Open Source Software

Case Studies Examining its Use

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Executive Summary

After releasing ***Linux, Inc.: A Survey of Open Source Software - October 2002*** [1]**,** we recognized a need to provide perspectives on the benefits and challenges associated with open source software. Discussions with dozens of firms in the commercial, government and non-profit sectors resulted in this report, which illustrates the diverse uses of open source software.

The case studies extend from the embedded to the data center market, with deployments in varied organizational settings. ***Verisign*** and ***Afilias*** are supporting the Internet's infrastructure; ***TiVo*** embeds open source in its Personal Video Recorders; the ***US Postal Service*** is scanning mailing addresses; in ***Largo, Florida,*** the city supports the majority of its staff; ***devIS*** provides outsourced applications to U.S. government agencies; ***Marionhospital***, in Germany, and ***Westone Laboratories*** are migrating their information technology infrastructures; and efforts from the ***Simputer*** project, in India, are prototyping applications to meet needs in developing nations.

Key Research Findings

- **Cost is a significant factor driving adoption.** Lower licensing fees, leveraging commodity hardware and avoiding cumbersome software license management processes were the most frequently identified benefits of using open source solutions. Also, the potential for avoiding software license "scope creep", as a project expands to address a larger user group, allow organizations to maintain their focus on the business value of applications, rather than software budget issues.
- **Control and flexibility are considered benefits as well.** Being part of a community-based development effort, with access to source code, reduced many organizations' dependence on individual technology providers. In addition, with some solutions supporting multiple processors and operating systems, organizations can examine a broader set of price/performance options when developing systems and products.
- **Implementation of open solutions is evolutionary, not revolutionary.** The sea change of the open source model presents new challenges and opportunities to all users of technology, and its adoption will be an evolutionary process. Most organizations will likely incorporate open source as a extension of their existing infrastructure. Open source is still in a very early stage of adoption. Even if commercial software eventually becomes viewed as legacy solutions, its shelf life will be long and co-existence with open source solutions will be required.
- **Open source extends across the entire software stack**. With Linux demonstrating momentum in the operating system market, and open source dominating the web server market, the remainder of the software stack is showing open source traction as well. Usage of open source databases and application servers are increasing, with various middleware and network management open solutions considered as viable alternatives. Although we do not present case studies illustrating the deployment of open source ERP/CRM solutions, we understand that efforts are also occurring in this area.
- **Product support is not a significant concern.** The quality of support is not unlike that of commercial software providers. Both have variable levels of quality, with open source support generally improving as a product matures and its community of users and developers expands. Unlike proprietary products, where support may be provided by a limited number of firms, there is a diverse and growing number of

1 Our **Linux, Inc.** report can be downloaded from our website at www.dravis.net

support options for many open source offerings.

- **Open source is not a magic solution.** Traditional development methodologies are still required to deliver high quality, usable and functional applications. Open source deployment should be done using the same methodologies and disciplined care as any other enterprise solution.
- **Open standards may be more important than open source.** While open source software does not imply an adherence to open standards, open source developers seem more aligned with this goal than some commercial providers. This open standards bias should increase interoperability and information sharing among various technology constituencies and benefit users.

Most initial open source adoption has been driven by its lower cost. As usage increases, its practitioners continue to build and enhance a flexible, creative, and global community. While the complete impact of open source cannot be definitively assessed, it is redefining the dynamics of the software industry while reviving a sense of innovation in this market.

Open source implementers we encountered exhibited high levels of enthusiasm toward their efforts. They are pragmatic in their pursuits as well. A consistent message from all is that solid planning and a strategic view are required for successful open source projects, and aligning business processes with technology capabilities remain key components in delivering valuable solutions.

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Summary of the Case Studies

Our report presents the breadth and depth of open source use in a diversity of markets. For many organizations, a successful initial experience with open source deployment is leading to the consideration of other open source application to meet their needs. The following is a summary of the case studies.

- **Afilias, Ltd. - Open Source Database and the Internet.** In January 2003 Afilias, Ltd. assumed operational support for the Internet's .ORG registry from Network Solutions, Inc. In this effort, .ORG Internet domain information was migrated from Oracle databases to a PostgreSQL database environment.
- **DevIS - Providing Solutions to the US Government.** DevIS provides IT services to government agencies such as the U.S. Department of State, U.S. Department of State, U.S. Department of Labor, U.S. Agency for International Development and U.S. General Services Administration. Their solutions include the use of Zope, Python, Java, XML, PostgreSQL, xmlBlaster, Debian Linux, and Apache.
- **Largo, FL - Open Source Software Supports the City.** The city of Largo, FL, has the majority of its city employees (approximately 650) using Linux and other open source services, to address many of its information processing needs. The infrastructure is based on a thin client architecture.
- **Marienhospital – Reducing Costs with Open Source.** Marienhospital, in Stuttgart, Germany, in order to address the growth of their information technology infrastructure and satisfy budget constraints, migrated to SuSE Linux based servers supporting Oracle databases.
- **Simputer - Computing Alternatives for Developing Nations.** Efforts are underway to deliver open source solutions addressing the needs of developing countries. Initial prototypes target village banking, education and land use applications.
- **TiVo Inc. - Changing the Dynamics of Entertainment.** TiVo, Inc. is the creator of the personal television recorder. With Linux supporting both its 640,000 receivers used by its customers, and its back-end servers, TiVo's deployment is among one of the largest uses of open source technology in the market.
- **US Postal Services - Solid Delivery with Lower Costs.** In 1997, the USPS implemented Linux-based systems in 250 mail distribution centers to recognize destination addresses on envelopes in its mail routing processes. This deployment is still in operation and uses over 6,000 Linux systems supporting OCR applications.
- **Verisign, Inc. – Expanding Open Source in the Infrastructure.** Verisign, Inc. is a provider of managed security and network, Internet registry and telecommunications services. Historically, their information technology infrastructure was dominated by proprietary UNIX systems. Today, 1,100 Linux servers are in production, and their deployment, along with the use of other open source solutions, continue to expand.
- **Westone Laboratories – It Started with Databases.** In addressing application migration needs, Westone Labs implemented MySQL and Linux-based solutions. The firm plans to extend open source technologies into all areas of production and transaction processing.

Open Source and the Software Stack

Open source initiatives are occurring across the entire spectrum of the software stack, from operating systems to end-user applications encompassing web servers,databases, browsers, network management, media servers, e-mail systems and workgroup collaboration. Some development efforts are research-oriented, while others have evolved into commercial franchises. Open source programs are not exclusive to the Linux platform, with many open source applications available for multiple operating systems.

The universe of open source solutions and projects is quite broad and beyond the scope of this report. The following table presents the open source solutions appearing in the case studies.

Table 1: Open Source Solutions in the Case Studies

Solution	Description
Evolution *personal/workgroup*	- Integrates email, calendar, meeting scheduling, contact management, and task lists, in one application. Developed and supported by Ximian, Inc., the program is released under the GNU General Public License (GPL).
FreeBSD *operating system*	- An operating system for x86 compatible, DEC Alpha, IA-64, PC-98 and UltraSPARC architectures. It is derived from BSD UNIX, a version of UNIX developed at UC – Berkeley. Released under the Berkeley Software Distribution (BSD) license.
JBoss *middleware*	- Development started in March 1999, JBoss is a Java application server. It is available under the "Lesser" General Public License (LGPL).
Linux *operating system*	- Operating system designed to provide Intel users as a low-cost alternative to UNIX. Released under the GNU General Public License (GPL). Our case studies highlight the use of Debian, RedHat, SuSE and hand-crafted versions of the operating system.
MySQL *database*	- Relational database started in 1996 by MySQL AB, based in Sweden. The product is available under the GNU General Public License (GPL) and a commercial license.
Nagios *network management*	- A host and service monitor, previously known as NetSaint, designed to identify network problems. It is released under the GNU General Public License Version 2.
OpenOffice.org *personal productivity*	- Suite consisting of word processing, spreadsheet and graphic/presentation software using XML formats. Uses a dual-licensing scheme for source-code contributions: the GNU Lesser General Public License and Sun Industry Standards Source License.
PostgreSQL *database*	- An object relational database, started in 1986 at UC - Berkeley. PostgreSQL runs on many different operating systems. Released under the Berkeley Software Distribution (BSD) license.
XmlBlaster *middleware*	- A publish/subscribe message-oriented middleware (MOM) server. Free for private, commercial,education use under the "Lesser" General Public License (LGPL).
Trolltech's QT *development tools*	- A multiplatform, C++ application framework for developing applications that run on Windows, Linux/Unix, Mac OS X, and embedded Linux. The Qt Free Edition and the Qt/Embedded Free Edition are available under the GPL.
Sendmail *e-mail*	- Development started in 1981 at UC Berkeley to enabled the routing of email between networks. Released under the Berkeley Software Distribution (BSD) license.
Zope *middleware*	- A software system providing application server, a web server, and a content management system.

Afilias, Ltd. - A Database for the Internet

Afilias, Ltd. was founded in 2000 by a consortium of ICANN accredited domain name registrars. In November 2000, the firm was selected by ICANN to operate the .INFO domain registry, which was launched in 2001. Afilias is headquartered in Dublin, Ireland with operational facilities in Toronto, Canada, and administrative offices near Philadelphia, Pennsylvania.

Transferring Control of the Internet's .ORG Registry

In April 2002, under an agreement with the Internet Corporation for Assigned Names and Numbers (***ICANN***) and the ***US Department of Commerce***, responsibility for the .ORG domain was passed to the ***Public Interest Registry (PIR)*** in Reston, VA[2]. In this transition, Afilias, Ltd. provides the back-end services of the domain name database for PIR. Network Solutions Inc. continues to operates the .COM and .NET Internet domain registries.

In January 2003 ***Afilias, Ltd.*** assumed operational support for the Internet's .ORG registry from ***Network Solutions, Inc.*** a division of ***Verisign, Inc***. .ORG is the Internet domain for non-commercial organizations and consists of over 2.4 million domain names worldwide.

Managing .ORG with an Open Source Database

The .ORG registry is the master database of all registered .ORG domain names and stores information on the organization registering the name, such as contact, billing and administrative data. Afilias maintains this database and generates a "zone file" which is used to route Internet traffic among domains globally.

In the transfer process of .ORG information to Afilias, data was migrated from ***Oracle*** databases at Network Solutions, Inc. to ***PostgreSQL,*** an open source database environment. According to Ram Mohan, Afilias' VP of Operations and CTO, the hardest part in selecting a database product to address their needs was deciding between a proprietary database strategy or aligning with an open source solution.

The business rationale for selecting PostgreSQL was both the strength of its open-source community and the avoidance of software licensing and on-going maintenance fees associated with commercial offerings.

The primary technical factors for using PostgreSQL are its support of SQL standards and multi-version concurrency control (MVCC). MVCC helps ensure that each database transaction sees a consistent view of the database, while ensuring that high transaction volumes are supported. Additionally, PostgreSQL supports over 65,000 GB of data in a single table, which is more than adequate for the needs of .ORG or .INFO database management support. .INFO and .ORG each use PostgreSQL version 7.2.

2 ICANN selected PIR from 11 organizations that bid to oversee the .ORG domain registry. PIR was created to manage the .ORG registry by the Internet Society, a nonprofit organization founded to ensure the open development of the Internet.

Consideration of Perceived Risks

As Afilias approached the .ORG opportunity, the team was able to leverage prior experience with PostgreSQL from operating the .INFO domain, where the database platform had meet their needs from a support and stability perspective.

A risk cited with open source development efforts is the potential impact of developers losing interest in the community, which could diminish support and reduce the pace of development. Afilias has a contract with ***PostgreSQL, Inc.*** of Wolfville, Nova Scotia, which provides unlimited 24/7 support. PostgreSQL, Inc. is able to offer the assistance of core developers from the PostgreSQL project. Assistance is also available from the ***PostgreSQL Global Development Group,*** a community of companies and people coordinating the development of PostgreSQL.

In the context of these resources, the PostgreSQL database system has support comparable to many other commercially available systems, and also leverages the capabilities of an open developer community. If there is a need to migrate to another database platform, PostgreSQL support for open standards should permit such a transition.

Their Processing Environment

Afilias' registry technical support and operations monitoring group are located in Toronto Canada and use secured hosting facilities provided by ***IBM Corp***. in St. Louis, MO and West Orange, NJ.

Afilias' application environment consists of three database servers with ***PostgreSQL 7.2*** on ***Sun Microsystem's*** E4500 8 x 400 Mhz running Solaris 8.0***, Nokia Corps.'s*** IP650 servers with ***Checkpoint Software's*** Firewall-1 and Enterprise Security Suite VPN-1 software, ***IBM Corp.'s*** Netfinity PIII servers running a Linux 2.4 kernel and packet filtering/traffic shaping software as a database firewall, ***IBM/Tivoli's*** Storage Manager and Disaster Recovery and ***Veritas Corp.'s*** File System and Volume Manager.

Afilias continues to monitor the improvements of Linux and BSD multiprocessor support for query process handling of the PostgreSQL database. The release of **FreeBSD 5.0** could prove to be an interesting alternative for consideration.

Afilias' Advice on Open Source Use

According to the Afilias team, when becoming involved with open source software implementations, users must realize that participation in the online community is needed. Many technical details found on mailing lists and interaction with the community will help drive the success of a project. Avoiding this approach can lead to frustration.

Also, recognize that no software is truly free of charge. Software license costs are lower with open source, but if organizations are reluctant to invest in quality support or various add-on software components, problems can occur. The need to hire and maintain professional staff to administer the software remains a requirement for success.

DevIS - Providing the US Gov't with Open Solutions

Development InfoStructure (devIS) was founded in 1992 to provide IT services to government agencies. The firm's philosophy is based on the "open" paradigm that shifts software ownership to organizations and users, independent of a single vendor and free from licensing constraints. This approach should facilitate increased sharing of applications and infrastructure across the government sector.

Pursuing an Open Philosophy, Focusing on User Needs

The Internet enables information sharing between government agencies and US citizens that is independent of computer hardware or software technology. As open source software use proliferates, government agencies are becoming more confident with it. Web (XML) service initiatives are moving the discussion of solutions beyond historical vendor/proprietary software biases. According to Peter Gallagher, devIS' president, these dynamics drive their mantra: “Open Standards, Open Source, Open Minds”.

The firm's approach to its market is to: 1) focus on addressing client needs; 2) enable information sharing and leverage reuse and 3) deliver solutions on a solid, cost effective technology infrastructure. The results are solutions developed with less redundancy, lower costs, greater flexibility, and providing better service to their constituents in the government sector.

Success Drives Increased Open Source Use

DevIS is involved in all parts of the application life cycle, including internetworking application design, portal development and web hosting. The firm's use of open source technology started in 1995, and has steadily increased. While they have no aversion to using commercial software, most solutions developed and deployed today for clients are based on open source technologies.

Their solutions typically include using ***Zope*** for content management, ***Python***, ***Java***, XML, a ***PostgreSQL*** database, ***xmlBlaster*** as a messaging server, the ***Debian*** Linux distribution, the ***Apache*** web server, and ***Resin*** as an XML server.

Significant to the firm's value proposition is the ability to host and manage applications in a secure environment. This approach can simplify deployment and minimize costs for their clients. ***NTT Verio*** is used as the hosting facility and a variety of security solutions such as intrusion detection from ***Riptech/Symantec Corp.*** are also used.

Is Support a Real Concern?

According to DevIS' CTO Martin Hudson, the quality of support for open source is not unlike that of proprietary offerings. He believes both have variable levels of quality and that open source support generally improves with the maturity of the offering and the size of its user/developer community. Unlike proprietary products, where support may come from one, or a limited number of firms, there is a diverse and growing number of support options for many open source offerings. As demand builds, larger systems integrators will likely increase their involvement in open source support as well.

Avoiding Software License “Scope Creep”

Many government projects begin by addressing the needs of a small constituency. As the project progresses, the application may satisfy the needs of a larger group of users, many of whom are geographically dispersed. Traditionally this “scaling up” of the user base results in increased software licensing fees. A project which may have started with a

departmental budget evolves into an enterprise software deal. The economics of open source software avoid this potential "enterprise drag" when considering a wider deployment. As a result, focus is maintained on investing on the application's business value, rather than being impacted by a potential software budget increase.

Open Source, devIS and the US Government

The following are examples of devIS' efforts in securing U.S. government contracts for information and communications technology services using open source software.

- **U.S. Department of State:** The ***Federal Exchange Database (FEDS)*** is an outsourced Web service which collects performance data from all federal agencies. The initial version was developed in 1999 and was the first Federal government-wide application using open source software, JAVA, and XML formatted data. Information is shared among 195 federal programs with 400,00 participants and $1 billion in federal funding.
- **U.S. Department of Labor:** ***DisabilityInfo.gov*** contains information on civil rights, education, employment, housing, health care, technology and transportation, among other subjects. The site is designed as a one-stop source of government information relevant to people with disabilities, their families, employers, and service providers. DisabilityInfo.gov has a secure Web browser interface for USG experts to post content/learning objects of any type. All content is stored in the PostgreSQL object/relational database.
- **U.S. Agency for International Development:** ***TraiNet (Training Results and Information Network)***, is a secure Internet-enabled visa application processor which allows staff to comply with new security requirements for training foreign nationals in the US. The system is built on a distributed fat-client application that communicates via XML messaging, to create a central shared data repository. The system is operational in over 70 countries and 250 installations with a messaging architecture that addresses variable Internet connectivity around the world.
- **U.S. General Services Administration:** The federal procurement workforce will monitor and plan skills development through a secure Web application called ***Acquisition Career Management Information System (ACMIS)***. The system allows federal procurement officials to plan and monitor their skills base. DevIS has designed and developed the application using standard XML formatted data with 100% open source technology.

Solid Planning and Execution are Still Required

Open source software continues to be assessed by users, developers and technology providers in terms such as cost reduction, code reuse and application sharing. DevIS has seen its value and relies on its use as often as possible. The devIS team stresses that open source is not magic. Traditional development methodologies are still required to deliver quality, usable and functional applications addressing an organization's needs.

Open Standards May be More Important than Open Source

DevIS believes using open source technology may provide more than a cost effective infrastructure. While its use does not imply an adherence to open standards, devIS' experience is that open source practitioners are more aligned with this goal than commercial offerings, a bias likely to benefit devIS and its clients alike.

Largo, FL - Open Source Supports the City

The city of Largo, FL, with a population of over 70,000, has over 650 city employees using Linux, and other open source services, to address many of its information processing needs. Largo's technology team supports the city's administration, along with various health and safety departments. Performance must be delivered on a 24/7 basis to staff in roles as varied as accountants, purchasing agents, bookkeepers, police and fire personnel, clerks, secretaries and receptionists.

A System Migration Effort...

In 1993, as part of a system upgrade effort, Largo implemented a thin-client, thick-server architecture to support a community of 650 users, accessible from 425 thin client workstations. When considering options for their upgrade and migration strategy, a network of Microsoft Windows PCs was determined too expensive to purchase and maintain. Instead, Largo provided its staff a graphical workstation environment via thin client devices. As a part of their architecture, some of Largo's applications were deployed on Intel servers running OpenServer and UnixWare.

In 2000, difficulties arose at ***Santa Cruz Operation***, the provider of OpenServer and UnixWare. These issues were significant enough to have Largo's IT staff evaluate replacement options.

... Drove Thin Client Support with Linux

In assessing alternatives, ***Microsoft Corp.'s*** Windows 2000 solution was considered impractical because of the significant upfront investment in hardware and software, as well the potential commitment to a 2-3 year upgrade cycle. Largo was also reluctant to abandon its existing thin-client infrastructure which had served the city well.

Largo's IT team decided to evaluate ***Red Hat, Inc.'s*** Linux offering as a replacement. During 2000 in-house testing began, and by early 2001, 20 city employees were selected to participate in a usability test of the new environment. By mid-year, the team was comfortable with the results and rolled out support to its entire user community. According to Largo's CIO, Harold Schomaker, the deployment was smooth and uneventful.

Open and Proprietary Software are Meeting Their Needs

Today Largo's environment supports 650 user accounts on Largo's network of 400 ***Network Computing Devices Inc***. Explora 451 thin client terminals. The delivery of services to this user community are managed on two ***Compaq*** servers, a 933MHz dual-processor ML370 and a 1GHz dual-processor ML350 running Red Hat 7.2 and Advanced Server 2.1. Each server supports approximately 220 concurrent users. Overall, the city's server environment consists of 20 systems running a combination of Windows NT, Unix, and Linux applications.

Largo's staff use the KDE desktop environment, Web browsers (both Netscape and Opera) and ***Ximian*** Evolution (for e-mail). Thin client devices also provide access to ***Microsoft's*** Excel and PowerPoint running on Windows NT Server with ***Citrix Systems Inc.'s*** MetaFrame, and Unix-based applications, including WordPerfect 8, and several police applications. Largo also runs an ***Apache*** Web Server, ***Oracle Corp.'s*** 9i database and Financial software on Linux servers.

Largo's Approach Provides Financial Benefit...

Largo's IT approach has had positive financial benefit. From a software acquisition perspective, the city avoided the cost of purchasing an operating system to support hundreds of users and several servers, along with software support and upgrade costs. With Linux support delivered on thin-clients, workstations have a lower hardware cost. The thin clients are obtained second-hand, when possible, sometimes for $5 or less. With application processing occurring on servers, the need to upgrade workstations is less frequent than a PC implementation would likely require. In total, Largo's IT expense is approximately 1.7% of the city's budget, versus 3% or higher for cities of comparable size. In an era of continued budget reductions, these financial savings were cited as a widely applicable advantages for switching to Linux.

... and Operational Efficiency

Operational efficiency was achieved because all data is stored on network servers. As a result, the IT staff spends less time administering their infrastructure. The thin-client architecture allows the city to store all user data on the network and remove the potential for loss of user data. Also, if a thin client fails, a replacement unit is easily installed. This approach minimizes the number of IT personnel required to maintain and support the Largo environment.

Largo's thin client environment also eliminates many security issues, such as concerns about staff loading personal software onto the system. Firewalls and facilities to deal with viruses have also been implemented.

More Open Solutions are Planned For Implementation

With its success using Red Hat Linux, the city is making Linux its core operating system and will expand its use over the next 18 months. Largo plans to implement ***SuSE's*** Linux Openexchange Server along with ***Ximian's*** Connector technology to handle the city's group scheduling needs. ***OpenOffice*** will soon be the standard word processing/spreadsheet tool and ***Sun Microsystem's*** StarOffice will be licensed for staff workers needing better file import capabilities. The city will also centralize a number of its databases under one database, managed by ***Oracle Corp.'s*** 9i running on a Linux backbone. The ***PostgreSQL*** database is being considered for use with all Internet/Web related data storage.

Largo Recommends Following Their Example

In an era of reduced governmental budgets, the financial savings derived from adopting Linux are attractive. The city's IT administrators believe that open source software, along with a thin-client IT infrastructure, have allowed them to provide excellent service at low cost. Largo's success can be replicated at other municipalities as well.

Largo's architectural design provides access to any application regardless of platform, by any user (local or remote). Managing services centrally, with minimal workstation administration minimizes both initial costs and recurring expenses.

A Final Thought

The Largo team believes that skepticism of open source solutions remains a major barrier to widespread adoption of open source in many organizations. As the value of open source solutions becomes better understood, open source software will be more widely used.

Marienhospital – Reducing Costs with Open Source

Marienhospital, in Stuttgart, Germany is one of Germany's premier hospitals with pioneering work in fields such as radiology and anesthesiology. Marienhospital has over 1200 employees. The technology staff is responsible for hospital information systems, digital radiology and image archives, and networking services for the hospital and its associated clinics.

Costs of Upgrade Drive Their Systems Migration

In 1997, several systems were consolidated with the introduction of a heath case solution by the ***GWI Company,*** a German software provider. The solution combined medicine care, patient management and accounting functions, with information stored on an ***Oracle*** database, running on a ***Sun Microsystems*** Ultra Enterprise 3000 server.

Increasing data volumes at the medical center required adding hard disk capacity, system memory and upgrading processor power. Over time, these incremental upgrades were no longer sufficient and a new system was needed. At the same time, IT spending was constrained because of expenditures to address new regulatory reporting requirements and an increasingly competitive health care market. These dynamics drove an assessment of new technology alternatives.

The Process of Assessing a New Technology Platform

Primary requirements in evaluating platforms were continued support for the GWI solution and the Oracle database environment. Alternatives considered included ***Sun Microsystems*** Solaris running on a SPARC system or i86 system, an IBM system running AIX, and Linux running on a Dell PowerEdge 6400 with 4 Pentium III Xeon processors. The Dell system was selected for its lower acquisition cost (35% of the alternatives) and ongoing service charges, running the SuSE Linux Enterprise Server 7 platform (25% of the alternative systems).

In assessing which Linux distribution to implement, Marienhospital's database administrators focused on offerings from ***Red Hat, Inc.*** and ***SuSE Linux AG***. SuSE Linux was selected because, at that time, Oracle had used SuSE Linux as a development and porting platform, which reduced the transition costs and provided a high degree of investment security during the application migration.

According to Bernd Ruhle, head of the Marienhospital's IT Department, the ability of the vendor to understand and troubleshoot issues related to both the operating systems and the database were very important.

Factors driving Linux use by Marienhospital are 1) cost savings, 2) increased investment security through maintenance and access to open source code, and 3) its ability to accommodate an increasing number of users.

Lower Costs and Improved Performance Were Achieved

In January 2001, the system conversion process began with the installation of a Dell PowerEdge Server preloaded with SuSE Linux 6.4 and Oracle 8.0.6. The implementation proceeded rapidly with the assistance of SuSE's Installation support. The IT team commented that SuSE's mail list was particularly helpful in resolving problems. In April 2001, the system was integrated into the medical center's production operation.

The new system improved performance for many applications. One statistical application, which previously required an overnight 15-hour run, was completed in 1 hour. A data-intensive transaction, which had taken 120 seconds in the past, was processed within 8-10 seconds. Overall system performance improved by a factor of three.

The new environment also accommodated an increase in concurrent users to 600, up from 150. The platform was effective in consolidation as well, reducing the number of database servers from three to one. The system, fully operationally in June 2001, supported patient administration, financial accounting and data warehousing applications.

Since the initial installation, further upgrades have been completed. In 2002, SuSE Linux Enterprise Server 7 was installed. During 2003, Marienhospital will be upgrading its operating system to SuSE Linux Enterprise Server 8 and is considering upgrading to ***Oracle's*** 9i database.

Going Forward – More Opportunities Exist

Marienhospital's IT team believes the Linux platform exceeded their cost and performance expectations, with improvements measured not in terms of increments, but in orders of magnitude. While Linux was straight forward to install, as with most technology projects, difficulties were encountered. Accessing SuSE's support services was helpful in resolving some migration issues.

The IT team is considering SuSE Linux based solutions for other uses at Marienhospital, and other medical centers under their supervision. Among the uses are print and file servers, Internet Firewall applications, along with the migration of a digital imaging library from an IBM AIX platform to Linux.

However, complete adoption of SuSE Linux is restrained because of a lack of certain industry specific solutions and desktop applications. Marienhospital's staff believes once these solutions become available, their entire infrastructure will migrate to SuSE Linux.

Simputer: Computing for Developing Nations

In many developing countries, computer use faces issues such as power consumption, connectivity, cost, literacy and computer competency; along with the availability of relevant applications which meet their needs. A solution attempting to address these challenges is the Simputer, a low-cost Community Digital Assistant.

Simputer started as a project at the the Indian Institute of Science to bring to market a handheld computer which could be shared among multiple members of a community in India. The device runs open source software that supports 1) text-to-voice conversion (currently in any Indian language), 2) a wireless modem and 3) removable smart memory cards allowing users to store their data separately and conduct secure transactions.

Leveraging the efforts of various open source efforts, applications are being developed and tested to meet needs such as providing teachers with learning materials, farmers with market information, and small businessmen with procurement opportunities.

The Background of the Simputer

The Simputer project was conceived in October 1998 at an International Seminar on Information Technology for Developing Countries. The project's vision was to develop a low cost device which supports local languages and is accessible to a large audience of users. The technology was developed at the Indian Institute of Science, Bangalore, then licensed to ***Picopeta Simputers Pvt Ltd*** (founded by the original researchers of the Simputer project at IISc, Bangalore) and ***Encore Technologies Ltd.***

The ***Simputer (Simple, Inexpensive, Multilingual People's Computer)*** is based on the Linux kernel version 2.4 running on an Intel Strong ARM processor for low power consumption. It is designed to be a shared device within a community of users. Smart card support provides storage of user specific information. For input, the device has a 240x320 LCD panel with a touch panel overlay. The Simputer can have up to 64 megabytes of random-access memory and 32 megabytes of flash memory.

The Information Markup Language (IML) browsing environment was developed to provide application independence that are easy to use, support multilingualism, accommodate smart card usage and provide transparent access to remote and local resources. Text to speech features support Indian languages like Hindi, Kannada and Tamil, making it eligible for use in a major part of India. In-built speakers and a microphone are included, along with Tap-A-Tap, a character-input application similar to Graffiti.

Why use Open Source?

The developers of Simputer believed writing an operating system from scratch would make their project infeasible. Using the Linux kernel would minimize the cost of both development and the Simputer units themselves. The inclusion of proprietary software cost would have driven the system out of reach of its intended target audience. The use of Linux and other free software initiatives are critical parts of the Simputer vision. In fact, the General Public License (GPL) inspired a similar model of distribution for the Simputer hardware.

Simputers – The Prototype Phase

The following are examples of Simputer use in prototype efforts within India.

- **Automating land records procurement (Project Bhoomi):** PicoPeta's Bhoomi-Suggi project (Land-Harvest in Kannada) is a part of an effort by the Karnataka Government to automate the land records procurement process which involves collecting information about crops being cultivated by farmers. The objective is to reduce the data collection and processing time from one year to within a month. Deployment and testing is taking place in the districts of Bagalkot, Belgaum, Raichur, Gulbarga and Bijapur. Data collected by village accountants is saved on the Simputer. Once they return to a central office in Taluk, a Windows based application is used to transfer the data to Government servers for analysis and archival. The data collection interface on the Simputer is completely in Kannada, the primary reading language of many village accountants.
- **Microfinance - The Sanchan project for loans in rural Karnataka:** The project intends to track farmer loans in over 110 villages where villagers are barely literate. Mobile bankers use Simputers while they visit villages. After returning from the field, data is transferred to a Linux PC to generate reports and monitor progress of the loan disbursal programs. Sanchan can be customized to specific requirements in terms of business process, logic, language and extensions in terms of SmartCard usage and other interface requirements.
- **Educational use:** PicoPeta's Chhattisgarh project involves a combination of providing hardware and software, along with a methodology and infrastructure plan to develop a sustainable and self-contained model for school education using technology. Instead of relying on outside experts, teachers use their experience and creativity to develop content for the Simputer. One Simputer is provided for every 5 school children, with a Linux PC used at each school for teachers to create content. Applications include a basketball game for children to understand projectile motion, a geography quiz and a Hindi-to-English dictionary.

The Challenges of a Startup, and the Road Ahead

The goal of Simputer is to bridge the "digital divide" by developing a thriving local information technology market. Many of the challenges encountered by the Simputer licensees are those associated with other start-up efforts: integration of software with hardware, assuring product stability, and evaluating the varied tradeoffs associated with the product's cost, functionality, performance. Efforts continue to move forward for the Simputer offerings, with production release planned in the third quarter of 2003.

According to Dr. Swami Manohar, PicoPeta's CEO, their goals remain unchanged since 1998. Perhaps the most significant challenge for Simputer is increasing the commercial commitment to bridging the gap of the digital divide.

TiVo, Inc. - Changing the Dynamics of Entertainment

TiVo, Inc. is the creator of the personal television recorder (PVR). Founded in 1997 with the mission to improve the consumers' television viewing experience, TiVo developed a platform to deliver a variety of home entertainment services. The firm's service simplifies the way television is watched and enjoyed by digitally recording television shows, without the need of videotapes. This approach allows customers to watch what they want, when they want to watch it.

With Linux supporting both its 640,000 receivers used by customers, and its back-end servers, TiVo's deployment is probably one of the largest uses of open source technology in the market.

It Starts with the Personal Digital Recorder

TiVo is a personal television service that removes the time constraints of watching television programs when they are scheduled by the networks. The flexibility to automatically record, pause, rewind, slow motion and replay live TV is a revolutionary concept. By adding functions, the service can be programmed to record a subscriber's favorite shows, artists or topics.

The TiVo receiver is a closed box system. Its components include a ***MIPS*** processor running a hand-crafted operating environment consisting of the ***Linux*** kernel and other tools, a modem, an MPEG encoder/decoder and a standard IDE hard drive. The phone connection allows the system to download 14 days of TV program guide information.

The unit records video and stores it on the hard drive, with the recording capacity dependent on both the video quality setting and the hard drive's capacity. New systems features include network and broadband connectivity, along with sharing of digital photos, and streaming MP3 audio.

Why use Linux as the Operating System?

According to TiVo's CTO, Jim Barton, factors for adopting Linux in their PVR were cost, control and flexibility. Cost savings are achieved because there is no impact from per-unit licensing fees and the firm avoids the cumbersome task of software licensing management. With Linux's community based development and user access to source code, business control is increased while reducing the dependance on technology providers. Finally, with Linux supporting a wide range of microprocessors, TiVo has the flexibility to examine cost/performance/utility tradeoffs when choosing microprocessors for each generation of product.

TiVo's system can be considered a thin client Internet appliance positioned as an intelligent television set-top box. With this design profile, TiVo focused on configuring a minimal operating environment for the set-top with various open-source and proprietary software, such as Linux and various general utilities. A MIPS processor, with a modified Linux system was the best option for TiVo. This platform continues to deliver consistent stability and performance.

Design Incorporates Open and Proprietary Software

TiVo' philosophy for technology selection and adoption are pragmatic. They simply "use the right tool for the right job". When evaluating components for the initial PVR, it was determined that the system would store data on a hard drive, which ruled out many traditional embedded operating systems and opened the way for considering Linux.

Their development strategy leverages open source technology with in-house development efforts. Once the basic system was built, the development team focused on increasing the ease of use of the receiver, adding new services and security. Where appropriate, the firm releases code to the open source community (posted on their website), while in areas such as security, source code remain proprietary to the firm.

The Linux platform has enabled development of proprietary drives and deployment of a reliable and scalable system. In addition to the Linux-based receivers, TiVo also uses low cost ***Redhat*** Linux/Intel systems in its service back-end. A parallel distributed architecture provides a flexible environment to add systems as customer volume and service offerings expand. The architecture also provides for easy replacement of a system when hardware problems are encountered.

TiVo's Sphere of Influence Expands

TiVo technology has been licensed by ***Toshiba, Sony, Hughes Electronics, Philips, Thomson.*** Sony has created a localized and customized product using TiVo technology in Japan***. Toshiba*** plans to use TiVo technology in next generation consumer electronics. Other partnerships include ***AT&T Broadband***, ***AOL Time Warner***, ***DIRECTV*** and ***BskyB. NBC*** and ***The Discovery Channel*** have seats on the TiVo board. These and other developing relationships with cable operators, content providers, satellite television providers, and digital equipment manufacturers could lead to a wider use of open source solutions.

The Road Ahead Involves More Than Technology

Considering the size of its installed base, TiVo is a quiet open source success story. 640,000 TiVo systems are running on Linux accessing 13,000 different program information packages supported through a Linux based server farm. The environment, which enables television viewers to watch what they want and when they want, is often described by its users as "providing a change in lifestyle".

As the product evolves, so are its facilities for providing security, addressing early concerns related to hackers changing the TiVo offering and the potential for stealing/redirecting its service. The system works, and 97% of TiVo users recommend it to others. The largest challenges facing TiVo are not likely to be technology related, but associated with its market, where copyright issues and consumer choice dynamics continue to be redefined.

US Postal Services - Solid Delivery with Lower Costs

The United States Postal Services (USPS) has over 40,000 post offices and is among the most automated postal systems in the world. The costs associated with all aspects of mail processing, such as identification, sorting, handling and distribution, are a constant focus. With many of USPS's activities adhering to well defined workflows, leveraging technology is an integral component in addressing their workload. Also, because of the scale of the USPS operation, small improvements in product configuration or continuous service fees have a significant impact on cost savings.

In 1997, with these dynamics in mind, USPS leveraged work performed by ***RAF Technologies, Inc.*** and implemented systems in 250 mail distribution centers to automatically recognize destination addresses on envelopes to assist in its mail routing processes. This deployment, which still operates today, utilized over 6,000 Linux based systems supporting Optical Character Recognition (OCR) applications to deliver fast and cost efficient mail identification.

Linux Behind the Scenes in Mail Address Scanning

The initial configuration of the deployed Linux based system consisted of 5 CPUs, linked to an independent mail scanner, which share a monitor and keyboard. Each mail item processed by the system is scanned within 12 seconds at a 212 dpi resolution. The binary image is sent to one of the Linux systems, where it is compressed and processed for the hand-print recognition and machine-print recognition.

Specialized OCR algorithms recognize the text from the image within one second and send an ASCII result to a database on a separate computer to perform a zip code lookup. The complex recognition algorithms can identify handwritten and machine printed addresses with enhanced accuracy and speed. This system was deployed to USPS distribution centers over a 7 month period.

Benefits of the Linux Approach

John Taves, a consultant from Pacific Northwest Software involved in the design of USPS' initial deployment, believes Linux is an excellent fit for single process applications. For this application, the operating systems and OCR software needed to address a low memory requirement. To meet this need, the Linux kernel was recompiled with only the bare essentials incorporated to support the application.

Mr. Taves also believes that product support from the Linux community is often superior to that of the proprietary software community because of its ability to access a large pool of on-line developers who can help solve problems quickly.

Low cost scalability to a large number of systems was essential, due to the large scale and multiple location deployments at USPS. With USPS' implementation consisting of several hundred systems, the absence of a licensing fee was a factor in its use. Equally appealing was the the freedom to alter the source code, write device drivers, and reduce application requirements.

According to Jasbir Sandhu, of the USPS engineering team, system performance scaled to their needs and provided limited down-time. Generally, problems that have been encountered were attributable to hardware component failure, which were dealt with promptly by USPS' IT support organization.

Their Deployment Evolves and Expands

In 1999, the USPS wanted to expand its mail address scanning capabilities and also take advantage of improved hardware and advances in OCR algorithms. The USPS entered into a $150 million contract with ***Lockeed Martin Corp.*** to fund the RCR2000 project.

Leveraging developments at ***SUNY Buffalo*** and ***ParaScript LLC,*** Lockheed's Distribution Technologies division implemented their Remote Computer Reader (RCR) processing systems modifications at USPS Processing & Distribution Centers throughout the country.

The RCR was also supported by the ***Linux*** operating system. The application resolves both handwritten and machine printed addresses and significantly reduces the manual keying workload required in the processing of letter mail images. Technology enhancements allowed the system to improve the rate of successfully reading handwritten address, from less than 5 percent to 75 percent. Again, the Linux operating environment provided solid and reliable performance.

Additional Observations

With major organizations using the Linux platform, continuous service and upgrade concerns are diminishing. USPS has invested in successfully developing solutions to upgrade its infrastructure on Linux and other technology platforms as well. Today, these systems are not considered "Linux systems", but simply systems that work addressing the needs of the USPS.

Last year, USPS improved productivity by 1.1%, despite setbacks from 9/11, threats of anthrax-laced envelopes and subsequent restrictions in air/ground cargo due to all around cost efficient measures. Technological implementations like RCR/OCR implementations developed at low cost contributed towards an improved bottom line.

Verisign, Inc. – Expanding Open Source in the Infrastructure

VeriSign's infrastructure services deliver security and reliability to Internet and telecommunications customers around the world. VeriSign's Internet and Telecommunications Groups include security and network services for public key infrastructure (PKI), digital payment gateways and managed security services and their Telecommunications group manages the largest independent Signaling System 7 (SS7) network in North America. Nearly all Fortune 500 companies, along with numerous governmental bodies and other organizations, and small businesses use their trusted digital commerce and communications services.

Rationalizing Their Technology Infrastructure

Founded as a provider of Internet security solutions, VeriSign has expanded to deliver the infrastructure services to engage in commerce and communications with security services, telecommunications services and directory services. Historically, a large portion of the firm's information technology infrastructure was dominated by proprietary UNIX systems.

To rationalize their production computing environment, Intel or RISC hardware platforms running a proprietary software, along with a Linux/Intel architecture were evaluated. Linux was chosen for commodity 32-bit processing for various Internet needs. The Registry was an early adopter of Linux and continues to develop and deploy custom code (C, C++, Java) for its domain name registration applications.

During the summer of 2002, recognizing that Linux and open source adoption was at varying levels within Verisign, Ari Balogh, SVP of Operations & Infrastructure initiated a project to standardize their infrastructure components. Today, 1,100 Linux servers are in production and their deployment, along with the use of other open source solutions, continue to expand.

Assessing a New Technology Platform

Verisign initially evaluated Linux/Intel systems for use as technical workstations supporting application development. This approach introduced Linux with minimal risk, since the systems could be replaced by Microsoft/Intel systems if the evaluation went poorly. Success in this effort, lead to assessing Linux/Intel use in other areas, with benchmarks repeatedly demonstrating similar or superior performance to proprietary UNIX systems, at a lower cost.

After showing that Intel/Linux performed well in production, a plan to create corporate standards for Linux systems was started. A team determined which Linux features were appropriate for use behind and outside firewalls, and how to build, deploy, monitor and maintain these systems. With Intel as the preferred system platform, a two vendor hardware strategy was pursued, understanding that selecting the right partners was critical to their success.

Vendors were evaluated on their ability to deliver product, purchasing, and technical support. Support was prototyped by entering Linux problems to evaluate their technical responses and response time. Systems were subjected to security and other evaluations to assure that systems administrators could build a system in about 7 minutes. Ultimately a 1 rack 'U', 2 CPU, 2 Drive ***Intel*** Pentium 3 with a hardware RAID-1 SCSI card defined the "sweet spot" of Linux TCO.

A development environment was established to port in-house code (Java, C, C++) to the new platform. Internal certification of ***Oracle*** on Intel/Linux systems also supported Verisign's reduced TCO view; along with high reliability and scalability up to a 4 CPU design. ***Redhat, Inc.'s*** Advanced Server product, and other distributions provided software to support a highly available Oracle solution.

With Linux/Intel providing cost saving compared to UNIX/RISC systems and an environment familiar to UNIX systems administrators, its use could expand without risk to Verisign's production environment.

Linux: It's Exciting, but Let's Keep it Boring too!

For Verisign's technology team, Linux is exciting, but they want to keep it as basic as possible from a systems operations perspective. VeriSign operates three large data centers along with other sites supporting the DNS constellation and other operating divisions. Based on direct prototyping, quality assurance testing, and production results, Linux has proved to be reliable and stable. The firm uses ***RedHat, Inc's*** Advanced Server, with some databases supported by ***Oracle Corp.'s'*** 8i and 9i offerings; along with other Linux distributions to serve commodity Internet protocols.

Approximately 2000 1U, 2-CPU Pentium 3 systems have been deployed, with 1U 2-CPU Pentium 4 increasing in use as a result of their lower cost and solid performance. The highest performing Linux systems used are 4-CPU 2GHz designs, with prototyping taking place on 4 CPU Itanium II systems to assess their use in high performance solutions. The open source systems management solution, ***Nagios***, is used to monitor the entire infrastructure.

Is Linux Enterprise Ready?

At Verisign, responding to the question “Is Linux enterprise ready?”, the answer is “Yes”. Good UNIX system administrators and developers can easily become proficient with Linux. Choices for selecting systems hardware and peripherals increase over the options available with proprietary UNIX solutions. Additionally, with Linux/Intel's low TCO, replacing troublesome systems in load balanced environment have minimal production impact.

While Intel continues to deliver more capabilities in the 32-bit market, Verisign's recent prototyping with the IA-64 architecture on Linux has been positive, with plans for production use during the second quarter of 2003. Many existing proprietary 64 bit solutions can be complemented if not replaced by Linux on IA-64 class systems. Note also that open source operating systems, such as ***FreeBSD*** are available on Intel IA-64 systems to complement the Linux platform.

Open Source is a Participatory Community

Verisign agrees that using open source often requires participation in the open source community. Their experience has been that community interaction extends to vendors as well. It was noted that during a prototyping effort, consisting of a ***Network Appliance, Inc***. Networked Attached Storage solution, ***RedHat, Inc.'s*** Advanced Server 2.1 using ***Oracle Corp.'s*** 9i database in an asynchronous cluster configuration, failover times in some situations were an unacceptable 10 minutes. After discussing the problem with Network Appliance and RedHat, a workable fix was available within days.

Choices Increase, Deployment Dynamics Are Unchanged

Accompanying the tremendous amount of choice available in the Linux community, there is increased responsibility for individuals tasked with deploying it. Linux deployment should be done using the same methodologies and disciplined care as other enterprise solutions. Service level agreements with customers should not change, and the same focus on creating the best possible solution should prevail.

The notion of choice in open source also extends to choosing vendor support. Some vendors have self-appointed themselves as 'Enterprise Linux' technologists but can fall short in sales, support, and general technology integration. Verisign's advice is prototype a vendor's capabilities and partner with the best.

Going Forward: More Linux and Open Source Software

Verisign's increased familiarity with open source solutions have brought about increased comfort. Early Linux success has driven more Linux deployments, and greater consideration for other open source solutions. ***Apache*** web servers and ***Sendmail*** are components of their technology mix and evaluations of other open source solutions such as the ***JBoss*** application server, and databases such as ***MySQL*** and ***PostgreSQL*** are underway. The process developing at Verisign is to evaluate technical and business requirements against both open source and proprietary solutions. With open source quality and innovation increasing, if an open source solution satisfies the requirements, that solution will prevail.

Westone Laboratories - It Started with Databases

Westone Laboratories is a leading global manufacturer of custom earpieces for hearing aids, in-ear monitors, communications devices, hearing protection systems and related supplies. As a manufacturer, supplier, and a source of technical advice and assistance to this market, Westone Labs manages data about its many customer constituencies, including doctors and hospitals, patients and the hearing health professionals that distribute its products. The firm has 150 employees at 3 locations.

Financial Prudence, with a Long Term Perspective

Westone Labs' IT staff recognizes that addressing practical business priorities is their first objective. They continuously examine ways to refine their processing needs in a financially prudent fashion. All systems are assessed in meeting business needs, and how they will endure over time.

Understanding that over time all systems become legacy systems, Westone Labs always considers the long-term implications of their technology development and deployment decisions. With these dynamics driving their decision making process, and recognizing the changes occurring in the software sector, open source solutions have been increasingly included in their evaluation efforts.

Seeking a New Database Platform

Historically, Westone Labs has relied on various Intel based solutions and maintains customer and suppliers data on a variety of applications. With some applications, such as those supported by ***Paradox*** database and ***BEST Software, Inc.'s*** MAS200 accounting system becoming outdated, it was necessary to consider alternatives.

Applications either implemented, or under consideration to leverage a new technology platform included Westone Lab's online dispenser referral database, a large customer account history database and a business-critical patient information database. These data sources help address the firm's need to archive up to ten years of data on customer interaction on patients, long term customers and other end-users. Westone Labs was also interested in selecting technology that could address both internal needs and was supported by their hosting provider, ***NTT Verio***.

After reviewing their requirements, databases from ***MySQL*** and ***Oracle Corp.*** were considered as the most viable from a functional perspective. With the significant cost difference between these offerings, Westone Labs brought MySQL in-house for further testing. According to Cal Pearson, Westone's head of IT, performance was better than expected, and the MySQL platform proved to be very stable as well. Chief among its strengths were its ability to handle multiple concurrent requests and quick response time. The offering's low cost, solid documentation and simplicity of use also contributed to their selection.

Moving to a Linux OS

Initial MySQL development at Westone Labs was done on a ***Microsoft*** Windows 98SE system. Upon receipt of their new server hardware, the database was migrated to a Linux based system. The migration was unexpectedly trouble-free, with the first production system consisting of the ***MySQL*** database running ***Redhat, Inc.'s*** Linux Professional on a ***Dell Computer*** PowerEdge server. Today there are 3 Linux servers in place at their Colorado Springs, CO headquarters facility with 3 additional Linux systems planned within 12 months. Netware, Windows NT and SCO Unixware servers are also used.

Open Source Development Continues

Westone Labs' internally developed "External History System for AR" has exported various historical accounting transaction data from their MAS200 accounting system into this new system, which consists of a ***MySQL*** database, ***Perl*** scripts, an ***Apache*** web server and is accessed with ***Opera Software's*** browser. Queries have returned results 45 times faster than the firm's current accounting system. This experience further validates their decision to move to an open source software based environment.

Going Forward

Westone Labs notes that open-source software can initially be more difficult to configure, but its reliability, stability, and security are worth the effort. Based on their success with ***Linux*** and ***MySQL***, the firm plans to extend its use of open source technologies into all areas of production and transaction processing.

In-house development efforts are leveraging this platform and incorporating the use of ***Trolltech's*** QT multiplatform C++ application development framework. This should accommodate the deployment of applications for use on both Windows and Linux workstations accessing Linux based servers. Plans also include the ability for remote facilities to work in both a connected fashion, as well as in stand-alone mode.

As the IT team approaches applications to address manufacturing needs, an environment historically serviced by embedded or proprietary databases, their strategy is to use open source solutions to consolidate their business data, while enhancing application performance and usability

About The Dravis Group

The Dravis Group was founded to assist technology providers, users and investors in assessing and navigating through the changing technology landscape. Our research intends to bring clarity to market dynamics leading toward focused and practical decision-making.

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Appendix 1: Terms to Know

Apache An open source Web server available on most UNIX systems (such as Linux, Solaris, Digital UNIX, and AIX), and Windows NT/2000.

Application Server - A server program in a computer in a distributed network that provides the business logic for an application program. The application server is frequently viewed as part of a three-tier application, consisting of a graphical user interface (GUI) server, an application (business logic) server, and a database and transaction server.

Free Software Foundation(FSF) - Founded in 1983 along with its demonstration GNU project by Richard Stallman at MIT to prove that an operating system could be developed and shared freely. "Free" does not mean at no charge, but refers to the use the person who acquires the software has with it. FSF believes that individuals the right to study and make changes to program's source code that improve the program , and redistribute and sell improved versions of the software, as long as it is "open" to others.

GNOME (GNU Network Object Model Environment) - A graphical user interface and set of applications including word processor, spreadsheet program, database manager, presentation graphics, Web browser, and e-mail. GNOME comes from work of the Free Software Foundation.

GNU - A UNIX-like operating system built with source code that can be copied, modified, and redistributed. The GNU project was started in 1983 by Richard Stallman and the FSF. Linux consists of GNU components and a kernel developed by Linus Torvalds.

Java - A programming language introduced by Sun Microsystems in 1995, designed for use in the distributed environments. IBM, Microsoft, and others offer Java compilers.

Kernel - The center of an operating system providing basic services for to its other parts.

KDE - K Desktop Environment is an open source graphical desktop environment. KDE includes a file manager, a window manager, a help system, a configuration system, tools and utilities, and several applications. The KDE project was started in October 1996 by Matthias Ettrich.

Linux - An operating system designed to provide Intel PC users with a low-cost alternative to UNIX systems. Linux's kernel was developed by Linus Torvalds at the University of Helsinki. To complete Linux, Torvalds used of components from the Free Software Foundation's GNU project. Linux is available on major hardware platforms.

Mono Project - Initiated by ***Ximian, Inc.*** to provide developers with a set of open source tools for building .NET applications that run on Windows or any Mono-supported platform, including Linux and UNIX.

Mozilla - Mozilla was Netscape Communication's nickname for Navigator Web browser, and more recently, the name of an open source Web browser project.

.NET - Microsoft's strategy and programming efforts to address Web services. Their goal is to provide seamless interaction between applications and computers.

Open Source - Any program whose source code is made available for use or modification as users or other developers see fit. Historically, proprietary software developers have not made source code available.

Operating System - The program loaded into the computer by a boot program (BIOS) that manages the other programs. Linux, Windows 2000, VMS, OS/400 and AIX are examples of operating systems.

Web Server - A program that manages the files that form Web pages which are presented Web users. The leading Web servers are Apache and Microsoft's Internet Information Server (IIS).