployments are likely to rapidly result in an even stronger Linux desktop. As Hollywood studios migrated to Linux workstations, for example, one of the studios commissioned an open source company to make Adobe Photoshop run under Linux. Thanks to the open source development process, all Linux users can now run Photoshop on their desktop.

Significant pieces of work do remain to be done, especially in terms of providing missing pieces of desktop foundation infrastructure (such as better support for hardware devices) and providing improved interoperability between the various major desktop efforts. There are signs that the open source community will rise to this challenge, further accelerating the momentum of Linux on the desktop.

While technical challenges remain, we agree with several of the people we spoke with who argued that desktop Linux has evolved from being a technical challenge to a marketing challenge. Linux is now good enough for large numbers of people. A key remaining task is to convince buyers to consider a Linux desktop on its merits. The success stories that will emerge over the next few years will be an important part of this marketing challenge; market reports such as this one, we hope, will also help to educate decision makers.

"The desktop is Microsoft's last stand for near dominance, which will gradually erode with greater awareness of the maturity of Linux desktop offerings."[1]

2   DEFINITIONS

Strictly speaking, the Linux project, as overseen by Linus Torvalds, is just the kernel of an operating system. The entire operating system commonly referred to as Linux could arguably be more accurately named GNU/Linux, and it includes the Linux kernel along with thousands of tools, drivers, applications and a graphical user interface. In this document, we use the term Linux in this broader, more casual, sense.

Open source software is software for which the source code is made available under a license that allows modifications and redistributions. In this document, we use the term open source software to include "free software", which is software released under a more strict set of guidelines created by the Free Software Foundation.

The scope of this project is "desktop Linux" rather than "open source desktops" because using the latter terminology is both broader and more restrictive than fits our purposes:
- There are a number of open source operating systems other than Linux, most notably the FreeBSD operating system, but almost all of the efforts to offer an open source desktop solution focus on Linux-based operating systems[2].
- While it is important that the "platform" pieces of the operating system, upon which applications are built, be open source, we believe that a healthy software eco-system includes a thriving community of commercial software vendors. Indeed, one of the weaknesses of the current Linux desktop offerings is the absence of a strong end-user ISV industry.

3   THE LONG LINUX MARCH TO THE DESKTOP[3]

The Long Linux March to the Desktop
1991: **Linux introduced**
1991: **Unix X11 GUI framework ported to Linux**
1998-1999: **KDE 1.0 & GNOME 1.0 –** real GUI environments for Linux
2001: **Ximian Evolution 1.0 –** can be turned into a Microsoft Exchange client
2002: **StarOffice 6.0 / OpenOffice 1.0 –** real alternatives to Microsoft Office
2002: **Mozilla 1.0 –** a competitive browser
2002: **KDE 3.0 & GNOME 2.0 –** Linux GUIs become more polished
2003: **Munich switches to Linux –** The first big desktop success stories emerge

In China, more than 1 million PCs shipped with Linux preinstalled last year.

4   THE ADOPTION CYCLE

4.1   Looking back

Many technologies have enjoyed widespread success when a new application was released that allowed the benefits of the new technology to fully demonstrate themselves. The Macintosh computer, for instance, started gaining momentum with the release of Adobe Pagemaker and the postscript printer, creating the desktop publishing industry. Likewise, the Internet was used only in academic and technical circles until the release of the Mosaic web browser. As a result, some people believe that the emergence of a "killer app" will be critical to broader desktop adoption of Linux.

Examining the adoption of Linux servers reveals a different dynamic of adoption, bearing some striking similarities to the adoption cycle of the personal computer: from the edge towards the center. First adopted on the fringes of the enterprise, Linux is now well on its way to the center of the enterprise, the data-center. Until around 1997, Linux use was largely restricted to researchers, scientists, "hackers" (enthusiasts) and users in the academic communities. The dot-com boom lead to much broad adoption of Linux servers, with ISPs and dot-coms leading the way. Linux was typically deployed "on the edge" for mail, web, DHCP or DNS servers, for instance. Medium-sized and larger corporations started deploying Linux also as departmental file- and print-servers. Having proven its reliability as a reliable, cost-effective work-horse, Linux is now being deployed more centrally. It is increasingly used as the basis for databases, application servers, and is even beginning to support the ERP and CRM applications at the center of the data-center. In a February study by IDC, 14% of respondents indicated that they were supporting database software on Linux, versus 2% who reported supporting ERP or CRM applications.

While web- and mail-server applications could be described as "killer apps" for the Linux server, Linux has always been more of a Swiss-army knife. Its real advantages have been the broad range of available tools and applications, similarity to UNIX, broad implementation of open standards and protocols, low deployment cost, and, perhaps most importantly, the thriving community of users and developers and the rapid cycle of bug fixes and innovation that flow from the open source nature of the OS. Open source has been the real killer feature of Linux, and will continue to be as Linux takes hold on the desktop, with early adopters solving problems they encounter and contributing those changes back to all users using the open source development process.

4.2   Factors and trends that are favoring Linux desktop adoption

We do not believe that there will be a killer app that will propel Linux desktop adoption. For one thing, innovative applications, especially open source ones, tend to be network-oriented and can be relatively easily ported to different operating systems. Instead, we believe that a number of factors and trends will lead to more broad-based adoption of Linux as a client user environment. It remains to be seen what the relative strength of these factors will be, and how powerful their cumulative impact will be.

4.2.1 The success of Linux as a server computing platform

As Linux proves itself as a server operating system and the Linux eco-system grows, existing and potential customers begin to consider it more seriously for the desktop as well.

4.2.2 The emergence of credible desktop offerings, including the availability of solid productivity applications that interoperate with their Windows counter-parts

The KDE and GNOME desktops have reached a level of maturity where they offer an acceptable end-user experience. The availability of strong cross-platform application suites, including the Mozilla/Netscape browser suite and the OpenOffice/StarOffice office suite, complemented with other core productivity applications that interoperate and offer a similar user-interface to their Windows counterparts, such as Ximian's Evolution PIM suite, are the cornerstones of a credible desktop offering. The availability of client software allowing users to access their organization's transactional applications is the next critical step. Less visible to most users, but critical to people with disabilities and to government adoption of Linux on the desktop, is the progress that, notably, the GNOME project has made in the area of accessibility, which is the reason that the Department of Defense is now able to consider Linux as a desktop alternative.

4.2.3 The commodification of the operating system

There have been few dramatic changes on the desktop in recent years. Many users feel that the desktop and the office productivity suites are essentially "done": they are mature products that work reasonably well. As a result, consumers and corporate users alike are increasingly reluctant to upgrade their software. With the phase of rapid innovation essentially over, the desktop operating system is becoming a commodity product. The increasingly web-centric nature of computing also contributes to the commodification of the OS: the OS is becoming less important for some users than the web browser, for instance. These factors make it easier for alternatives such as Linux-based desktops to catch up in terms of the functionality and the user experience they offer, and provide a "good enough" alternative for many users. Microsoft and other stakeholders, such as OEMs, will make efforts to fight this trend but, unless a new killer application appears that dramatically raises the stakes in terms of desktop software requirements, their efforts to sell upgrades to their existing customers will increasingly meet with resistance from end-users, especially in tough economic times.

4.2.4 Structural challenges for the monopoly provider

Facing market penetration reaching saturation levels in the most lucrative markets, and pressure to maintain an astronomic market capitalization that is fueled by expectations of continued rapid revenues growth, Microsoft may have little choice but to resort to increasingly aggressive upgrade strategies (such as its new licensing practices) for the desktop operating system and productivity suite that bring in the bulk of its revenues, encouraging customers to look for cheaper replacements for commoditized software. This may have been the reason for Microsoft's Licensing 6.0 and the subsequent changes in their business practices.

4.2.5 The falling cost of personal computers

With new computers now for sale at Walmart and elsewhere for less than $200, the cost of the OS and other bundled Microsoft software has become the most expensive component of a PC. Vendors operating on razor-thin margins and price-conscious customers will naturally look to save on the most expensive components.

4.2.6   *Centralization and more server centric computing (including Net-centric computing)*

Facing a long and deep economic slump, and with some analysts claiming that the competitive advantages of IT investments have been oversold, IT managers are under pressure to rationalize their computing infrastructure. Manageability issues and more network-centric operations are leading many to take another look at server-centric computing, including thin clients, at the same time that more enterprise applications are deployed as web applications. Consumers, for their part, are spending an increasing fraction of their time in front of the computer online, in chat rooms and destination web sites, rather than using client-based applications such as word processing. Conceived as a network operating system, featuring a number of solid web browser alternatives and with an increasing number of terminal emulation and other virtualization solutions, Linux stands to gain from these changes.

4.2.7   *Increasing concerns by corporations and public institutions about being beholden to a monopoly supplier, and a desire for open standards and a level playing field*

Many people have serious misgivings about their ability to maintain access to their data if that data is encoded in closed, binary files. As one writer put it:
"We continue to live in a world where all our know-how is locked into binary files in an unknown format. If our documents are our corporate memory, Microsoft still has us all condemned to Alzheimer's."[5]

One concern is the ability in future years to access documents in by then obsoleted file formats. Office 2000 no longer natively supports the ability to read ten year old Office 4.0 documents. Ten years is a long time for a consumer, but it's a heartbeat for the archivists and librarians who help public and private sector companies develop their data management strategies. In some countries, the medical and legal communities require archival access for longer periods of time. Another oft-cited concern is the ability to extract data from corrupted binary documents.

A greater concern to US buyers and, even more so, public and private institutions abroad, is the tremendous reliance on an aggressive monopoly provider for critical and costly pieces of the computing infrastructure. Buyers, especially large, institutional buyers, want choice and control. Deploying Linux in and of itself provides them with both: it increases their choices and gives them more control: open source solutions don't provide a vendor with a proprietary lock-in (witness the number of vendors offering OpenOffice-based productivity suites) and a buyer who deploys Linux in their enterprise finds itself instantly in a much stronger bargaining position with Microsoft and able to get more favorable treatment.

Public institutions must additionally consider the policy considerations that public funds should as much as possible be used on technologies that support open standards, help maintain national sovereignty, and nurture the local IT industry.

4.2.8   *Anti-piracy efforts*

According to the Business Software Alliance, 94% of software installed in China in 2000 was pirated[6]. Things have gotten slightly better since then, but even so, seven out of ten million PCs shipped in

China last year shipped without a licensed operating system. As China and other developing countries crack down on software piracy, people will switch from pirated software to the most inexpensive legal solution. It comes as no surprise therefore that Red Flag Linux, the leading Linux distribution in China, came pre-installed on more than a million desktop computers last year.[7]

More Linux desktops are shipping this year than Mac OS desktops

4.3   The Linux desktop adoption cycle

Phase 1: Highly technical users	Phase 2: Transactional workers, web-centric consumers	Phase 3: Knowledge workers, small businesses, mainstream consumers
Engineers, System Administrators, Scientists, Content creators ...	Call-Center staff, Point of Sale workers, Car Dealers, Data Entry workers ...	Managers, Marketing staff, Business owners, Reporters ...
Now	*Starting in 2004*	*No major adoption in the US until 2007, if then*
Broad-scale adoption of Linux	Significant adoption of Linux	Some adoption of Linux

4.3.1   Phase 1: Highly technical users

Linux is already widely used as a workstation by computer programmers, system administrators, Hollywood animators, graduate students, and researchers in the sciences and other highly technical users. This class of Linux desktop users is mainly migrating from UNIX workstations.

4.3.2   Phase 2: Transactional workers, web-centric consumers

Many workers use only a very limited number of computer applications. Their workflow and job responsibilities are well defined. Substantial cost-savings can be realized by moving these workers to a computing platform that's "locked down" (ie. can't be changed by the user), free from viruses and other security risks and can be centrally administered. In Europe, pilot projects to deploy Linux for these types of transactional workers are already under way, and the all-important early success stories will become public later this year. US companies are, generally speaking, a little behind their European peers, so we expect that high-profile customer success stories are, for the most part, still 18 months or so away.

Web-centric consumers are another group of users for whom Linux may be an appropriate desktop solution. People who just want a cheap computer that allows them to browse the Internet, play music and check e-mail may be attracted to $200 computers running the Lindows or Lycoris Linux operating system.

4.3.3   Phase 3: Knowledge workers, small businesses, mainstream consumers

We believe it will take at least another four years before significant numbers of knowledge workers, small businesses and mainstream consumers adopt Linux, for reasons discussed below.

We believe that Linux adoption outside of the US will mostly follow the same adoption cycles as adoption in the US. However, it is quite possible that Linux adoption on the desktop will take place more quickly, and in greater numbers, outside of the US. For instance, while enterprises in the US are just now planning their Linux pilot projects, their European counter-parts may be already well into these projects. There are also countries where Microsoft Office's market penetration is not as high as in the US (Germany or Korea, for instance). Knowledge workers there may be more likely to convert to Linux. In developing countries, including Thailand and Brasil, government initiatives to support low-priced PCs for low-income citizens may boost Linux adoption among consumers.

In addition, there is a likelihood that Linux may be the more or less hidden OS on a broad range of less traditional computing devices – and one of those devices may become the killer device[8] that puts Linux in the hands of millions of consumers. This includes devices like TiVO, the Zaurus PDA etc.

5 DESKTOP LINUX: THE STATE OF THE PRODUCT

"Bill Gates was the first to realize the power of 'good enough.' We don't have to offer the perfect desktop environment, just one that's good enough for most people."

5.1 The desktop

There are two main desktop environments for Linux, KDE and GNOME. Both are fully open source and include a desktop environment, file manager, a number of administration tools, a set of applications ranging from simple games to integrated web browsers and full-fledged office productivity suites (in the case of GNOME, Ximian offers a version of OpenOffice that has been integrated with the rest of the desktop environment; the KDE organization offers its own office suite, KOffice) and a set of libraries and tools that help programmers develop applications for these desktop platforms. Ximian also offers a desktop updater called Red Carpet[9].

KDE and GNOME have both reached relatively mature status: these desktop environments still lack some of the polish of Windows XP or Mac OS X, but they are reasonably polished and stable, and include at least as many end-user applications as the main commercial desktop operating systems.

Each of the desktop projects claims that their project offers an easier migration path for Windows users. The reality is that both projects behave slightly differently from Windows, but both can be easily themed and configured to look, feel and behave quite similarly to Windows. While they can also be made to look very similar to OS X, few would argue that either project comes, as of yet, close to offering the same polished, integrated look and feel and ease of use.

Some people believe that the existence of two competing desktop environments creates confusion in the minds of users. While this may be true, neither project is likely to disappear anytime soon: each project has a significant base of developers and users, with GNOME more prevalent in the US due to favored treatment by Red Hat and Ximian's efforts to polish this product, and KDE more popular in Europe, where SuSE, which has invested more energy in polishing KDE, has a greater marketshare. Competition also has its positives, encouraging both projects to improve and adopt the best features of the other. Red Hat has focused on creating a unified look and feel for both KDE and GNOME, to the point that the user can hardly tell which environment they are in. Recently, the two projects have

pursued somewhat diverging strategies, with the GNOME project developing comprehensive user interface guidelines and focuses on developing a simple, elegant solution and removing some of the unlimited configurability that has long been a hallmark of open source projects, while the KDE project continues to offer its users an almost infinite number of configuration option. This divergence gives uses a richer choice, with different projects suiting the needs of different types of users. Increased cooperation between the two main desktop projects makes it easier for users to "mix and match" applications built for different desktop environments.

In sum, the two desktop environments are here to stay, but, encouragingly, they are pursuing somewhat different visions, resulting in more meaningful choice for users. It is also becoming easier to use applications built for GNOME with KDE, and vice versa.

Bottom line:[10] ☺

5.2   The desktop developer platform

KDE and GNOME are not just end-user desktops with assorted utilities, they are developer platforms, offering tools and development libraries to people who want to develop applications for these platform. Unlike Windows or the Macintosh OS, which each provide one desktop platform with a unified look and feel and one dominant developer environment, the existence of multiple desktop platforms for Linux, along with the small market share of the Linux desktop, has lead to a proliferation of desktop developer platforms on Linux, including not just KDE and GNOME but also WINE, a set of libraries that allow Windows applications to either run unmodified on Linux or be easily ported to Linux, and OpenOffice and Mozilla, which each come with their own programming environments. These platforms are not all equivalent, and each have their own reason for being, but the resulting heterogeneity makes it hard to offer a consistent end-user environment and can be bewildering for developers considering porting their applications to Linux.

It should be pointed out that efforts such as Galeon, the Mozilla-based web browser for GNOME, and Ximian's integration of OpenOffice into GNOME have risen to the challenge of integrating the Linux desktop. But many other end-user applications, from Adobe Acrobat, to Real Player, to, obviously, Microsoft Office running under CrossOver Office, or any application that's either running under WINE (Adobe Photoshop) or has been ported to Linux using the WINE libraries (IBM Home Page Builder), presents the same challenge, ensuring that offering a truly integrated Linux desktop will continue to be a challenge for years to come.

With no easy solution to this problem in sight, collaboration between the various projects and joint efforts at a lower level of the desktop stack –somewhere between the kernel and the desktop platforms— will be a key to the viability of the Linux desktop.

On the positive side, there are a number of solutions that make it easy to build cross-platform applications:

- Qt, a cross-platform toolkit, supports Linux, UNIX, Windows and OS X;
- The WINE libraries can ease the migration of Windows applications;
- Borland's Kylix development tools for Linux make it very easy to port applications from Windows and Delphi 7: porting can be as simple as recompiling applications with Kylix;
- wxWindows is an open source, cross-platform native UI framework used, among others, by OSAF's Chandler project;
- Java applications will run on Linux, UNIX, Windows, Macintosh and embedded devices.

"There is technology to write code once and to deploy on Windows, Linux, UNIX and the Macintosh platforms with little extra cost. Companies that plan to use heterogeneous desktops in the future, or even intend to switch totally, could start preparing today, either by developing against cross-platform APIs or by requiring their contractors to develop against cross-platform APIs." - Matthias Ettrich

Bottom line: ☺

5.3 Hardware support

5.3.1 Main devices

Linux can be easily installed on most desktop computers sold by major vendors these days, thanks to solid device support in the Linux kernel and with leading Linux distributions offering easy to use graphical installer software that features good automated hardware detection. It can still be a challenge, however, to install Linux on many popular laptops. Power management or screen brightness adjustment, for instance, are poorly supported on many laptops. And if the Linux installer doesn't identify the floppy drive or CD/DVD reader in a laptop's docking station, installing Linux can quickly become a daunting task.

This is more of a problem for reviewers (including, significantly, reporters and IT decision-makers) then for most average end-users, since few users ever attempt the daunting task of installing an OS on a computer. Enterprise users get their computers from system administrators who can either purchase systems with Linux pre-installed or who have a centralized system that automates the process of installing operating systems on a PC. Average home users, of course, use the operating system that came pre-installed when they purchased their computer.

Bottom line: Desktop computers: ☺ | Laptops: ☺

5.3.2 Peripheral devices

Peripheral device support has gotten a lot better on Linux, with software such as CUPS offering an abstraction layer that can identify and support a broad range of printers. Support for USB devices is also becoming more common on Linux. As a result, an enterprise looking to deploy hundreds of Linux desktops can easily purchase systems and peripheral devices that will be fully supported on Linux.

Still, too many devices remain unsupported or poorly supported on Linux. A consumer trying to make his MP3 player, DVD burner, storage peripheral, scanner, webcam, PDA or camcorder work under Linux is likely to give up in despair. Drivers may not be available for Linux. Some devices require recompiling the operating system's kernel. Devices that have been mounted onto the kernel may not automatically appear on the desktop. End-user applications may not recognize all the available devices. Graphical installation software for printers may not offer "discovery" of devices, graphically displaying which computers are available on the network, and which devices are available on each computer.

In sum, while it may be true that Linux already supports a broader range of peripheral devices then, say, the Macintosh platform, it is too often a lot harder (to put it mildly) for a Linux desktop user to install and get access to critical peripheral devices and a significant amount of work remains to be done before peripheral device support on Linux will be acceptable for a mainstream consumer. Some of the work needs to be done by device vendors, some of it by the Linux vendors, some of it by the maintainers of end-user applications.

One of the people we spoke with, Red Hat's Havoc Pennington, has proposed a hardware abstraction layer which would manage all the peripheral devices installed on a computer and provide an easy way for applications to recognize and support the relevant devices. Havoc's proposal is available at http://ometer.com/hardware.html.

Bottom line: Enterprise users: ☺ | Home users: ☹

5.4   Core apps: Browser

There are three mature (families of) web browsers available for Linux users: Mozilla and Mozilla-based browsers such as Galeon, Konqueror (the rendering engine of which is also used in Apple's Safari browser) and the commercial Opera browser. Each of these browsers (in the case of Konqueror, the browser's rendering engine) gets the majority of its users not from Linux users but from Windows or Macintosh users, so that the adoption of these browsers is not limited by the size of the desktop Linux market. Linux users can also run Internet Explorer under CrossOver Office.

While some sites don't display correctly on the browsers that are available to Linux users, the vast majority do. Plug-ins for the major multimedia file formats also work correctly under Linux. As a result, with some exceptions, Linux users in the US have few significant problems accessing web sites.

In Asia, the situation is somewhat different. Many popular sites are targeted and tested only on Internet Explorer and do not work at all with other browsers. For example, popular music sites in Korea use embedded Windows Media players and only run on Internet Explorer – and Internet Explorer for Windows, for that matter.

Microsoft's recent announcement that they will drop support for Internet Explorer on the Macintosh is good news for Linux desktop users. It means that large web sites that want to serve Macintosh users will have no choice but to test their sites on Safari, leading to more standards-compliant web sites. And since many web designers develop sites on the Macintosh, they are also more likely to

build more standards-compliant sites. This will benefit not just the Konqueror browser, but Mozilla, and all alternative browsers.

On the other hand, America Online's renewed partnership with Microsoft, as part of which AOL will continue to use Internet Explorer for years to come, raises renewed questions about the future of the Netscape browser.

Bottom line: US users: ☺ | Users in Asia: ☹

5.5   Core apps: PIM

Ximian's Evolution PIM suite deliberately mimics the look, feel and functionality of Microsoft Outlook, adding in powerful additional functionality such as vFolders. Evolution can also interoperate in a Windows environment, acting as an Exchange client for Exchange 2000 servers. The KDE project and the Mozilla suite also offer PIM functionality.

Chandler, an innovative PIM project currently under development at the Open Source Applications Foundation, has been designed to perform equally well under Linux, Windows and OS X.

The weakness of all of these projects is that they do not interoperate with all versions of Microsoft Exchange (Exchange 5.0, for instance, is not supported by Ximian Evolution) and do not always easily synchronize with PDAs, cell phones, popular web portals etc.

Bottom line: Standalone users: ☺ | Users who interoperate with Exchange or use PDAs etc: ☺

5.6   Core apps: Productivity suite

OpenOffice and StarOffice, the commercial version, are by far the leading productivity suite on Linux, but there are other choices. Corel continues to offer WordPerfect on Linux. The KDE project offers KOffice. AbiWord and Gnumeric, while less integrated than KOffice and OpenOffice, have also emerged as mature projects that provide good, modular applications that serve their target market and in many regards compare favorably to OpenOffice and even Microsoft Office.

After more than 10 years of development, OpenOffice is a complete, mature product that adequately reads and writes most Microsoft Office files[11], and the version released by Ximian as part of the Ximian Desktop 2.0 integrates reasonably well with the rest of the Linux desktop.

Fairly aggressive marketing of StarOffice, which also runs under Windows and a number of other operating systems, by Sun Microsystems, combined with resistance towards Microsoft's newest licensing schemes have lead industry analysts to conclude that StarOffice is likely to capture up to 10% of the office productivity suites market by 2007[12].

Still, while OpenOffice boasts a feature set that meets and, in some cases, exceeds Microsoft Office, Microsoft Office offers a far more polished user interface and user experience than its open source competitor. The icons and templates that ship with OpenOffice lag behind those provided by Microsoft Office and more work remains to be done for OpenOffice to smoothly integrate into the

Linux desktop. Also, while the licensing by SuSE and Ximian of commercial fonts that mimic the main Windows fonts, has made it a lot easier to correctly display Windows documents on Linux, file incompatibilities continue to be a concern for knowledge workers looking for an alternative.

"The last mile for OpenOffice/StarOffice still needs to be funded by someone."

We anticipate that it will take at least two more years before the industry press and other opinion leaders declare OpenOffice "compatible" with Microsoft Office, assuming that Microsoft does not create significant new file-format obstacles to its challengers (a risky assumption given the company's past practices). To be fair, even Microsoft doesn't achieve perfect compatibility between different versions of Microsoft Office. The OS X version of Microsoft Word, Word 2000 for Windows and the Word Reader software all have slight incompatibilities, not that dissimilar from the problems OpenOffice users face.

Bottom line: Transactional workers: ☺ | Knowledge workers: ☹

5.7   Core apps: Instant messaging

GAIM, one of the leading open source instant messaging products, supports AIM, Yahoo Messenger, MSN and ICQ. GNOME Meeting is compatible with Microsoft Meeting (if you can get your webcam to work under Linux). The open source Jabber instant messaging system shines on Linux. In sum, instant messaging is one of the areas where Linux shines.

Bottom line: ☺

5.8   Core apps: Multimedia support

Flash, Adobe Acrobat and Realplayer are all available under Linux. Windows Media Player and Quicktime can be run using CrossOver Plugin. Still, multimedia support is problematic for many Linux desktop users, with MIME type settings confusing under most environments and many popular sites, such as Yahoo's video services, not working on Linux without major tweaking. Part of this is due to patents conflicting with the GPL and being generally unfriendly to open source, an issue that looms over other parts of Linux as well.

Bottom line: ☹

5.9   Other applications

While there are thousands of applications available for free under Linux, few popular commercial consumer titles are available on Linux. There is financial management software available for Linux users, but not Quicken or Microsoft Money. Most popular games are not available on Linux, although a company called TransGaming Technologies has made hundreds of leading Windows games run properly under Linux based on WINE.

The reality is that the best effort to offer a consumer catalog of end-user applications, Lindows' Click & Run Warehouse, is still a somewhat drab affair when compared to the aisles of commercial software

available to Windows users. This situation is unlikely to improve for several years. Even if Linux secures a larger place of the desktop market than the Macintosh OS, many of these desktop users are likely to be transactional workers, not consumers who purchase lots of commercial applications. It should also be pointed out that the Macintosh ISV industry is tiny when compared to the Windows ISV community. When consumer applications are ported to Linux, they are likely to be ported using the WINE libraries, and look and feel like Windows applications, integrating poorly with the rest of the Linux desktop.

Nonetheless, as a practical matter the continued improvement of WINE and the WINE libraries will continue to be important for gamers and other consumers wishing to move to Linux.

Fortunately, applications are increasingly moving to the web. Consumers playing games on Yahoo, or enterprise workers running Java applications in a web browser may find Linux to be a fine client platform in most cases.

Bottom line: ☹

5.10   Connectivity with Windows

There are any number of ways for Linux users to interoperate with Windows users:
- **Dual booting**: Linux and Windows partitions can be installed on the same computer, allowing the user to choose at start-up time which OS they wish to boot in;
- **Network access**: Linux users can more or less readily access Windows network volumes using the SMB protocol. Lycoris, Lindows and Ximian users, for instance, have access to a GUI network device utility that is very similar to My Network Places under Windows, allowing them to easily access Windows volumes;
- **Virtual machines**: solutions like VMWare and Win4Lin allow Linux users to install Microsoft Office as a virtual machine, and run Windows, complete with any Windows application, in a window on their Linux desktop;
- **Terminal servers**: products such as Citrix's Linux client or Tarantella's Enterprise 3 allow Linux users to remotely run Windows applications in a window on their Linux desktop;
- **Windows emulation**: WINE and its commercial offspring, CrossOver Office/Plugin and WineX allow users to run Windows applications as-is under Linux. This works great for Microsoft Office, Internet Explorer, Windows Media Player, and Adobe Photoshop, for instance. Other applications, including Macromedia Dreamweaver, almost work – these applications either crash occasionally, or are lacking specific functionality (such as FTP support in Dreamweaver);
- **File format compatibility/functional equivalents**: As discussed above, applications such as Ximian Evolution and OpenOffice offer varying degrees of file format compatibility, cloned functionality or ability to integrate in a Windows environment.

All in all, there is an impressive range of connectivity solutions for Linux users who need to interoperate with Windows users. These solutions go a long way towards solving the compatibility problem for Linux.

Bottom line: ☺

6   THE DESKTOP LINUX ECO-SYSTEM

Above, we reviewed the functionality and competitiveness of the different parts of the Linux desktop stack. In this section, we take a look at the health of the different parts of the Linux desktop "eco-system" – largely, we examine the availability of a critical mass of development activity at the different levels.

6.1   Linux distributions

The Linux project lead by Linus Torvalds is not an operating system. It is the kernel of an operating system. Linux vendors such as Red Hat and open source efforts such as the Debian project, focus on offering complete operating systems, which include hundreds of drivers, utilities, development tools and both server- and end-user applications.

While Red Hat is the global leader in the Linux industry by a significant margin, it has a healthy number of competitors, including SuSE and MandrakeSoft in Europe, Red Flag Linux, Turbo Linux, and Hancom Linux in Asia and Connectiva in Latin America. Thanks to the open source nature of the OS, there are few barriers to entry, and there are customized Linux distributions for numerous countries and user profiles. In the US, for instance, many universities maintain their own Linux distributions, often derivatives of Red Hat Linux with just minor modifications.

There are also a number of open source collaborations that produce Linux distributions, most prominently the Debian and Gentoo projects.

Debian, it so happens, is also the basis for two of the most visible desktop-oriented Linux distributions, Lindows and Xandros.

While a number of Linux distributions have gone out of business or are struggling financially, and while Red Hat is increasingly emerging as the global brand leader, there is a rich ecosystem of Linux distributions that each meet unique niches.

These projects compete in the market place, but there is often close cooperation at the engineering level, and there are some business partnerships (eg. United Linux).

Bottom line:[13] ☺

6.2   KDE, GNOME, other desktops platforms

KDE and GNOME are the leading open source desktop projects. Each of them counts hundreds of volunteers developers, supplemented by tens of employees contributing to the projects on behalf of companies with a vested interest in Linux (SuSE, Ximian, Sun Microsystems etc.). In addition to KDE and GNOME, there are a number of smaller desktop efforts. Most of these focus on delivering a desktop, as opposed to the full desktop environment (including developer platform and suite of end-user applications).

Both KDE and GNOME continue to sport a lively community and significant market place momentum. Neither project is likely to disappear, and there is no real prospect of the two projects 'merging'. Each of the projects has ensured corporate sponsorships including, in the case of GNOME, a paid staff position, that help the projects organize developer conferences and the like. There are also increasing efforts to improve interoperability between the two environments, so that users can mix and match applications from both platforms without sacrificing a consistent experience.

Likewise, other development platforms such as WINE, OpenOffice and Mozilla, have each succeeded in attracting a critical mass of developers and users.

Bottom line: ☺

6.3   Open source application developers

The Sourceforge project has made a significant contribution to the way open source applications are developed, offering a suite of tools to develop software in a collaborative fashion. The site hosts tens of thousands of open source projects, the best of which rapidly gain popularity as word spreads throughout the online communities of Linux users.

The tools and infrastructure offered by Sourceforge are supplemented by other major projects, such as Mozilla, the Linux kernel project, OpenOffice, GNOME and KDE. These large-scale projects incubate tools such as Bugzilla and serve as training grounds or reference points for individual developers who strike out and start their own projects.

The combined toolsets, know-how and open source code base are hard to match and explain to a large extent Linux's success as a server operating system.

There are also thousands of open source end-user applications. However, if we look beyond the leading projects, we find a set of applications with often incomplete feature sets or unpolished, inconsistent user interfaces. This is hard to remedy in an open source settings, where applications are typically developed by programmers wishing to "scratch an itch," as opposed to entrepreneurs itching to meet a need and make a buck. One noteworthy development in this regard are the GNOME project's user interface guidelines. All of the GNOME applications have benefited from these guidelines, which may make an important contribution to the establishment of a collection of applications and utilities that share a uniform and consistent user interface.

Bottom line: quantity: ☺ | quality: 😐

6.4   Commercial end-user ISV community

There is no end-user Linux ISV industry to speak of. The leading consumer desktop applications for Linux are either open source (Mozilla, OpenOffice) or Linux ports of free utilities (Adobe Acrobat, Realplayer, Flash).

The small number of commercial desktop applications for Linux are mostly connectivity building blocks (CrossOver Office, Lin4Win) or inexpensive ports that use the WINE libraries (IBM Home Page Builder). TheKompany and Hancom Linux are exceptions, struggling to build a viable business offering end-user software to Linux users.

It is unclear whether this situation will ever really change. It should be noted that even the Macintosh ISV community appears to be steadily shrinking, with more and more OS X software developed by individual developers or small businesses on a shareware model. In the case of Linux, even if desktop adoption does continue to increase, we predict that the majority of users will be in the enterprise, education and public sectors, and are likely to rely on open source applications, specialized enterprise applications and web-based applications, leaving few opportunities for a desktop ISV community.

In view of the limited market potential, we predict that most consumer software for Linux will continue to use WINE libraries. The cross-platform Qt toolkit, combined with Borland's cross-platform developer suite may be a logical choice for enterprise applications.

Fortunately, the absence of a significant range of commercial end-user desktop applications does not spell the failure of Linux on the desktop.

Bottom line: ☹

6.5   OEMs

Hundreds of white-box vendors ship PCs that come with Linux pre-installed. Lindows alone claims to have signed up more than 100 such OEM partners.

Some leading US OEMs offer workstations or desktops with Linux pre-installed, mostly outside of the United States. Some leading OEMs outside the US also ship Linux desktop systems. Still, in view of Microsoft's tremendous power over OEMs, mostly through joint marketing and discount programs, major OEMs will continue to be very reluctant to put real muscle behind Linux-based desktops until there is a clear demand for these systems. After all, they stand to lose tens (if not hundreds) of millions of dollars in Microsoft marketing funds and discounts.

Vendors have made important contributions to the Linux desktop though. For instance, Sun Microsystems played a critical role in adding accessibility ("Section 508") technology to the GNOME desktop, which is the reason, for example, that the US Department of Defense is even able to consider Linux on the desktop.

Bottom line: ☺

6.6   Distribution channels

Like OEMs, PC retailers stand to gain a lot if Linux emerges as a real competitor on the desktop. All of them devote a significant amount of their shelf space to Microsoft products, some (including Best Buys and, in California, Fry's Electronics) also offer house-brand PCs.

Like OEMs, retailers are wary of falling from Microsoft's good graces, as they too stand to lose millions of dollars in marketing dollars and promotions. There are some notable exceptions to this rule, such as Walmart and TigerDirect, each of which offer both systems without operating systems and Linux-based desktops.

With commercial applications lacking, and OEMs and retailers relunctant to embrace Linux desktops, it is easy to see why it will take years before consumers start adopting Linux in meaningful numbers.

Bottom line: ☹

6.7   Consortia, other organizations

United Linux, the most high profile industry alliance uniting Germany's SuSE, Brazil's Connectiva, US-based SCO Group and Turbo Linux in an effort to offer a unified Linux distribution that could become a real standard, has suffered severe setbacks lately as Turbo Linux withdrew from the US market and SCO Group abandoned its Linux products as part of its lawsuit against IBM.

There are a number of other collaborative efforts in the Linux community that, while less high-profile, are each making meaningful contributions to Linux' long-term success, including success on the desktop:
- **Open Source Development Labs (OSDL):** a joint effort between a number of industry leaders, including Dell, Fujitsu, Hitachi, HP, IBM and Intel, OSDL focuses on improving Linux as an enterprise-grade operating system. The organization recently made the news when it recruited Linus Torvalds as its first fellow, allowing Linus to finally dedicate his full-time efforts to the Linux kernel;
- **The Linux Standards Base**: a working group of the Free Standards Group, this is an effort to create a standard to which all Linux distributions adhere, allowing software developers to build applications that will install and run on any LSB-compliant distribution. The first version of the LSB has been adopted, and LSB-compliant distributions (including Red Hat Linux) are now available;
- **The GNOME Foundation**: while this organization does include an industry advisory board, the foundation is mostly a governing body for the GNOME project. The foundation's board of directors, elected by GNOME contributors, oversees GNOME releases and sets strategy for the project, helping keep this super-sized "project of projects" moving in one direction;
- **The KDE League**: the KDE League focusing mostly on PR activities for the KDE project;
- **Freedesktop.org**: an informal collaboration, mostly between GNOME and KDE developers, that has already lead to improved interoperability between these two desktop environments;
- **GWU's Center on Cyber-Studies**: affiliated with George Washington University, this think-tank has recently added a number of open source leaders to its advisory organization. The center has organized several conferences on Linux in Government which are important forums for public-sector officials interested in Linux and open source;
- **Consumer Electronics Linux Forum**[14]: a new industry consortium that includes Matsushita, Sony, Hitachi, NEC and other consumer electronics companies that want to collaborate on making Linux more appropriate for consumer electronics devices through

joint development in areas such as improved boot-up time and better performance in digital video recorders.

- **OpenForum Europe**: a subsidiary of technology lobbyist InterForum that aims to persuade businesses around Europe of the benefits of open source software, and to level the playing field for open source when it comes to government procurement.

In sum, there are a number of organizations where stakeholders can work together to address issues that need to be resolved in order to ensure broader adoption of Linux. These organizations also contribute to Linux' success on the desktop.

Bottom line: ☹

6.8   News, conferences and support resources

There is a broad range of information materials available to people interested in Linux, ranging from publications such as Linux Journal and Linux Magazine to news sites such as Linuxworld, Linux Today, Linux Weekly News and Slashdot. People interested in Linux on the desktop can go to Desktoplinux.com, among others.

There are also a number of Linux trade shows and conferences, including Linux World, Linux Tag, Ottowa Linux Symposium, Enterprise Linux forums, the GNOME project's GUADEC conference, the Open Sources conference, Lindows' Desktop Linux Conference and more.

Most importantly, perhaps, there are hundreds of Linux Users Groups, mailing lists and message boards where Linux users can go for help. The mailing lists and message boards offer an unmatched online support system that allows Linux experts to solve their problems. Many of these lists, however, are inaccessible to end-users, given the often cryptic and jargon-laden way in which the experts offer assistance. End-user oriented businesses, and Lindows in specific, do offer lively discussion boards that solely focus on helping end-users, but finding simple, end-user oriented answers to user-space questions such as "My DVD burner doesn't work. What do I do?" can be a daunting task in the Linux world.

Bottom line: 😐

6.9   Customers

While Linux has achieved near-mainstream adoption as a server operating system, these are still very much the early days of Linux desktop adoption. Most Linux adoption continues to take place among highly technical users. As a result, there is a lack of success stories about Linux adoption on the desktop and, for average consumers, there is no critical mass of peers who are using Linux. The emergence of enterprise, public sector and SMB success stories will be critical to Linux' success on the desktop.

Bottom line: ☹

7   MARKET ADOPTION

Last July, IDC released a report on Linux desktop adoption where it anticipated an installed base of 9.5 million Linux desktop for 2003, a number it expects to grow to 27.8 million desktop users by 2006 (versus 9 million Linux servers). IDC predicts a CAGR of 44% for desktop Linux over the next 4 years and, by 2006, a marketshare of 7% of the installed base and 10% of new unit shipments. According to IDC, Linux desktop shipments outstripped Macintosh shipments in 2002. By 2006, Linux will likely have a larger installed base than the Macintosh OS.

We should remind readers that counting Linux adoption is an inexact science at best due to the open source nature of the OS: people can download Linux from any number of mirror web sites, burn and redistribute their own CDs, or install Linux on thousands of desktops across an enterprise from a single purchased copy. Also, IDC's surveys indicate that Linux users tend to upgrade their systems at a much higher rate than users of other operating systems. Still, the general picture is clear: Linux is already in use by millions of users and these numbers will continue to increase rapidly, with industry analysts seeing Linux take up anywhere between 7% and 20% of the installed base by the end of the decade, and Linux outpacing the Macintosh OS as the alternative to Windows on the desktop over the next few years.

7.1   Technical users

Linux has already made significant strides in gaining over technical users such as engineers, system administrators, scientists, 3D animators etc. As these users deploy Linux, they often end up making contributions that benefit all Linux users, paving the way for the next wave of Linux adoption.

Example: Dreamworks' new Sinbad: Legend of the Seven Seas was entirely created on Linux workstations and rendering machines[15]. Dreamworks uses about 1000 Linux workstations. Industrial Light & Magic has also switched to Linux workstations, and Disney is deploying Linux as well. Hollywood animation studios often deploy Linux-based render farms and follow that up with Linux workstations for the designers. Some of the studios even take advantage of unused CPU cycles on the workstations to have them contribute to rendering jobs during designers' lunch breaks. One of the studios asked CodeWeavers for help in making Adobe Photoshop run under Linux. With CodeWeavers contributing all their code back to the WINE project, all Linux users are now able to run Adobe Photoshop under Linux, another example of the open source network effect.

7.2   Transactional workers

Many workers use only a very limited number of computer applications. Their workflow and job responsibilities are well defined. Customer support staff, bank tellers, sales reps, administrative staff or even many lawyers spend almost all of their time using just a few applications and don't need the ability to run arbitrary third-party applications. Substantial cost-savings can be realized by moving these workers to a computing platform that's "locked down" (ie. can't be changed by the user), free from viruses and other security risks and can be centrally administered. The ability to save hundreds of dollars on each workstation by using open source software is a secondary advantage. Training costs, while significant, are not necessarily a blocker for Linux.

Example: 2% of the American workforce works in in-house or outsourced call-centers. These are the people that answer the phone when you call a customer service number. We talked to an IT

manager at one of the nation's largest credit card companies. He's currently rolling out Linux as the desktop platform for hundreds of technical workers in his firm. Once Linux has proven itself for that class of workers, he wants to convert several thousand call center workstations to Linux-based thin-clients. Terminal servers such as Citrix and open source tools such as RDesk will allow him to deploy Windows applications to these Linux clients, but his real goal is to convert the legacy Windows client applications used in the call center to Java applications that will be delivered to a Mozilla web browser on Linux. He plans to use almost exclusively open source software such as Mozilla and OpenOffice and isn't worried about technical support: "IBM, HP, Red Hat and SuSE would all be delighted to provide support for us." And if call center staff can't install their favorite IM software or MP3 player, that's fine for the IT manager, since it makes life easier for his system administrators.

Example: An IT manager at one of the leading IT outsourcing companies told us he wasn't worried about training costs. When his firm signs up a new client, the company may hire hundreds of new employees for engagements lasting at least six months. The new agents go through a six-week training period. The least of his training challenges is teaching workers how to use the desktop environment. Getting to know the hundreds of obscure features of the custom software that each client provides is a lot more challenging. The big challenge is making the new employees intimately familiar with this custom software so they can provide professional assistance to customers.

7.3   Knowledge Workers

We believe it will take at least another four years before significant numbers of knowledge workers in the US adopt Linux, for a number of reasons:
- Exchanging documents with the rest of the world is not an occasional task for them, it is the lifeblood of their livelihood. "OpenOffice will properly display *almost* any PowerPoint presentation" is just not good enough for them;
- They want and need the ability to install arbitrary applications on their system. They may have an application or macro they've relied on for the last 10 years that they never want to give up;
- They've fine-tuned their desktop and developed work-habits on their computer that suit them perfectly. They're in no hurry to give up a trusted, proven OS for something new and experimental that was developed by a group of hackers that creates features that "scratch an itch," as opposed to in response to market research. In Neil Stephenson's words, they may not want these "freaks" coming to their house[16]. And they're not impressed by an application that has "all the features and more" of the application they're familiar with, if it lacks the polish and integration they've gotten used to;
- The software cost is relatively small compared to the value-add of these workers.

7.4   SMB sector

At least one analyst is upbeat about Linux prospects in the small and medium-sized business sector (SMB). Based on her customer research, Laura DiDio at the Yankee Group believes that these businesses are ready to move to Linux for a couple of reasons:
- The transition to another desktop is easier and less traumatic than at larger companies, and decisions can be made more quickly;
- Small businesses are most sensitive to cost issues than large enterprises;

- Linux has proven itself as a server operating system, and applications such as StarOffice help position Linux as a credible desktop platform.

According to Ms. DiDio, the main concerns for these businesses are:
- Clearly understanding the TCO of Linux versus Windows;
- Clearly understanding transition and retraining issues;
- Having a reliable source of support.

HP's recent announcement of a line of affordable desktops with Linux pre-installed that are geared at small businesses also points to small business interest in Linux desktops[17].

In response, the Yankee Group is preparing a set of documents that help businesses in the SMB sector understand TCO, transition and retraining issues, so that they can make an informed decision about whether to transition to Linux.

According to this analysis, there could be a significant opportunity for desktop Linux companies like Xandros, Lycoris or Lindows to offer tools that assist companies in transitioning to Linux and provide 24/7 support for Linux. Lindows, in particular, with its network of OEM partners, may be well equipped to tap into this opportunity since it already has partners (white-box vendors) in the field whose customers, in many cases, are the SMBs Ms. DiDio is talking about.

Still, we believe that significant SMB adoption of Linux desktops remains elusive for now, for much the same reasons that we believe that knowledge workers' move to Linux is at least several years away:
- Concerns about file-format compatibility. Document exchange with suppliers and customers is mission-critical to many small businesses;
- Less narrowly-defined job descriptions and fewer training opportunities mean that SMBs are more reliant on their employees' ability to maintain their own systems and are less open to deploying non-mainstream applications;
- They may not have access to in-house technical support, so they're much more careful about deploying experimental technologies, and more reliant on technical support provided by ISVs. CrossOver Office does a great job running Microsoft Office, but SMBs will worry whether Microsoft will provide assistance if something goes wrong (probably not).

7.5   Education

Like small businesses, educational institutions are very price-sensitive. Like enterprises, they are relatively centralized institutions. At first glance, this would seem to indicate that they hold great promise for Linux. There are significant opportunities, but Linux is not the right solution for every educational institution.

In the K-12 sector, there are major obstacles to broad-based desktop Linux adoption. Cash-strapped schools and other educational institutions are eager to realize cost-savings. On the other hand, they are reluctant to train students on non-mainstream tools and K-12 institutions in particular rely largely on educational software that is not currently available on Linux. In K-12 institutions, maintaining computers often depends on the ingenuity of teachers, students and volunteers, who are most likely

not familiar with Linux. Nonetheless, there is a community of K-12 educators that focuses on introducing open source solutions to elementary and secondary schools, at SchoolForge[18]. And, of course, there are major deployments taking place outside of the United States, such as the deployment of 80,000 Linux desktops in Spanish schools.

Things look more promising in universities and colleges:
- Many universities are traditionally UNIX shops that have started to migrate much of their server infrastructure to Linux running on PCs, in order to save costs. System administrators may be reluctant to become beholden to Microsoft. Many campuses have active Linux Users Groups that are advocates for broader Linux adoption;
- Graduate students and faculty in the sciences are already using Linux workstations in large numbers. If they're not, they probably log on to UNIX or Linux computing systems to run simulation and other computationally intense tasks. When this type of deployment of Linux workstations reaches critical mass, entire departments may standardize on Linux. The department, in turn, serves as a test-bed and model for other departments;
- Data archivists on campus technology policy committees worry about the ability to access old documents as technology evolves. Techies on the committee worry about open standards more generally. They may work together to recommend Linux desktop deployments to managers eager to save money. And many universities are quite centralized, with central technology offices able to impose standards and practices campus-wide.

As a result, we predict that, over the next 2 years, there will be an increasing number of desktop Linux deployments on universities. Many of these deployments will happen in sciences departments.

We expect one of the drivers of this development to be a movement towards open file formats. We expect that a number of universities will respond to librarians' and IT staff's concerns about open file formats by standardizing on open file formats for data interchange. The most likely beneficiary of these policies is likely to be the OpenOffice suite. We believe that more and more universities will set up OpenOffice in public access computer labs and making the application available to their students. While initial deployments of OpenOffice will mostly happen on the existing Windows computers, once students switch to OpenOffice, a major barrier to Linux adoption has been removed.

Example: The Physics department at Duke is almost exclusively Linux based. Approximately 100 graduate students, faculty and even administrative staff, do their work on Linux desktops. When necessary, the administrative staff boots up VMWare to run Microsoft Office. "Having administrative staff run MS Office using VMWare on Linux is a lot more secure and easier to administer then if we were running Windows desktops," boasts the department's system administrator. Like many other universities, Duke maintains its own Linux distribution based on Red Hat Linux. One of the sysadmins at the university also maintains Yum, a modified version of the Yellow Dog Updater that is used, among others by the ASPLinux distribution.

7.6   Public Sector

There are a wealth of Linux success stories in the public sector, mostly on the server side. Governments around the world are studying open source and promoting the adoption of Linux among public sector companies and agencies in a number of ways. Public sector consideration of open source alternatives often includes exploring the use of Linux on the desktop. We expect the public sector to be one of the major drivers of desktop Linux adoption.

Success stories of Linux desktop deployments in government agencies in the United States are now emerging. The City of Largo in Florida, where several hundred desktops were switched to Linux, is one of the most high-profile cases here. While there have been several promising developments at the federal level, it is at the municipal level that Linux desktops are most likely to be deployed in the US. As noted by Tom Adelstein in his review of Linux efforts by state and local governments[19], the Business Software Alliance, Initiative for Software Choice, Computing Technology Industry Association, American Electronics Association and Association for Competitive Technology all actively lobby against state initiatives to promote open source, including proposed legislation in Oregon and Texas.

Example: City of Largo[20]: In 2001, the Florida city of Largo switched from aging terminals to a thin-client environment based on Linux. Today, 5 people support more than 450 clients and over 800 users. The thin clients can be bought new for around $750 but are often purchased used for as little as $5 each. The network is powered by several Compaq servers running Red Hat Linux and the Oracle database. Clients run a KDE desktop, but can run Excel and Powerpoint thanks to Citrix System's Metraframe Windows 2000 terminal server. As noted earlier, the availability of terminal servers that can provide Linux clients with access to Windows applications is key to many organizations moving to thin Linux desktops.

Example: City of Houston[21]: After failing to negotiate an acceptable license agreement with Microsoft, the City of Houston this January started phasing out Microsoft Office in favor of SimDesk, a web-based office suite offered by a local company. While SimDesk is being deployed on Windows, the move away from Microsoft Office as part of a thin-client solution is a good example of the search for alternatives coinciding with renewed interest in thin client solutions. As recently reported in Linux Journal, the migration is progressing smoothly and the city is now exploring Linux-based alternatives[22].

7.7   Consumers

We believe that mainstream consumers in the US are least likely to adopt Linux as a desktop operating system. The absence of Linux desktops offered by mainstream vendors, scarcity of end-user applications, poor support for peripheral devices, the remaining lag in user-friendliness and the poor availability of end-user documentation and technical support will conspire against broad-based Linux adoption by consumers for a number of years to come.

There may be a limited demand for Linux-based alternatives by a relatively small-number of web-centric consumers who just want an inexpensive computer that offers Internet access and multimedia support.

7.8   Non-PC devices

Linux is likely to continue to be deployed as the operating system of choice for a growing range of non-PC devices, ranging from kiosks, web terminals, digital video recorders and PDAs to cell phones.

In some cases, the use of Linux in these devices will help strengthen Linux as a desktop alternative. The development and deployment of Linux-based kiosks and web terminals may lead to contributions to Linux desktop projects, web browsers etc. If a Linux-based web-browser secures a significant user base, that well help ensure that web sites will run properly on Linux.

In other cases, the underlying OS of popular new devices is likely to have relatively few benefits for desktop users. Linux' use for devices such as TiVo or the Danger hybrid cell-phone/PDA has few short-term benefits for desktop Linux users, but helps build momentum for the platform overall and may result in code contributions to Linux.

Example: On July 1, 2003, a group of leading consumer electronics companies announced the creation of the Consumer Electronics Linux forum to adapt and advance Linux for use in consumer electronics. Its efforts to improve Linux' boot-up time and video performance may well benefit all Linux desktop users.

7.9   Outside of the United States

The dynamic of Linux adoption in the US and Europe is very similar, with Linux adoption in Europe recently appearing to advance at a more rapid pace than in the US. Outside of the US and Europe, Linux adoption, including on the desktop, holds even more promise, for a number of reasons:
- As a result of education efforts by a number of different organizations, governments are increasingly sensitive to the importance of open standards;
- The public sector, businesses and consumers alike are much more price-sensitive in developing countries than consumers in the US and Western Europe;
- Anti-piracy efforts force people to obtain legitimate copies of software, and Linux is available free of charge;
- A desire by many governments to support a fledgling local software industry and control their own IT future;
- Especially in the wake of the Iraq war, there is an increased weariness of a United States perceived by people throughout the world as heavy-handed and controlling. People and governments around the world are eager to have a greater degree of independence when it comes to maintaining their IT infrastructure, rightly regarded as a critical part of their economic infrastructure. Many governments are wary about backdoors and other hidden features in technology that's controlled by US corporate interests;
- A smaller installed base means that it is easier to adopt non-Microsoft PCs.

While in some countries in Europe (eg. Germany), enterprises are leading the way for Linux adoption, the public sector is often driving Linux desktop adoption outside of the United States. Publics sector efforts range from studies that evaluate the state of open source, to directives that open source be considered where appropriate, to actual deployments.

Example: In India, IBM recently launched its first Linux desktop computer, the $850 NetVista A30 and a Washington-based startup called Linare is targeting its $200 Linux desktop largely at the Indian market. India's President Abdul Kalam recently confronted Microsoft Chairman Bill Gates, telling him that open source offers important security benefits and that open source offers developing nations such as India the best opportunity to modernize.[23]

"The Indian market is going to be very price-sensitive. And they may be less (concerned about) compatibility, since they don't have as huge an infrastructure tied into Windows. And despite a large middle class, Indians don't buy as many computers as do United States residents. They're called the software powerhouse of Asia, but they take only 2 million units a year" - IDC analyst Roger Kay[24].

"In India, open-source code software will have to come and stay in a big way for the benefit of our billion people."[25]

Example: One year ago, the German Minister of the Interior signed an agreement with IBM for the advancement of open source software in the administration. Over the last year, the number of migrations to open source has increased dramatically. The Federal Cartel Office, the Monopoly Commission, the Federal Commission for Data Protection and the Institute of Animal Experiments have all partially or entirely converted their IT infrastructure to Linux and other open source projects. A total of 500 public agencies have applied to join the outline agreement[26].
Example: The most high-profile Linux desktop deployment to date was announced on May 28, 2003, when the city council of Munich, Germany's third largest city, approved the Mayor's proposal to migrate 14,000 desktops and notebook computers to Linux[27].

"In the public sector in Germany we have seen a variety of new implementations of open standards-based software such as Linux. And worldwide, more than 75 IBM government customers--including agencies in France, Spain, UK, Australia, Mexico, the United States and Japan--have now embraced open computing and Linux to save costs, consolidate workloads, increase efficiency and enact e-government transformation." - Walter Raizner, Country General Manager IBM Germany [28]

Example: In Thailand, the Information, Communications and Technology Ministry recently launched a plan to offer up to one million low-priced PCs. To date, more than 160,000 of these computers, loaded with a Thai version of Linux, have been sold. 30,000 people showed up for the launch event of this initiative. Microsoft responded by offering a $35 version of Microsoft XP and Office for the Thai market.[29] OpenOffice reports that a Thai derivative of OpenOffice has sold 1 million copies.

The deployment of large numbers of low-cost Linux desktop computers doesn't always lead to an increase in the number of Linux users. As was pointed out by Gartner analyst Dion Wiggins, "Thailand is a market where pirated software is freely available. It's to be expected that a significant number of buyers of the Linux PCs will go home and reload them with a pirated copy of Windows."[30]

More generally, there is a risk that poorly planned, poorly supported, government-mandated deployments of Linux will fail, causing disillusioned end-users to wipe their hard drives, install a pirated version of Windows, and tell their friends never to try Linux. This is why analysts such as Tony Stanco caution against mandated Linux deployments, arguing instead in favor of education and training efforts and efforts to "level the playing field."

Desktop Linux momentum outside of the U.S.

14,000 seats	Munich city government
80,000 seats	Schools in Extremadura, Spain
1,000,000 seats	People's PCs in Thailand

8   THE FUTURE

8.1   <u>Assumptions</u>

- The economic environment will moderately improve over the next two years. A continued slump would further accelerate the deployment of Linux on the desktop: the longer than expected economic downturn is already driving enterprises and public agencies to look harder at their IT budgets and consider inexpensive alternatives;
- There will be no major discontinuity in the ability of Linux productivity software to read or write Microsoft Office documents. If Microsoft were to totally break with its current default file formats, that could set back file format compatibility. This is quite unlikely though, given customer pressures that Microsoft is facing. Conversely, if Microsoft's move to XML-based file formats were to make it dramatically easier to offer file compatibility, that would benefit Linux, as it would remove the biggest single obstacle to broader Linux adoption. This, too, is unlikely. Based on early reviews of Microsoft Office 2003, OpenOffice developers claim that when saving documents in XML format, Office 2003 strips XML files of all presentation and formatting information[31];
- Despite intense lobbying efforts and aggressive price cuts, Microsoft will not be able to stop the flood of government-led efforts around the world to promote the adoption of Linux on the desktop, since cost considerations are just one of the motivations for these efforts;
- Microsoft will try to avoid repeating marketing blunders like the introduction of its new licensing scheme, but will continue to aggressively steer increasingly reluctant enterprises to upgrade their desktop software. Now that the Linux desktop has matured, companies will be much more willing to consider moving to Linux if Microsoft commits further major blunders in the way it maintains its relationships with major enterprises;
- There will be no dramatic changes in desktop computing over the next few years;
- The SCO lawsuit against IBM will be resolved in a way that does not jeopardize the future of Linux;
- It will take several more years for WINE to be able to run the majority of third party Windows applications flawlessly. As discussed below, an acceleration of the development of WINE could remove, or at least reduce, one of the major obstacles to consumer adoption of Linux.

8.2   <u>Predictions</u>

- Responding to efforts such as the People's PC project in Thailand, Microsoft will dramatically cut prices in selected developing countries. Microsoft has incentives to aggressively cut prices in some parts of the world: offering lower-cost versions of its software not only helps beat back Linux-based desktops, it may also benefit the bottom-line, even in the long term. The incidence of software piracy in developing countries is very high, often more than 90%, so the company can increase revenues if, by dramatically lowering its prices, it can boost legitimate installations. Making its software more affordable is a way to combat piracy and maintain its dominance in the desktop market;
- The Linux desktop will continue its current pace of gradual improvements and will be increasingly perceived as a reasonably mature, "good enough" alternative to Windows;
- Within the next four years, Linux may achieve as much as 10% market share worldwide on the desktop and will account for an even larger percentage of new shipments;

- Linux desktop deployment will first happen outside of the United States and will be fueled to a significant extent by public sector deployments similar to recent moves in Munich, Extremadura and Thailand;
- Linux desktops will be adopted in enterprise environments over the next four years, but, in the United States, almost exclusively by highly technical workers and transactional workers;
- Linux adoption by a significant number of consumers and productivity workers in the US is at least four years away;
- The success of Linux on the desktop will not lead to the emergence of a significant consumer ISV industry over the next few years. This is one of the factors holding back consumer adoption of Linux and there is no easy solution to this chicken and egg problem.

8.3   Leverage points

"Much of the work that remains to be done are things that have either fallen through the cracks (they don't fall within the domain of any of the big, successful projects) or require the larger projects to work together.[32]"

There is no single major factor that will "make or break" desktop Linux adoption. Linux will be adopted for different reasons by different classes of users in different parts of the world. The obstacles and benefits are different for each class of users. But the principal requirements for modest Linux success on the desktops are now in place. A lot of work remains to be done, and we believe that most of these tasks will get done over the next few years. Below is a list of some leverage points for Linux desktop adoption: developments that can accelerate the adoption of Linux on the desktop, and remaining barriers to broader deployment.

8.3.1   *A strengthened desktop foundations layer that can provide the missing common infrastructure that the major open source desktops need to rely on, along with standards and joint projects that improve interoperability between major desktop platforms*

There are not just two Linux desktop platforms, there are at least four: KDE, GNOME, OpenOffice and Mozilla. Each of these big, successful projects includes a vibrant community of developers, is an umbrella to a significant number of projects, and is built on a different toolkit. And, of course, OpenOffice and Mozilla are cross-platform projects whose users primarily run the Windows operating system.

Following is a partial list of foundational work that needs to take places to further advance the Linux desktop[33]:
- A hardware abstraction library that makes peripheral devices available to applications and end-users;
- Improved cut-and-paste and drag and drop support across the various desktop platforms;
- A universal MIME system;
- A universal configuration/manageability framework;
- A common end-user document filing system (~/Desktop, ~/Documents, etc.);
- An improved sound and multimedia framework (including sound server);
- A universal virtual file system so that the same URIs are known to all applications (currently, the list of available file systems may differ from one application to another);

- Improved accessibility;
- Help indexing;
- A process spanning multiple desktop projects for interaction and UI-design.

Tackling these and other remaining challenges to offering a competitive, integrated Linux desktop may be best taken on by a new effort that brings together people from the different desktop-related projects.

8.3.2 *Emergence of an open, XML-based file format that becomes widely recognized as an alternative to the Microsoft Office file formats*

The availability of a rich, open and XML-based file format standard for productivity applications will be a major boost for Linux desktop adoption. An effort is under way at OASIS to develop a formal standard, largely based on the OpenOffice file format. This standard is expected to be adopted by the end of the year. Development, adoption, and implementation of the standard by OpenOffice and other Linux productivity applications will offer librarians, data archivists, policy makers and other interested parties an open alternative that they can adopt as a standard for document exchange in government, educational institutions and elsewhere.

8.3.3 *Further improvements to the Microsoft Office filters in OpenOffice and other open source productivity applications*

The OpenOffice filters are already quite good and continue to get better (witness the improvements made for OpenOffice 1.1). Developers at OpenOffice, KWord and other open source productivity applications are already collaborating informally to solve remaining problems. Improved, collaboratively maintained documentation by the open source community of the Microsoft Office DTDs, similar to the OpenOffice project's documentation of the Excel file format[34], could further improve this situation.

8.3.4 *More opportunities for public sector decision-makers to learn about other open source efforts and get access to useful information*

The Cyberspace Policy and Research Institute's annual Linux in Government conference and OpenForum Europe provide rare opportunities for public sector leaders to learn more about how open source can benefit government. More online resources are needed to assist public sector decision makers who are interested in Linux.

8.3.5 *Improved organizational infrastructure for open source projects*

Sourceforge has revolutionized the way open source projects are developed. What may be missing is an organizational equivalent: a set of resources to help open source projects organize themselves as non-profit organizations and function effectively. In many cases, this may be as simple as offering fiscal agency support to projects that wish to organize themselves as non-profit organizations.

8.3.6 *More commercial end-user applications for Linux*

The lack of a critical mass of commercial end-user applications is a major barrier to broader consumer adoption of Linux. This chicken and egg problem is unlikely to be resolved within the next few years.

8.3.7   The WINE project

The WINE project is an important part of Linux adoption on the desktop. Thanks to the efforts of the WINE community and CodeWeavers, many Windows applications, including Microsoft Office, Internet Explorer, Windows Media Player, Quicktime and Adobe Photoshop already run unmodified under Linux. TransGaming, the other company that builds on the WINE libraries, boasts that it allows 250 of the world's hottest games, including EverQuest, Battlefield 1942 and SimCity, to run unmodified under Linux. Additionally, the WINE libraries offer an easy way for ISVs to port applications to Linux. For instance, a few years ago MusicMatch was ported to Linux using WINE. In the not so distant future, further improvements to WINE may allow end-user Linux distributions to credibly claim that Linux runs Windows applications,

8.3.8   Absence of a standard Linux

The multitude of Linux distributions and hardware platforms supported by Linux makes it hard for ISVs to package applications for Linux. Especially in view of the uncertainty surrounding United Linux, Red Hat is the de facto Linux standard. It should be noted that several desktop-oriented Linux distributions (including Lindows, Lycoris and Xandros) are not based on Red Hat Linux. Efforts such as the Linux Standards Base and easy-to-use software installers such as Lindows' Click'N'Run Warehouse help to address this challenge.

8.3.9   User-friendly documentation and support options

Most Linux documentation, and the most popular mailing lists and support forums are hard to parse for non-technical users, making it a daunting task to solve the inevitable problems that arise.

9   CONCLUSION

"Desktop Linux is no longer a technical challenge – it's a marketing challenge."

Making the Linux desktop more user-friendly, elegant, and interoperable with competing desktops is a never-ending challenge. The effort has reached the point where, in many regards, Linux is "good enough" for significant classes of users. If the current pace of improvements continues, Linux will emerge as a mature and credible desktop alternative for tens of millions of users over the next few years. If the current interest by the public sector in promoting open source persists, and in the absence of other major shifts, Linux is slated to achieve a market share of as much as 10% over the next four years. The process of desktop Linux adoption can be accelerated by some of the efforts listed in this document.

FOOTNOTES

[1] Forrester analyst Stacey Quandt, quoted at http://www.newsfactor.com/perl/story/21815.html

[2] Both KDE and GNOME, the two leading open source desktop environments, do run on a variety of operating systems, including Linux, FreeBSD and different variants of UNIX. For that matter, it is possible to run them on top of Windows and OS X systems.

[3] Headline and inspiration courtesy of ZDNet:

http://techupdate.zdnet.com/techupdate/filters/specialreport/0,14622,6023357,00.html other

[4] http://www.gnome.org/pr-extremadura.html

[5] Simon Phipps, quoted at http://mailshare.nmu.edu/listserv/network-users/msg00176.html

[6] http://www.techtv.com/news/security/story/0,24195,3354075,00.html

[7] Observers agree that the majority of these systems are wiped clear and Linux is replaced by a pirated copy of Windows. As the Linux desktop matures and piracy declines, more and more people will stick with the Linux OS that came preinstalled on their system.

[8] Thanks to Dan Kusnetzky for this phrase.

[9] Since many Linux vendors offer their own software update solutions, this is not a significant drawback for KDE.

[10] Ratings scale: ☺: ready for prime time; ☹: needs more work; ☹: not ready, from an average user or IT decision-maker perspective.

[11] Notable areas of weakness remain, including VBA macro support and the ability to read and write encrypted office files.

[12] http://www.computerworld.com/softwaretopics/software/appdev/story/0,10801,70710,00.html

[13] Rating: Health of each part of the eco-system: ☺; healthy; ☹; needs nurturing; ☹; weak

[14] http://news.com.com/2100-1045_3-1022584.html?tag=fd_top

[15] http://news.com.com/2100-1016_3-1022472.html?tag=fd_top

[16] http://steve-parker.org/articles/others/stephenson/mgbs.shtml

[17] Starting at $350. http://www.pcworld.com/news/article/0,aid,111442,00.asp

[18] http://schoolforge.net

[19] http://www.linuxjournal.com/article.php?sid=6927&mode=thread&order=0

[20] http://newsforge.com/newsforge/02/12/04/2346215.shtml?tid=19 and
http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2860180-1,00.html

[21] http://zdnet.com.com/2100-1104-981878.html

[22] http://www.linuxjournal.com/article.php?sid=6952

[23] http://news.com.com/2100-1016-1011255.html?tag=nl

[24] http://news.com.com/2100-1042_3-1020137.html?tag=fd_top

[25] http://news.com.com/2100-1016-1011255.html?tag=nl

[26] http://linuxtoday.com/it_management/2003062401426NWDPPB

[27] http://linuxtoday.com/infrastructure/2003052802126NWDTPB

[28] http://linuxtoday.com/infrastructure/2003052802126NWDTPB

[29] http://cnetasia.com/newstech/systems/0,39001153,39129420,00.htm

[30] http://asia.cnet.com/newstech/systems/0,39001153,39136847,00.htm

[31] http://www.internetnews.com/dev-news/article.php/2109101

[32] Havoc Pennington

[33] List provided by Havoc Pennington

[34] http://sc.openoffice.org/excelfileformat.pdf