Bloor Research – North America
Independent Technology Research & Analysis

Research Brief

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Linux Is Ready: IBM's Strategy

Preface

In 1999, Bloor Research took a very close look at the "enterprise readiness" of Linux. We ran Linux side-by-side with Windows NT — comparing the two operating environments as file, mail, database, application, and groupware servers. And we concluded that:

> As a file and print server, Linux comes out on top, particularly for large organisations with various locations where remote management is an important option. The same goes for Web and mail servers where the uptime is crucial, although NT doesn't score badly in combination with Exchange either. In a database server environment, there is little or no difference between the two — it really depends on the characteristics of the database and the vendor's advice. The scale tips to Windows NT when it comes to application servers, because there is so much more software available for this platform, even if Linux is starting to catch up. And as for groupware servers: the application will determine the ultimate choice, but except for Lotus Notes, NT is the favourite here. [If you] have mixed workloads (Web server, mail server, file and print server, etc.), then Bloor Research says: by all means, go for Linux. ***But not up to the enterprise level, because neither of the operating systems is ready for that task yet.***

Now, almost three years later, we've been asked by IBM to reexamine our Linux position and to provide our thoughts on Linux "enterprise readiness" for mission-critical computing. What IBM wants to know is:

1. Is Linux enterprise ready (how is Linux faring from reliability, availability, scalability, flexibility, security, manageability, and server consolidation perspective toward the goal of being enterprise ready?); and,
2. How is IBM doing from a strategic/product/services/applications perspective with its Linux products and services?

This *Research Brief* represents the result of our analysis.

Is Linux Ready? — The Criteria

The characteristics for measuring the "enterprise readiness" of an operating environment are well known. To deploy an operating environment in a mission critical situation it needs to be:

- Scalable (providing the enterprise with the ability to expand processing headroom as needed to meet enterprise processing requirements, and/or to allow for server consolidation);
- Available (ensuring that most applications can run in a highly-available fashion with 99.999% availability if required);
- Reliable (ensuring that systems, applications, and databases do not crash);
- Secure;
- Manageable; and,
- Flexible.

The remainder of this report examines Linux from these perspectives, and contains our critical review of IBM's Linux strategy and products.

Linux Is Ready

After examining Linux scalability, availability, reliability, security, manageability, flexibility, as well as server consolidation characteristics, *Bloor Research believes that Linux is ready*. The following subsections describe the reasons why we have reached this conclusion.

Linux Scalability

Enterprises evaluate Linux scalability from two perspectives: vertical and horizontal scalability.

1. Vertical scalability refers to the number of processors available within a single system environment — and vertical scalability is important because some applications have been designed to exploit multiple local processors (and do not work as well when processing is distributed). For instance, some monolithic applications from SAP and PeopleSoft have been designed to exploit 8-, 16-, 32-way symmetrical multiprocessing (SMP) servers.
2. Horizontal scalability equates to distributed computing. Using this configuration/-technique, IS managers are able to harness and aggregate the processing power of multiple distributed systems to achieve scalability objectives.

Note that some IS designers and managers consider clustered systems that share the same database to be vertically scaled — but we do not. Nor do we consider blade servers (essentially distributed processors collocated in the same system enclosure) to be vertically scaled systems.

Bloor NA Linux Scalability Findings

With respect to Linux scalability, Bloor NA found that:

1. At present, ***Linux scales well vertically to 6-way SMP on Intel hardware***. But, over the next three months, expect to find Linux 2.5 scaling functionality to be backported into

Linux 2.4 kernal distributions (allowing for 8-way scaling in the very near term). And expect the next major revision (Linux 2.6) to provide up to 16-way scaling in about one year.

2. Bloor NA found that IBM can scale Linux on its zSeries mainframe using virtual machine technology. This approach may address Linux vertical scaling limitations for some prospective buyers — and these virtualization technologies allow for better resource sharing across mixed workloads (workloads that place mixed demands on the processor). Note that these technologies will also be ported to IBM iSeries and IBM pSeries machines.
3. ***Linux does scale extremely well horizontally in distributed computing configurations***. IBM, Sun, and Dell all report that they are having great success deploying Linux in tightly coupled cluster environments where Linux is used in mission critical computing environments for high-performance technical computing (HPTC), financial modeling, and life sciences computational tasks.

   Additionally, Bloor NA interviewed twelve Independent Software Vendors (ISVs) that build and deploy computing Grids (Grids are large, distributed resource sharing computing environments) — including AVAKI, DataSynapse, Entropia, Parabon, Platform Computing, United Devices, and others — and these ISVs are also reporting great success scaling Linux in distributed computing scenarios.

Linux Availability

How does one make a system highly available? Availability is measured in uptime (for instance, a highly-available system could be available 99.99% of the time; and even more highly-available system could be available 99.999% of the time; a fault-tolerant system would be available 100%). To provide high levels of system availability systems are usually configured to "failover" to other systems in order to ensure that computing can take place while the failure is being addressed.

Bloor NA Linux Availability Findings

Early editions of Linux were designed to operate in single systems environments and did not have the functionality needed to take automated corrective action or failover should a failure occur. Accordingly, if failure occurred, human interaction (such as a physical reboot) was required. But, as a result of contributions from the vendor community to the Linux kernel, as well as by contributions from the Linux open source community (that now numbers 400,000 developers), the Linux kernel now has the needed extensions to allow for automated failover.

Failover extensions can be found in the base Linux kernel (downloadable for free over the Internet); from Linux suppliers such as Red Hat, SuSE, or other United Linux suppliers; from traditional hardware/software vendors such as Sun and IBM; and from Grid suppliers (in the form of distributed resource management DRM software).

Linux Reliability

How does one determine whether a system or subsystem is reliable? From a reliability perspective, Information System (IS) managers look at statistics such as "meantime between failure", or examine log files to determine the number of failed processes that have occurred or the number of system reboots that were initiated to restart a system or process. Systems that perform reliably have

high meantime-between-failure (MTBF) occurrences (mainframes have MTBF in the 60 year range) and few failures recorded in log files.

Bloor NA Linux Reliability Findings

From experience as well as user feedback, Bloor NA knows that reliability is dictated by systems hardware as well as the level of sophistication of the operating environment and related applications that run on that operating environment:

1. Bloor NA's research indicates that almost ***90% of Linux is installed on Intel hardware platforms*** — and these *platforms* (the systems themselves) are generally known to be reliable (but note: ***hardware reliability is highly dependent on the system/component testing done by the equipment manufacturer).*** Further, there are other, more reliable platforms than Intel servers from which to choose (mainframes, for instance) — but these are available at a higher cost.
2. ***The Linux operating environment has also been proven to be reliable — especially when used to run dedicated applications*** (for instance, Linux platforms operate extremely well when deployed as dedicated firewalls).
3. ***When Linux systems have failed, the failures have largely been caused by incompatible applications contending for the same systems resources; poorly written device drivers; or limitations in the operating environment (for instance, early revisions of Linux were not written to exploit multi-processor environments).*** One way to avoid this dilemma is to buy "advanced server" or "enterprise server" pre-tested environments from reputable Linux suppliers because these vendors conduct quality assurance on a variety of diverse systems, devices, and software environments.

Linux Security

Linux, like all operating environments, can be subject to security attack. And like all operating environments, the approach to protect the enterprise from mischief, malfeasance, and damage involves putting in place the proper policies and procedures (such as "don't open e-mail from people you don't know") as well as the right technologies to reduce risk.

From a technology perspective, Linux closely resembles Unix and provides Unix-like security. Users require passwords and authorization rights to access Linux services and resources. Linux contains logging, monitoring, and audit capabilities that make it possible to trace system and user activity. And Linux provides secure shells, secure sockets, transport-level security and encryption capabilities to help prevent security breaches. And numerous vendors provide additional point products that operate on Linux — providing additional security functions. So, when you think "Linux security", think "Unix security" — they are both pretty much the same.

Bloor NA Linux Security Findings

But, Bloor NA did find that ***Linux security and Unix security are hugely different in one respect: openness.*** Because Linux is based on open source code, developers can read and potentially modify Linux source code to meet their needs (vendors usually close their Unix source code, thus making modification and reading of source difficult to achieve).

This "reading" aspect of Linux is important because users and developers have long suspected the existence of "trap doors" in some Unix implementations, and in Windows. There are two types of trap doors: accidental (that are security exposures), and purposeful (as in "planted"). Purposeful trap doors are alleged entryways into operating environments that only vendors (and potentially some governments) know about. Accidental trap doors are entryways (such as buffer overruns that open entrances into operating environments) that were not planned — but can create security exposure. Conspiracy theory aside, because Linux is open, a large community of developers can closely scrutinize Linux code for both types of trap doors — ensuring that such entryways are exposed and closed. Such is not the case with closed operating environments.

Further, this "modification" aspect of Linux is important. ***Linux developers can build their own layers of security directly on the Linux kernel — and such proprietary extensions are extremely difficult to break***. Note that as long as this modified source code is not made available for license in the general marketplace, enterprise developers need not make their security enhancements known. The ability to modify source code (and keep those modifications secret) results in making Linux virtually unbreakable for some enterprises (and governments) that choose to invest in specialized security development. However, it should be noted that most business CIO's will want to avoid making source code modifications that would limit their support options.

Linux Manageability

From a manageability perspective, Linux manageability is similar to Unix manageability:

1) Linux buyers can download various open source management tools and utilities (for data management, content management, and so on); and/or
2) Linux buyers can purchase commercially available Linux point product solutions from companies like BMC, Heroix and Easilize; and/or
3) Linux buyers can purchase complete management suites such as IBM's Tivoli or Sun's Management Center.

Bloor NA Linux Manageability Findings

Although many Unix-based manageability tools, utilities, and applications can be used to manage Linux environments, ***Bloor NA found that several existing Unix management products need to be quality assured (tested and certified) to ensure that they can manage Linux-based servers***.

Still, ***we found very sophisticated Linux management tools (including workload balancing, performance/tuning, and other Linux management products) available from Grid vendors in the form of distributed resource management tools, utilities, and applications.***

And we found that some vendors with major commitments to systems management (such as CA, IBM, and Sun) have done Unix to Linux systems management ports — and currently offer rich suites of Linux management tools, utilities, and applications .

Linux Flexibility

For thirty years IS managers have been looking for a flexible operating environment that would allow applications to be moved easily from one hardware platform to a distinctly different hardware platform. The reason that IS managers desire flexibility include:

1) Operating environment flexibility maps to cost savings opportunities (because IS managers are not "locked-in" to a particular platform or supplier — a strategic Total Cost of Ownership manageability advantage); and,

2) Operating environment flexibility provides IS managers with the ability to completely swap hardware to accommodate new or changing workload requirements.

To date, Linux has been highly successful in achieving its flexibility goals — running on small, mobile hardware chipsets such as ARM; various embedded chipsets; popular but somewhat obscure chipsets such as Saturn, Hitachi's H8, Amtel AVR, the Motorola 68K family; all the way through powerful, enterprise server chips such as HP's Alpha, Sun's UltraSparc, Intel's Pentium, and Itanium series, and IBM's PowerPC series.

Note that IS managers are not the only ones to benefit from the ability of Linux to run across multiple platforms — Linux platform flexibility also has benefits for Independent Software Vendors (ISVs). ISVs write and sell software solutions. And because there are so many platforms and operating environment permutations and combinations from which to choose, ISVs have had to standardize on certain brands of Unix, and on Windows, in order to reach the broadest range of customers while minimizing quality assurance costs. Linux offers ISVs the opportunity to write code once — and run that code on many different platforms.

More precisely, Linux, and the consistency of the GNU toolchain across various hardware architectures provides ISVs with the ability to write C/C++ applications that can be engineered once an a Linux/Intel platform and then rebuilt and deployed on other hardware architectures without re-engineering.

ISVs also have the opportunity to write Java applications that can run on Linux. These applications are written once (at a higher level of abstraction than at the operating system level) and can then run on numerous hardware platforms without having to be compiled. The benefit here is that applications can run on multiple platforms without having to compile code for each specific platform (a portability versus performance trade-off).

The net result: ISVs that build on Linux can save time and quality assurance costs by creating one version of their code (as opposed to numerous specialized versions as is the case with Unix) that can run on multiple platforms.

Bloor NA Linux Flexibility Findings

To ascertain which microprocessors are supported; to locate drivers, compilers, assemblers, and other resources for deploying Linux across a wide variety of processor architectures, Bloor NA recommends that IS managers visit www.SourceForge.com or www.Linux.org — homes of the Linux development community. These sites contain valuable information on processor support, tools and utilities, assemblers, debuggers, and other ancillary software that can help IS managers deploy and manage Linux environments.

Linux Server Consolidation

Many IS executives know that it is expensive to manage and secure a distributed computing environment. These IS managers also know that if they are able to consolidate their computer systems into larger, vertically scaled systems, they can realize several administrative, operational, and license-related benefits.

In order to consolidate servers, it is necessary to have two things:

1. An operating environment that can exploit SMP; and,
2. A vertically scalable systems platform that allows IS managers to run the same work-load that had been distributed amongst smaller (generally 2- and 4-way) servers.

Bloor NA Linux Server Consolidation Findings

As we described in the scalability section, Linux scales well to 6-way SMP on Intel servers, but does not yet scale well vertically on Intel architecture beyond 6-way server environments. Yet, despite this Linux inability to exploit large, vertically scaled Intel architecture, ***Bloor NA did find Linux installed on IBM's zSeries large enterprise server for server consolidation purposes***. IBM's zSeries allows up to 15 Linux (and other) operating system images to be loaded and run on a zSeries system. This configuration is possible because logical partitioning (the ability to run multiple, separate instances of an operating environment in their own "space") is a standard feature of IBM's z/OS as it exploits the z/900 chip set. IBM's z/VM makes it possible to run hundreds or thousands of Linux instances virtually on an enterprise-class, mainframe server platform. IBM's virtualization technology provides the ability to host mixed workloads. These two types of virtualization – one at the microcode level (hypervisor / LPAR) and one at the OS layer (z/VM) – allow for server consolidation. The first type offers native speed but limits the number of OS instances that can be run. The second allows for "virtually unlimited" scaling in the number of OS images that can run concurrently.

IBM Linux Strategic/Product Positioning

To understand IBM's position in the Linux marketplace, it is necessary to examine IBM's strategic objectives for Linux as well as its product and services offerings. This section examines IBM's Linux strategic positioning.

Strategic Considerations — The Business Revenue Model

Linux is based on a licensing scheme called "GPL" — General Public License. This license allows users/vendors to copy and distribute copies of Linux using the GNU General Public License (and these users can make money reselling licenses with support if they so desire). But this license also states that users/developers who modify Linux and make the modified version generally and commercially available also need to publish any Linux code they modified (and make that source code generally available to the Linux community). In other words, vendors can add Linux "extensions", but they are not able to create proprietary value added extensions — instead, these extensions (if marketed commercially) need to be documented and provided back to the Linux community.

Given these business constraints, many Linux suppliers have struggled with the issue of how to make money on Linux (because it's difficult to make money by adding value to the operating environment and its also difficult to make money when the operating system is available as a free download). Some vendors have tried to earn revenue by providing product support or integration services; others have tried to make money by selling Linux applications; still others have tried to make money selling hardware. (Note that when writing applications on top of Linux, the GPL does not apply; these can be closed source as well as open source not limiting the ISVs ability to make money on that application.) Although IBM doesn't sell Linux (it partners with Red Hat and with United Linux suppliers such as SuSE), IBM is one of the few companies that can make money selling all of the above.

- From a hardware perspective, IBM provides Linux on its four hardware platforms. So, even if buyers obtain Linux for free (or at a very low cost), IBM still makes money selling its hardware platforms.
- From a software perspective, IBM provides a complete J2EE (Java-based) Web services application development environment as well as integrated infrastructure components that run on top of the Linux operating environment. The company provides vertical middleware for program-to-program communications such as WebSphere MQ. And IBM provides horizontal infrastructure integration components such as Lotus Domino (for Linux messaging/workflow), Tivoli (for Linux management), WebSphere (for J2EE Web services application development), and DB2 (as an enterprise-class integrated database). All of these integrated infrastructure solutions provide IBM with Linux revenue opportunities.
- From a services perspective, IBM provides education, training, deployment, migration and support services; as well as professional integration services through its IBM Global Services (IGS) organization. Professional services provisioning also provides IBM with Linux-related revenue opportunities.

How does a prospective buyer of IBM Linux solutions benefit from IBM's ability to make money by selling Linux hardware, software, and services? Where other vendors are having difficulty making their Linux value propositions economically feasible, IBM has clearly found a business model that makes investment in Linux profitable. Accordingly, IBM is willing to spend money:

- enriching the Linux code base;
- deploying horizontal and vertical integrated infrastructure components (Tivoli, Lotus, WebSphere, and DB2) on top of Linux and,
- investing in initiatives such as Unix/Linux integration and/or migration.

Therefore, in the short term as well as the long run, IBM customers benefit directly from IBM's ability to build a healthy Linux business model.

Strategic Considerations — Applications Capture

IBM's Linux strategy involves more than how to make money. It also considers "how to capture applications on IBM platforms". The goal of any systems software/hardware maker is to have the "preferred" platform that attracts the most ISVs (because ISVs bring applications to the platforms — and applications are ultimately what sells a given platform and related services). But how can a vendor attract prospective Linux buyers and ISV business partners when the operating environment is open and when the underlying Intel platform is based on a commodity platform (in other words, how can IBM differentiate its standards-based, open systems Linux offerings?)

IBM differentiates its Linux offerings in several ways:

1) IBM supports Java-based application development on its zSeries and xSeries servers.
2) IBM cascades enterprise server capability from the z, p, and iSeries onto the xSeries;
3) IBM offers a scaling alternative to Intel servers with its zSeries; and,
4) IBM provides "integrated infrastructure" that enables application developers to focus on building applications rather that integrating applications with underlying infrastructure components.

Java Support

IBM offers a complete J2EE (Java Enterprise Edition) Web services development environment that enables application developers to write Java applications that can run on all IBM hardware platforms (so developers can write Java code once, and it can run on IBM's p, i, x, and zSeries). But note, at present J2EE on Linux is supported on IBM's Intel and mainframe platforms only (Linux J2EE on iSeries and pSeries will be available shortly).

The next logical question becomes: "why would a potential customer choose to build on an IBM platform?" The following subsection considers this question.

Platform/Infrastructure Value-add

Why should prospective Linux server buyers choose IBM platforms? To address this question, IBM has created a compelling case for prospective Linux buyers and ISV partners to adopt IBM platforms:

- *Cascading* — The concept of "cascading" involves taking functionality from high-end systems (such as mainframes) and migrating that functionality to underlying systems (such as mini-computers and desktops). At IBM's Linux Technology Center, IBM has ported Linux to its four systems platforms — and has "cascaded" enterprise-level functionality from its zSeries (mainframe) and pSeries (AIX Unix) to Linux — thus creating systems platform (hardware/software) environments that are rich in enterprise-level functionality. (IBM makes these enhancements available over time as open source contributions to Linux).
- *Scalability* — Most vendors in the Linux market sell Linux on Intel. And as stated previously in this brief, Linux presently does not scale well beyond 6-way SMP. IBM, on the other hand, offers Linux on its Intel-based xSeries; as well as its mainframe zSeries architecture. IBM's zSeries implementation can allow 15 instances of Linux to be run in

logical partitions (providing native speed) — or can allow thousands of concurrent instances to be run using z/VM technology (providing virtually unlimited scaling).

- *Integrated infrastructure* — IBM has ported and integrated its WebSphere, DB2, Lotus, and Tivoli product lines to Linux. By so doing, IBM is able to provide application developers with highly integrated infrastructure components (enabling developers to focus on building applications value add — while not having to worry about integrating a variety of underlying open source infrastructure modules and applications with Linux).

  WebSphere contains the tools and utilities needed to build J2EE Web services custom applications (or for ISVs to build standards-compliant packaged applications); Tivoli provides the systems and security management infrastructure for Linux systems, applications, and databases; Lotus provides enterprise-class Linux messaging and workflow capabilities; and DB2 provides a Linux-integrated, proven, scalable, cross-platform database environment.

Linux Design, Deployment, and Management Professional Services

With respect to IBM, IBM's Global Services (IGS) organization provides far more than just Linux support services. The company also provides a wide range of integration services (for instance: application integration, or Linux/Windows integration, or Linux/Unix integration, and so on). And IGS also provides worldwide deployment services as well as outsourced management services. This ability to provide a wider range of lucrative value-added services beyond mere deployment and troubleshooting services, coupled with IGS's sheer size (over 150,000 people), positions IBM extremely well to make money in Linux services where other vendors struggle to do so.

Are IBM Customers Buying-into This Approach?

Bloor NA research found many examples of ISV packaged applications that are being built on middleware that runs on Linux; or are being built directly on Linux by writing to Linux APIs. Examples of this phenomenon include ISVs such as:

- JD Edwards (JD Edwards has built its CRM on IBM's WebSphere and DB2 database — and has easily ported that application to Linux);
- SAS Institute (SAS has built applications on IBM's DB2 — and because DB2 runs on Linux, SAS DB2-based applications have migrated easily from Unix to Linux platforms);
- ACCPAC and SAGE (accounting packages that run on DB2 have also been migrated easily to Linux); and,
- SAP (runs in its own database environment and on Oracle — as well as on IBM's DB2 environment — and accordingly can run several of its Internet-enabled applications on IBM Linux platforms).

Bloor NA also found numerous customer examples of IBM Linux buyers who purchased IBM platforms because of the company's value-add enterprise features, its complete development environment, and its integrated infrastructure. Detailed descriptions of these customer accounts can be found in our "*Linux Is Ready*" 50+ page in-depth Linux market report that will be posted by IBM free-of-charge in mid-November, 2002.

Summary Observations

With respect to the "enterprise readiness" of Linux, Bloor NA found that:

- *Scalability*: Linux does scale well vertically on Intel platforms up to 6-way SMP — but does not scale well beyond on Intel architecture today. However, over the next three months expect Linux 2.5 scaling functionality to be backported into Linux 2.4 kernal distributions — making it possible to scale with reasonable linearity to 8-way SMP on Intel architecture. Also note that Bloor NA found that Linux scales extremely well vertically on IBM's zSeries. Finally, note that we found that Linux scales extremely well in horizontal distributed computing configurations — especially in cluster and Grid environments.
- *Availability*: Linux systems can be configured to provide five 9s (99.999%) availability;
- *Reliability*: Linux reliability greatly depends on the reliability of systems hardware, device drivers, and other factors. Bloor NA believes that if Linux is run on a reliable systems platform, and if related device drivers and applications are properly quality assured, Linux can be run in mission-critical computing environments. (Users told us they measure Linux reliability in years, as opposed to hours or days…).
- *Security*: Security depends on security practices as well as security hardware and software. Linux security is similar to Unix — so if the proper security procedures are followed and the proper patches are administered, Linux can be made just as secure as Unix. Additionally, Linux has the added advantage of being open source code — meaning that Linux users can very closely scrutinize Linux code to ensure it meets their security requirements. And because Linux users have access to Linux source code, additional security can be built on the Linux operating environment — enabling enterprises to add their own custom-levels of Linux security to their private computing environments.
- *Manageabilty*: Many point product manageability products that operate on Unix have yet to be qualified to operate on Linux. However, many vendors that offer suites of management products such as Sun, IBM, and Computer Associates have already conducted Unix-to-Linux ports of their products — thus making it possible to easily monitor, control, and administrate Linux environments. Finally, Bloor NA also found sophisticated Linux management capabilities supplied by Grid vendors
- *Flexibility*: Flexibility is the ability to run Linux across multiple, heterogeneous platforms. Linux runs on dozens upon dozens of hardware platforms — proving that Linux is flexible. Bloor NA believes that as long as Linux remains open, and as long as it does not splinter into various source code versions, Linux is likely to become the most flexible operating system ever delivered.
- *Server Consolidation*: As identified in the scalability section, Linux does not scale well beyond 6-way on Intel architecture (although Linux will scale to 16-way on Intel architecture with the next major revision of the operating system). But, we also note that Linux does scale well on IBM's zSeries enterprise servers in conjunction with IBM's virtualization technologies. Bloor NA concludes that if server consolidation is an objective, enterprise buyers may find IBM's zSeries to be a viable platform for Linux server consolidation needs.

IBM's Linux Strategy/Product Offerings

IBM competes on multiple dimensions (software, hardware, and services) — and has much breadth and depth in each dimension. The company's approach to the market is to:

1) provide the tools and utilities for building custom and packaged applications;
2) cascade enterprise-server functionality to all of its Linux platforms;
3) offer middleware and infrastructure components on top of Linux (to provide messaging, workflow, security, management, Web development, Web services applications development, and database integration); and,
4) provide Linux-related training, education, migration, integration, and outsourcing services.

From our perspective, IBM is better positioned than any other competitor to offer Linux-related applications, platforms, and services. IBM's business model is focused on solving customer problems in the key areas of e-business infrastructure and business application support based on the Linux operating system. Further, we observe that because IBM's Linux business strategy is sound, the company is willing to invest developmental and service resources into improving Linux — a clear benefit to prospective buyers of IBM's Linux products.

In the end, we understand why IBM asked us to reexamine Linux. Linux as an operating environment has advanced tremendously since our last review (three years ago). It scales; it's reliable; it's available; it can be secured and managed; it can be deployed and used for server consolidation. The tools and utilities needed to build custom applications or for ISVs to build packaged applications on Linux have also advanced tremendously. And IBM has even further sweetened-the-pot by providing infrastructure modules from Tivoli, Lotus, WebSphere, and DB2 on top of the Linux operating system.

All of these factors lead us to conclude that:

1) Linux is enterprise ready; and
2) IBM's strategy, products, and services should be examined by prospective Linux buyers looking to develop and deploy Linux solutions in enterprise-class computing environments.

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