Sun Microsystems, Inc.: Solaris Strategy

As Anil Gadre, Vice President and General Manager of Sun Microsystems’ Solaris Operating Environment organization, returned to the conference room, his management team quieted down. The Solaris operating system ran virtually every Sun workstation and server in the world, and was given much of the credit for Sun’s increase in enterprise server market share from 9% (in terms of revenue) in 1996 to 30% in 1999. Yet the intervening years had also witnessed gains by Microsoft’s NT operating system, as well as the explosive rise of Linux, a new operating system. In addition to meeting its responsibilities as a profit center within Sun, the Solaris group was charged with “ownership” of the entire company’s response to Linux.

With only four months before the release of Solaris 8, Gadre and his team faced a number of competitive issues. Chief among them was: How could Solaris best continue to achieve its vision while addressing strategic issues raised by Sun overall, the company’s distributors, and rivals such as Microsoft, other UNIX variants, and now Linux?

Operating Systems

An operating system (OS), also known as an operating environment, was a collection of software programs that allowed an application program to interact with computer hardware. The OS performed basic tasks, such as recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on the disk, and controlling peripheral devices such as disk drives and printers. The OS was unique among software programs in that it “touched” everything within a computer, interacting with every piece of hardware and software associated with a machine.

The central module of an OS was known as the “kernel.” When a computer was first turned on (“booted”), the kernel loaded first. The kernel remained in main memory at all times, and handled most of the essential services associated with an OS.

The best known OS producer in the world was Microsoft. More than 90% of all personal computers in the world ran on a Microsoft operating system in 1999. The remaining share was divided among Apple Computer (4%) and a few niche players such as Amiga. Different OSs were generally incompatible, so that an OS developed for one PC platform would not run on another and an application written for one OS would not run on another.
Operating systems also ran technical workstations and servers, which typically relied on sophisticated reduced instruction set chip (RISC) microprocessors and were more powerful than personal computers. Workstations and servers were also more expensive: the average workstation and server list price exceeded $12,000 and $100,000 in 1999, respectively. In contrast, a high-end PC typically listed for less than $6,000.

Historically, most workstations and servers relied on UNIX-based operating systems. UNIX was developed for internal use by AT&T’s Bell Laboratories in the 1970s. At the time, AT&T was still a regulated telephone monopoly and legally prohibited from entering the computer market. AT&T licensed UNIX at a nominal cost to any interested party.

From these licensing arrangements emerged several significant branches of UNIX, such as the Berkeley Software Distribution (BSD), which was circulated widely in the technical and academic communities and which benefited from contributions submitted from around the world.

Some UNIX licensees evolved competitively with respect to each other, developing implementations and features that were proprietary to their UNIX implements. Notably, those hardware manufacturers that also produced an OS, such as IBM, Hewlett-Packard, and Sun, strove to adapt their OSs to perform optimally given their specific hardware architectures. Since these architectures were distinct, these firms’ UNIX-based OSs diverged over time. As a result, although efforts were made to make OSs compatible for applications development, different workstation and server manufacturers’ UNIX-based systems diverged in several characteristics.

**Servers**

When connected via a network, multiple computers could share resources such as a common printer, files, or applications software. Servers were the “backbones” of such networks, managing the networked computing environment and supporting high-end business functions. Servers were intended to be available on the network at all times and respond to client requests as they came in.

By the late 1990s, networked machines typically conformed to a “client-server” architecture. Individual computer users had computers on their desks and did much of their work locally. When they needed to access shared information or peripheral devices, or to perform some other kind of computational task requiring the resources of a more powerful machine, users accessed central computers (“servers”) from their desktop machines (“clients”) via the network.

The term “server” covered a wide range of systems, from those performing relatively simple tasks, such as serving files to clients or directing print jobs appropriately, to those performing relatively complex tasks, such as delivering applications and providing ERP functions. The demands placed on a server also increased with the number of users.

Higher-end servers relied on multiple microprocessors and were constructed so as to provide more reliable and more scalable operation than a PC or workstation. Servers were also equipped with server application software designed to handle the robust demands placed on them, whether related to processing or to communications.

Servers were also used to support connections to both the Internet and “intranets.” On the Internet, an individual computer could send a service request to any server in the world that was also connected to the Internet. An intranet was typically a subset of the Internet operated for the (principal) use of a single organization. The primary distinction between intranets and the Internet was that an Internet server could potentially receive massive peak service requests, since without some intercession, there was no way to control the pool of possible clients. Both the Internet and intranets faced issues of security in their normal operation (e.g., screening which computers should be allowed to access a particular server).
Open Source Software and Linux³

The Open Source Movement In 1984, Richard Stallman left his job at MIT’s Artificial Intelligence Laboratory to set up an organization dedicated to developing a freely available, UNIX-like operating system: the GNU Project.³ A computer programmer who frequently wrote and shared his own programs, Stallman was frustrated in his attempts to improve several software programs purchased by his lab because the manufacturer refused to share its source code with him. Stallman was also concerned that the rise of proprietary software threatened the ability of programmers to share ideas and advance programming according to the norms of open science.

Concerned that private sector firms might make proprietary modified versions of GNU software, thus defeating the purpose of his efforts, Stallman designed a new license for the software’s distribution. The GNU public license, or GPL (nicknamed “copyleft”), allowed free use of a program’s source code but required that any modifications be similarly made publicly available under the GPL.

Thus, in contrast to proprietary software, which was distributed only in “executable” form (encoded for use directly by the computer hardware and operating environment), the underlying source code for GNU “open source” software was made publicly available under the GPL. With access to the source code, a user could understand how a program worked, and could make changes to that program if desired.

By 1990, the GNU Project developed many of the essential pieces of software that surround an operating system, including command processors, assemblers, compilers, and text editors. Since these were generally compatible with UNIX and could be easily ported to UNIX-based systems, many of these programs became widely popular. For example, GNU Emacs was one of the most popular text editors in the UNIX world. However, the GNU project had not yet developed the core of such a system: the kernel.

Linux In 1991, Linus Torvalds was a computer science graduate student in Helsinki. Frustrated by the limitations of the DOS operating system on his home computer, Torvalds spent several months writing his own UNIX-like kernel to run on his Intel 386 chip-based PC. Torvalds posted his source code on an Internet newsgroup under the GPL, and shortly thereafter began to receive emails from users containing “patches” to the bugs they found and new features they designed. In 1992, Torvalds combined his kernel with the components that were developed previously by the GNU project, thus completing the GNU/Linux operating system.

Torvalds continued to oversee the development of Linux throughout the 1990s. As its popularity spread, he delegated code review duties to a core group of developers and module “owners.” A module owner reviewed other users’ contributions to determine which should be incorporated into the kernel, and passed these on to the core developers for a second evaluation. Torvalds retained final authority over all decisions. It was not uncommon for new versions of Linux to be posted daily on the project Web site.

Although new versions of Linux and GNU were made freely available on the Internet, the complexity of installing and integrating these parts meant that many potential users were willing to pay for the convenience of getting them all on a CD. A number of distributors began to ship their own branded versions of Linux, enhancing it with programs written by their own developers.⁵ All of these distributions offered a version of the kernel, a set of tools, and many of the same applications. They differed most sharply in the installation programs they employed, the documentation they supplied, and the support contracts that were offered. Prices for these CD kits (including some level of support) ranged from $40 to 200.
By 1998, the Linux kernel had grown to more than 1.5 million lines of code, less than 5% of which was written by Torvalds himself. The kernel’s contributor base had grown to perhaps 10,000 programmers. In addition to fixing bugs and developing new features, users had also adapted the software to run on a wide variety of hardware platforms. In mid-1998, several major software providers, including Corel and Oracle, announced their intention to “port” their software to Linux. In early 1999, HP, SGI and IBM all announced that they would support Linux on their hardware platforms. By the end of that year, more than 100 Linux distributions were produced by a wide range of for-profit and non-profit organizations, as well as by individuals. The ten largest organizations, nine of which were for-profit, accounted for more than 90% of all Linux distributions. Red Hat became the first Linux distribution firm to go public, and several other firms, such as Caldera, were rumored to be considering IPOs.

The rise of proprietary Linux distributions worried some observers, who feared that alternate distributions of Linux, bundled with other tools, could lead to divergence among Linux distributions similar to that experienced by UNIX in the 1980s:

> Reality isn’t as clean as theory. If you develop a product under one (version) of Linux, generally there are things that have to be modified to run under another (version or distribution).

Torvalds had no financial investment in Linux or any of its distributions. In the late 1990s his employer was a Silicon Valley startup called Transmeta. In contrast to most Silicon Valley startups, which actively sought publicity, Transmeta had been unusually secretive during its five-year existence. As a result, nobody outside of Transmeta knew exactly what the company was working on. Rumors on the Web implied that the firm was building an ultra-fast chip, developing new ways to use Linux, and so on. Some rumors seemed to contradict other rumors. In November 1999, Transmeta’s otherwise blank Web site suddenly included an announcement that on January 19, 2000, the company would hold a press conference to unveil its new technology – whatever that might be.

### The Competitive Environment

In the early 1990s, UNIX-based workstations comprised 85–90% of the workstation market. But as new Intel chips made personal computers more powerful, the line between personal computer and workstation began to blur. By 1998, some analysts assessed NT-based workstations as offering “about 80% of the performance of traditional workstations, but at half the cost.” In that year, NT workstations outsold UNIX-based machines by more than 1 million units, although UNIX still accounted for 54% of workstation market revenue. While unit sales of workstations grew by 22% in 1998 over 1997, total workstation revenue fell by 3% to $14.7 billion.

Competition was also heating up in the server market, which was divided into four segments (Exhibits 1 and 2). A $2,500 PC with server application software could handle “low-end” functions, such as file serving for a LAN with a few users. In contrast, a “high-end” server delivering enterprise applications cost in excess of $1 million and offered mainframe-like attributes.

### Customers

A single customer often purchased servers from multiple segments to handle different functions. A large Fortune 500 firm, for example, might purchase file servers for its local office network, “mid-range” servers for handling departmental applications, and high-end servers to provide company-wide enterprise applications or database functions. This customer also weighed
server features differently depending on the server’s use. For file servers, price and compatibility
with employees’ desktop systems were typically important. As the complexity of a server’s tasks
increased, and as the tasks involved became more “mission-critical” for an organization, issues of
reliability and customer support rose in prominence. Also, as the number of users increased,
customers were more likely to consider issues of reliability and “scalability” (the capability of a
server to handle multiple users at once, and to be expanded without disruption to handle additional
users).

In most firms, an Information Technology (IT) executive set parameters for purchasing
decisions. These parameters included a list of up to five approved vendors of hardware and software,
as well as a list of equipment that was acceptable for purchase. For servers and other computing
equipment above $500,000 or so, a senior line executive or IT executive contacted a salesperson from
the manufacturer of the desired equipment, provided specifications, and requested a price. Although
such purchases rarely entailed competitive bidding by multiple server manufacturers, it was common
for a buyer to press for a discount. For low-end servers and workstations, department managers often
bought machines from a value-added reseller or over the Web, rather than going through the IT staff.

Independent Software Vendors

As was true for PCs, the bulk of workstation and server application software was produced
by independent software vendors (ISVs). Since most OSs were not binary compatible with each other,
an application written for a given OS would not run on another OS unless it was recompiled. The
process of editing an application to run on another OS was called “porting.”

Porting a large application from one version of UNIX to another could take as little as one or
two days. However, testing, creating documentation, and developing support for the ported
application could take months. It was estimated that more than 80% of the total cost associated with
porting an application, which could run into the millions of dollars, was attributable to testing,
documentation, and support. These costs were significantly higher when porting between UNIX and
NT due to the architectural differences between the OSs.

An ISV typically chose one OS as a “reference platform,” writing all of its applications first
for that platform, and then porting the applications to additional operating systems. Until 1995, most
ISVs used one of the UNIX-based OSs as their reference platform. However, by the late 1990s, many
non-enterprise ISVs had begun to use NT as their reference platform for new products. In 1999, many
ISVs offered their applications on three operating systems – NT, plus whichever two leading UNIX-
based systems they expected would provide strongest demand for the application.

There were thousands of workstation and server ISVs, and tens of thousands of applications. Sun stated that more than 750 ISVs provided more than 12,000 applications for Solaris. Microsoft
claimed that more than 100,000 applications were written for NT.

In addition to these proprietary applications, there existed a large number of open source
programs covering a wide range of applications. Several of these had been ported to multiple OSs
and were quite pervasive. For example, the Apache Web server application, developed and circulated
by a handful of Webmasters around the U.S., ran on NT, Linux, Solaris, and other major UNIX-based
platforms, and claimed a 50% share of the Web server market in terms of units shipped. Similarly, the
open source Sendmail messaging program for routing and handling email was used by more than
80% of all email servers.
Competitors

In 1999, the market for server operating systems was divided among more than a dozen players, with Microsoft-based systems holding the largest market share (Exhibits 3 and 4). Within the UNIX-based server OS category, the UNIX-for-Intel provider SCO held the largest market share in terms of units shipped (Exhibit 5), although Sun led in terms of revenue.

Microsoft was born in 1975, when high school friends Bill Gates and Paul Allen teamed up to sell a version of the computer programming language BASIC. The company focused on developing software for programmers until 1980, when Microsoft signed a deal with IBM to provide the operating system for all IBM PCs. To meet this obligation, Gates bought an existing operating system from a Seattle programmer and renamed it the Microsoft Disk Operating System (MSDOS).

MS-DOS soon became standard on virtually all personal computers except those produced by Apple Computer Corporation. Although many users preferred the Apple Macintosh to DOS-based machines for its ease of use and graphical interface, DOS-based machines quickly dominated personal computer sales. This trend accelerated in the late 1980s, after Microsoft developed a graphical interface (“Windows”) that greatly resembled Apple’s OS. By 1990, Microsoft-based personal computers accounted for more than 95% of the personal computer market.

In its initial deal with IBM, Microsoft retained the licensing rights to its operating system. Throughout the mid-1980s, the firm began to develop its own compatible software applications such as Word, Excel, and Powerpoint. By the 1990s, these business software applications had achieved dominant shares in their respective segments.

Microsoft introduced Windows NT in 1993. This operating system was designed to provide desktops with more networking features, such as better connectivity. NT was intended to compete with Novell’s NetWare and UNIX-based operating systems for running computer networks. Early versions of NT were plagued by bugs and were slow to gain acceptance. However, in 1996, the much improved Windows NT 4.0 was an immediate success, and by 1999 NT accounted for nearly 40% of the server OS market. Although far more robust and secure than previous versions, NT still lacked the scalability and reliability of UNIX needed by many large corporations.

In 1997, soon after the launch of NT 4.0, Microsoft began work on its next OS. Developed at a cost of substantially more than $1 billion, Windows 2000 was intended to be a watershed product for high-end corporate customers. After multiple delays, Microsoft announced in October 1999 that Windows 2000 would be released in March 2000. Among other features, Windows 2000 would allow the “clustering” of servers – connecting multiple servers to each other – to expand server capacity. The NT 4.0 was incapable of scaling beyond four CPUs. Industry analysts conjectured that Windows 2000 would not be capable of scaling beyond eight CPUs.

Concurrent with Microsoft’s push into servers, the firm also responded to the rise of the Web. Microsoft’s first response to the Web was to push proprietary online services such as Microsoft Network. In December 1995, however, Bill Gates announced that Microsoft would aggressively seek to “embrace and extend” the Internet by first incorporating Internet protocols into its products, and later adding proprietary alterations to these protocols. Although early versions of Microsoft’s Internet Explorer (IE) browser were inferior to Netscape Navigator, Internet Explorer 3.0 (released in August 1996) closed this gap. IE was available for free over the Internet, and came bundled for free with Windows 95 and Windows 98. By January 1997, IE claimed 30% of the browser market. By mid-1998, IE had surpassed Navigator in browser market share, and in 1999, IE accounted for more than 70% of browser downloads.

Beginning in 1998, Microsoft NT incorporated Kerberos, a freely circulated network security system based on advanced cryptography that ensured the identity of a device attempting to connect
with a given server. By 1999, Microsoft was rumored to have altered some of the Kerberos code, making the NT version of Kerberos incompatible with non-NT servers.

Similarly, after licensing Sun’s Java programming language in 1997, Microsoft developed a modified version that Sun alleged was not fully compatible with other versions of Java. In November, 1998 a California judge found that this alteration violated the license agreement, and ordered Microsoft to make all of its software compatible with the latest Java technology. Microsoft appealed, and in August, 1999 won the right to continue shipping its version of Java until the appeal was completed.

As Microsoft grew, it faced increasingly hostile regulatory threats. In 1995, the firm was barred from a $1.5 billion acquisition of Intuit. In 1998, the U.S. Department of Justice (DOJ) and 20 states filed an antitrust suit claiming that Microsoft purposefully used its power to stifle Internet browser competition. By November 1999, a US District judge had ruled against Microsoft in the DOJ case, and another judge was arbitrating the resulting legal arguments concerning the sanctioning or dismantling of the company.

**Novell** In 1983, Novell began to focus on developing PC networking systems, introducing its NetWare product. Optimized to facilitate storing of files and printing on a network, NetWare became the most successful early LAN-based PC networking environment. Through a series of product introductions and acquisitions of rivals, Novell held 70% of the PC networking market in 1990. However, as Novell attempted to expand into other businesses, its share eroded significantly, especially after the introduction of Microsoft NT. Novell’s products ran only on Intel-based systems.

**Hewlett-Packard** Hewlett-Packard’s successful line of minicomputers dated back to the 1960s. HP began selling workstations in 1985, and entered the server business shortly thereafter. The firm initially produced servers running on its own UNIX operating system, HP-UX, and on hardware based on HP’s PA-RISC chip. However, by the late 1990s HP began developing a version of its HP-UX to run on Intel chips, and also began to produce Intel chip-based server hardware that could run NT, NetWare, and some UNIX operating systems. In 1999, HP committed to provide worldwide support for Linux on its Intel-based systems, and also announced plans to cease development of its own PA-RISC chip by 2002 in favor of Intel’s IA-64 (64-bit) chip.

**IBM** IBM was the world’s largest computer hardware company. IBM’s early servers, developed in the mid-1980s, ran on the firm’s proprietary UNIX operating system, AIX, and on the IBM RISC chip. During the late 1980s, IBM produced Intel chip-based servers that could run NT, NetWare, and some UNIX OSs. IBM also produced other operating systems, including OS/2, OS/360, OS/390, and OS/400. In 1999, IBM announced that it would provide global support for Linux on its Intel-based systems, as well as sell Intel-based Linux OS servers.

**SCO** Founded in 1979, SCO delivered the first packaged UNIX operating system for Intel processor-based PCs in 1983. In 1999, SCO produced multiple UNIX OSs, including OpenServer and UNIXware, as well as related applications for Intel systems, and was the leading UNIX server operating system producer in terms of units sold. SCO ported several of its applications to Linux, and offered professional support for Linux-based systems. SCO had also invested in several Linux distribution firms, including Caldera and Turbolinux.

**Red Hat** Red Hat was the most widely recognized Linux vendor in the world. The company launched its first Linux distribution CD in late 1994. By early 1999 the firm had annual revenues of $10 million, and had secured equity investments from numerous hardware and software makers including Compaq, Dell, IBM, Intel, Netscape, Novell, and SAP. Red Hat went public on August 11, 1999 at $14 per share. By the end of Friday, August 13, its price rose to $85.25, valuing the company at more than $5 billion.
The Red Hat Linux distribution was available for free over the Internet, but many customers preferred to purchase the CD version, which came with a manual and 90 days of support. The product was available through various distribution channels, including mail order and computer retailers. In addition, several hardware manufacturers, such as Dell, preinstalled Red Hat on their computers.

In 1999, Red Hat Linux 6.0 came in several variations, ranging from Standard ($29.95 direct) to Professional ($149.95), each with different support options and software. Red Hat Linux was capable of running on several hardware architectures, including Intel, Sun’s SPARC, and Compaq’s Alpha chips. The Red Hat product consisted of up to 650 different software packages and nearly 600 megabytes of code. The Linux kernel was just one of these packages, representing about 15 megabytes of code. Red Hat itself built 35 of the 650 packages, including a few crucial ones such as the installer program. In December 1999, Sun announced that it would make Red Hat Linux available on CD through its online “Sun Store,” for customers who wished to purchase one for a SPARC platform-based workstation or server.

With Red Hat’s commercial and IPO success, and the prospect of similar success for other Linux distribution firms, some in the open source community expressed resentment that shareholders were benefiting from the work done by volunteers during their free time. Tim Buckley, Red Hat’s Chief Operating Officer, stressed that one of Red Hat’s top priorities going forward was to stay closely involved with the community: “The last thing we want to do is start getting isolated from the community, which we are accused of a bit, but only because we are getting bigger and have a reputation, not because we’re doing anything to warrant that.”

Sun Microsystems

Founded in 1982 by four graduate students – three from Stanford and one from UC Berkeley – Sun Microsystems set out to deliver low-cost, general-purpose workstations to engineers at universities. By 1999, Sun was a leading player in powerful servers for the Internet and the exploding market for corporate intranets. The firm’s products included computer systems, microprocessors, storage products, and a complete line of software for operating network computing equipment. Sun also provided a wide range of services including support, education, and professional services. In contrast to many other server and workstation producers, such as IBM and HP, Sun did not produce hardware based on Intel chips. All of Sun’s systems relied on a single architecture based on its SPARC brand RISC chip.

Sun’s servers were priced from less than $5,000 to over $1 million, and gross margins ranged from 25% to more than 70%. The company’s workstations were priced at an average of $12,000, with an estimated gross margin of 25%. Led by server sales, Sun’s revenues grew by more than 18% per year during the late 1990s. In addition, by 1999 Sun’s revenues from software and services were a more significant portion of total revenues (Exhibit 6).

Sun and Open Standards

Before Sun, computer vendors traditionally sold systems based exclusively on proprietary architectures. In contrast, from its inception Sun embraced open systems, publishing specifications and interface protocols to facilitate the creation of components and complementary products. Even on those occasions when Sun developed its own hardware components – such as the SPARC microprocessor, which it developed out of concern that existing chipmakers might be slow to adopt RISC-based architecture – the company typically eschewed the opportunity to keep its components
proprietary and instead licensed them to several manufacturers, thus encouraging its adoption as a de fact industry standard.

Open system architecture provided several advantages to the customer, including “compatibility among Sun’s products, enhanced ability to interface with other vendors’ products, adaptability to future hardware developments, portability of applications programs, and availability of many third-party software packages.” Open systems provided advantages for Sun as well. First, using standard components allowed the machine’s design to be well-specified, which, in turn, made possible easier and more extensive testing. Second, sparked by co-founder Bill Joy’s observation that “innovation happens elsewhere,” Sun relied on open standards to encourage third-party vendors to develop products, particularly software, that complemented Sun products and enhanced their marketability. Third, this approach enabled Sun to bring new products to market quickly. Start-up companies often tried to create and market products in-house, while internal processes in larger companies often slowed down development. By embracing open standards, Sun could produce market-ready software and hardware, and concentrate on its unique contributions: the CPU, operating system software, graphics, networking, and general-purpose tools for technical professionals.

Although Sun outsourced the manufacturing of many of its hardware components to other firms, the company focused a great deal of internal effort on software development, especially for the operating environment. Whereas other computer companies typically bought an operating system from an outside vendor, Sun kept software expertise in-house. As a self-described UNIX company, Sun was able to hire many of the best UNIX programmers available. These UNIX experts advised the hardware engineers how to design a better total machine by taking advantage of the UNIX operating system’s capabilities. In turn, the software engineers tuned UNIX (in the form of Solaris) to best take advantage of the hardware design.

Workstations and Servers

Although workstations comprised a smaller share of Sun’s revenues as the server market grew, the firm continued to dominate the traditional technical workstation market. In 1999, Sun accounted for more than 50% of the UNIX-based technical workstation market. A wide range of ISVs continued to develop applications for these workstations, all of which ran on the Solaris operating environment.

Sun’s server product line had emphasized midrange and high-end products through the mid-1990s. In 1996, Sun augmented its high-end capabilities by acquiring Cray Business Systems from Silicon Graphics, facilitating the development of Sun’s top-of-the-line Sun Enterprise 10000 server. A year later, the company extended its product range into the lower end through its introduction of a line of workgroup servers priced between $5,000 and $15,000. By 1999, Sun offered a complete server product line from lower midrange through high-end.

Software

Java In 1995, Sun released a new programming language, Java, that generated widespread excitement among programmers. Java technology enabled software applications to run on any machine, whether it used Solaris, Windows, a UNIX variant, or another operating system. The Java approach relied on mini-programs (known as “applets”) that could be stored on a server and accessed via the Internet on a task-by-task basis by a user with a simple computer. Once the specific task was completed, the program was erased from the user’s computer and the data stored back on the server. In theory, pervasive use of Java technology could obviate the need for a single standard desktop OS. Sun licensed Java technology to all comers under its 1998 Community Source License
(CSL), an agreement that stipulated that 1) code could only be circulated to other CSL licensees, and 2) no changes could be made that affected compatibility of the language.

In November 1999, on the verge of signing an agreement with the European Computer Manufacturers’ Association (ECMA) that would make Java an official industry standard, Sun delayed handing over the 8,400 pages of specifications for the Java language and related programs. At issue was concern over copyright issues. ECMA copyright policies gave its members “unfettered access” to copyrighted material in a standard, including the ability to use only a portion of the material. Sun viewed this as inconsistent with Java technology’s promise of universal compatibility, providing a means by which competitors or standards-tinkerers would breach the compact Sun believed it had formed with the large community of software developers that had made the Java language so successful. Sun’s attempts to get the Java language accepted as a standard by the International Organization of Standardization (ISO) in early 1999 had foundered on similar issues. As one observer noted:

> It’s a fine line that Sun must ride because everybody sees the danger of having Java be ‘UNIXfied,’ meaning there’s no one gatekeeper controlling the standard. Of course, it’s also important to have a community process in place to allow partners from all over the industry to participate.

**StarOffice** During the summer of 1999, Sun acquired StarDivision, a German software developer, whose StarOffice productivity suite was very similar to Microsoft Office 97 from a user perspective, with similar placement of menus, buttons, and other features. Sun began to offer StarOffice software for free download over the Web and through preinstallation on personal computers. By the end on 1999, more than two million copies were shipped by Sun, and four million more copies downloaded through other means. StarOffice worked on multiple operating systems, including Windows, Linux, and OS/2, as well as Solaris. Sun was considering making a Web-based version of StarOffice to run remotely from a server instead of sitting on an individual desktop.

**The Solaris Operating Environment**

Sun’s first operating system, SunOS, was based on the freely available Berkeley 4.2 version of UNIX – which, in retrospect, was evocative of the Linux community with respect to its spirit of sharing and collaboration. As Sun introduced new features to its operating system to optimize its performance with Sun hardware, and as other UNIX-based computer manufacturers similarly adapted their operating systems to their unique hardware, SunOS and other versions of UNIX evolved to the point where they were no longer compatible with each other. In the late 1980s, AT&T and Sun agreed to collaborate in developing their next generation of UNIX. In a deal that involved AT&T’s purchase of a 20% stake in Sun for $300 million, Sun and AT&T combined their OSs in the resulting System V Release 4.

In response to the Sun-AT&T collaboration, Sun’s largest competitors formed the Open Software Foundation (OSF). OSF was a consortium whose stated goal was to develop and promulgate “vendor-neutral” open standards that all UNIX-based producers could use in their products. Sun and AT&T declined to join the OSF. Rob Gingell, Senior Scientist and Sun veteran, recalled:

> Declining to join the OSF was a difficult decision. It’s possible that by joining, we could have eventually moved toward a unified UNIX rather than the fragmented world that has persisted. But at the time, our sense was that working to reconverge with AT&T was the right way to reconstruct a compatible standard.
Sun released the operating system resulting from its collaboration with AT&T in 1991. It named the product Solaris 2.0, and retroactively renamed the previous version (SunOS 4.X) Solaris 1.0. Sun ported Solaris 2.0 to the Intel architecture in 1992, so interested customers could purchase Solaris for their Intel-based systems. At about the same time, the OSF released its own kernel called OSF/1. Although DEC produced a version of its operating system based on OSF/1, for the most part each UNIX-based vendor continued to invest in its own proprietary UNIX operating system.

Since all Sun hardware was designed around a single architecture based on the SPARC chip, the same operating environment ran on all Sun products, ranging from basic workstations all the way up to the most powerful servers. This bred a consistency across the Sun product line: for example, the same application could run on all Sun machines.

The Solaris platform was also well suited to the needs of the Internet. The development of the BSD UNIX distribution had been sponsored by (then) DARPA, the research agency of the U.S. Department of Defense that had sponsored the creation of the ARPAnet as the Internet’s precursor. In the late 1970s, DARPA had decided to move its sponsored research to a UNIX base and had funded UC-Berkeley’s efforts to modify UNIX to meet its research needs, including the support of the ARPAnet and the then-emerging TCP/IP Internet protocols. As a result of this heritage, Sun built every one of its products to be Internet-capable, and integration with the Internet was pervasive with Solaris software. Consequently, Solaris was able to run Internet-based functions without any specific revision to its code. In contrast, Microsoft relied on an additional program to run on top of its early NT operating systems to handle Internet communications. The additional programming increased the time needed to complete Internet functions.

**Responding to the NT Challenge**

Sun’s CEO, Scott McNealy, had earned a reputation as a brash, outspoken leader. As Microsoft moved to extend NT’s reach into higher-end workstations and servers, McNealy turned his attention to Bill Gates and Microsoft – in one journal’s assessment, assuming the role of “guardian of the Net.”

When the anthropologists and the archaeologists get their shovels and their vacuum cleaners, their brooms and Picks, and they uncover the 1980s and the 1990s, they will notice a huge productivity decline. They are going to blame Microsoft Office and Windows. We banned PowerPoint from Sun 18 months ago. The stock prices tripled. And about three years ago, Japan had this unbelievable economy going, and then they started deploying PCs everywhere. The economy nose-dived. I can’t promise you this, but if General Motors could eliminate Microsoft Office now, they could ship the 1999 cars next year at half price.

By 1997, Microsoft was responding in kind, and it was not uncommon for Gates and McNealy to trade barbs in the press.

The Solaris division became involved in the public debate as well. Brian Croll, Director of Marketing for Solaris, recounted:

We focused on industry analysts, and tried to persuade them that the Internet – whose fate was still far from certain – was going to dramatically affect the importance of servers. Our argument was, ‘the Internet is going to become ubiquitous, and the volume of traffic is going to be tremendous. When that happens, a server must be as reliable as an electric utility.’
The Solaris Group in 1999

In 1999, the Solaris group was one of several major divisions at Sun. Most Solaris employees were involved in programming. In addition to working on improvements to the operating environment itself, a substantial number of these programmers were dedicated to creating applications to run on the Solaris platform. The group’s product development cycle had shrunk by nearly 70% since the mid-1990s. According to Tom Goguen, Solaris Marketing Group Manager:

In addition to trying to get Solaris 8 out the door, we have engineers already working on the next version of Solaris. At the same time, we continue to provide support for older releases, and maintain our supply of applications for all releases. This consumes a lot of resources.

A profit center within Sun, the Solaris group sold its operating environment and applications through three different channels. First, the software was shipped with every Sun machine that was sold, and the Solaris division charged Sun’s workstation and server hardware divisions for each unit that shipped. The second channel was OEMs which produced Sun clones based on the SPARC chip or produced Intel architecture-based machines. Analysts conjectured that the Solaris division charged OEMs the same price that it charged Sun’s workstation and server divisions. Third, infrastructure applications and upgrades were sold directly to customers who owned Sun machines, either through direct sales, VARs, or Sun’s online shop Sun Store.

As Linux increased in popularity during 1998 and 1999, each division within Sun found itself responding to questions about its position regarding Linux. When Anil Gadre took over the reins of the Solaris division in June 1999, Scott McNealy gave him responsibility for coordinating Sun’s overall response to Linux.

Decisions

The next major release of the operating environment, Solaris 8, was scheduled for launch in January 2000. It would include a number of attractive new, high-end features, such as enhanced scalability and “dot-com features” such as Web performance, security, and resource management. But given the broader responsibilities of the Solaris group, this launch was an opportunity to establish Sun’s strategic direction regarding the changing competitive landscape. Should Sun adopt Linux? Open up its source code? Change its pricing structure? Or continue with the practices that had made Solaris and Sun successful over the previous decade? What strategic principles should drive this decision, and how did it connect to Sun’s broader challenges in the marketplace?

Anil Gadre looked at the whiteboard where the team had been taking notes throughout the meeting. After several hours of debate, there were far more questions than answers on the board. On the left-hand side, Rob Gingell had noted that moving toward open source would “enable Sun to again leverage the fact that ‘innovation happens elsewhere,’” as well as “take Sun back to its roots” – a sentiment widely shared in the room. Opposite this, however, the director of finance had queried, “how do we meet our numbers with an open source product?” In the center, slightly larger than the rest of the writing, was the question: “What is Linux, really?”

Gadre turned back to his team. “Okay, I think we’ve spent enough time laying out what we know. Now…what are our best options, and which should we pursue?
### Exhibit 1  U.S. General-Purpose Server Market, 1999

<table>
<thead>
<tr>
<th>Segment</th>
<th>Price</th>
<th>Typical use</th>
<th>Avg revenue ($000/unit)</th>
<th>Shipments (000 units)</th>
<th>Revenue ($ billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-end</td>
<td>&lt; $20,000</td>
<td>File/print, mail/groupware, Web site, small business</td>
<td>5.5</td>
<td>906</td>
<td>5.0</td>
</tr>
<tr>
<td>Workhorse</td>
<td>$20,000 - $99,999</td>
<td>Departmental applications, small database, midsized business enterprise applications</td>
<td>39</td>
<td>240</td>
<td>9.5</td>
</tr>
<tr>
<td>Midrange</td>
<td>$100,000 - $999,999</td>
<td>Database, departmental applications, enterprise applications</td>
<td>269</td>
<td>35</td>
<td>9.4</td>
</tr>
<tr>
<td>High-end</td>
<td>$1,000,000+</td>
<td>Database, enterprise applications</td>
<td>1,554</td>
<td>6.9</td>
<td>10.7</td>
</tr>
</tbody>
</table>

Source: Forrester Research

### Exhibit 2  U.S. General-Purpose Server Market Share breakdown by segment, 1998

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers Priced Below $100K</td>
<td></td>
<td></td>
<td>Servers Priced $100K - $1M</td>
<td></td>
<td>Servers Priced Above $1M</td>
<td></td>
</tr>
<tr>
<td>IBM</td>
<td>5.2</td>
<td>20.8</td>
<td>IBM</td>
<td>4.9</td>
<td>IBM</td>
<td>6.0</td>
</tr>
<tr>
<td>Compaq</td>
<td>4.5</td>
<td>18.0</td>
<td>HP</td>
<td>4.1</td>
<td>Fujitsu</td>
<td>1.4</td>
</tr>
<tr>
<td>HP</td>
<td>3.1</td>
<td>12.4</td>
<td>Sun</td>
<td>2.3</td>
<td>NEC</td>
<td>1.1</td>
</tr>
<tr>
<td>Sun</td>
<td>2.7</td>
<td>10.8</td>
<td>Other</td>
<td>6.3</td>
<td>Hitachi</td>
<td>1.1</td>
</tr>
<tr>
<td>Dell</td>
<td>1.7</td>
<td>6.8</td>
<td>Sun</td>
<td>0.9</td>
<td>Sun</td>
<td>0.9</td>
</tr>
<tr>
<td>Other</td>
<td>7.8</td>
<td>31.2</td>
<td>Other</td>
<td>0.7</td>
<td>Amdahl</td>
<td>0.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25.0</td>
<td>100.0</td>
<td>TOTAL</td>
<td>17.6</td>
<td>TOTAL</td>
<td>16.3</td>
</tr>
</tbody>
</table>

Source: International Data Corp.
**Exhibit 3**  Worldwide Server OS Market Share (% of all units shipped)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows NT</td>
<td>7.0</td>
<td>18.1</td>
<td>25.6</td>
<td>35.3</td>
<td>38.3</td>
<td>38.1</td>
</tr>
<tr>
<td>NetWare</td>
<td>39.6</td>
<td>34.7</td>
<td>32.1</td>
<td>26.7</td>
<td>22.8</td>
<td>19.1</td>
</tr>
<tr>
<td>Linux</td>
<td>0.0</td>
<td>0.0</td>
<td>6.5</td>
<td>6.8</td>
<td>15.8</td>
<td>24.8</td>
</tr>
<tr>
<td>Combined UNIX a</td>
<td>28.6</td>
<td>25.4</td>
<td>20.1</td>
<td>20.9</td>
<td>18.8</td>
<td>15.5</td>
</tr>
<tr>
<td>IBM OS/2 Server</td>
<td>13.9</td>
<td>13.8</td>
<td>11.2</td>
<td>6.3</td>
<td>3.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Other</td>
<td>11.0</td>
<td>8.0</td>
<td>4.5</td>
<td>3.9</td>
<td>1.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Total server OS shipments (000)</td>
<td>1,646</td>
<td>2,173</td>
<td>3,090</td>
<td>3,476</td>
<td>4,404</td>
<td></td>
</tr>
</tbody>
</table>

* Includes Solaris and all other UNIX variants

Source: International Data Corp.

**Exhibit 4**  Worldwide Server OS Market Share (% of revenue)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows NT</td>
<td>1,390</td>
<td>27.8</td>
<td>1,747</td>
<td>30.3</td>
<td>25.7</td>
</tr>
<tr>
<td>Netware</td>
<td>688</td>
<td>13.8</td>
<td>914</td>
<td>15.8</td>
<td>32.9</td>
</tr>
<tr>
<td>Linux</td>
<td>23</td>
<td>0.5</td>
<td>32</td>
<td>0.6</td>
<td>38.4</td>
</tr>
<tr>
<td>UNIX a</td>
<td>2,831</td>
<td>56.7</td>
<td>3,041</td>
<td>52.7</td>
<td>7.4</td>
</tr>
<tr>
<td>Other OS</td>
<td>64</td>
<td>1.3</td>
<td>40</td>
<td>0.7</td>
<td>-37.5</td>
</tr>
<tr>
<td>Total OS revenue ($million)</td>
<td>4,996</td>
<td>100.0</td>
<td>5,774</td>
<td>100.0</td>
<td>15.6</td>
</tr>
</tbody>
</table>

* Includes Solaris and all other UNIX variants

Source: International Data Corp.
Exhibit 5  Breakdown of UNIX-based Server Operating System Shipments, 1998-1999

<table>
<thead>
<tr>
<th></th>
<th>1998 Shipments (000)</th>
<th>1998 Share (%)</th>
<th>1999 Shipments (000)</th>
<th>1999 Share (%)</th>
<th>1998-1999 Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCO OpenServer</td>
<td>215</td>
<td>26.0</td>
<td>194</td>
<td>23.1</td>
<td>-10.0</td>
</tr>
<tr>
<td>Sun Solaris/SPARC</td>
<td>156</td>
<td>18.8</td>
<td>186</td>
<td>22.2</td>
<td>19.2</td>
</tr>
<tr>
<td>SCO UnixWare</td>
<td>114</td>
<td>13.8</td>
<td>119</td>
<td>14.1</td>
<td>4.1</td>
</tr>
<tr>
<td>IBM AIX</td>
<td>113</td>
<td>13.6</td>
<td>113</td>
<td>13.5</td>
<td>0.0</td>
</tr>
<tr>
<td>HP-UX</td>
<td>94</td>
<td>11.4</td>
<td>105</td>
<td>12.5</td>
<td>11.7</td>
</tr>
<tr>
<td>Sun Solaris/Intel</td>
<td>28</td>
<td>3.4</td>
<td>26</td>
<td>3.1</td>
<td>-7.1</td>
</tr>
<tr>
<td>Compaq Tru64</td>
<td>25</td>
<td>3.0</td>
<td>19</td>
<td>2.2</td>
<td>-25.0</td>
</tr>
<tr>
<td>SGI Irix</td>
<td>17</td>
<td>2.1</td>
<td>15</td>
<td>1.8</td>
<td>-11.8</td>
</tr>
<tr>
<td>SNI Reliant</td>
<td>11</td>
<td>1.3</td>
<td>8</td>
<td>1.0</td>
<td>-25.0</td>
</tr>
<tr>
<td>Other UNIX</td>
<td>55</td>
<td>6.6</td>
<td>55</td>
<td>6.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>828</td>
<td>100.0</td>
<td>839</td>
<td>100.0</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Source: International Data Corp.
Exhibit 6  Sun Microsystems Financial Estimates

Estimated breakdown of Sun Microsystems revenue, 1996-2000

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Net revenue ($mil.)</td>
<td>7,094.8</td>
<td>8,598.3</td>
<td>9,790.8</td>
<td>11,726.3</td>
<td>15,450.0</td>
</tr>
<tr>
<td>Servers, incl. Storage</td>
<td>34%</td>
<td>44%</td>
<td>49%</td>
<td>57%</td>
<td>61%</td>
</tr>
<tr>
<td>Workstations</td>
<td>52%</td>
<td>40%</td>
<td>32%</td>
<td>23%</td>
<td>18%</td>
</tr>
<tr>
<td>Service</td>
<td>10%</td>
<td>10%</td>
<td>12%</td>
<td>14%</td>
<td>15%</td>
</tr>
<tr>
<td>SunSoft a, c</td>
<td>2%</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>JavaSoft c</td>
<td>0%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Sun Microelectronics b</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Total Revenues</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*a* Excludes intracompany sales estimated to be $495, $635, $760, $850, and $950 in 1996-2000.

*b* Excludes intracompany sales estimated to be $225, $296, $359, $415, and $500 in 1996-2000.

*c* The SunSoft and JavaSoft business units were dissolved and incorporated into several other units in 1997. However, some analysts attempted to continue tracking the equivalent of these units in subsequent years.

Estimated gross margins of Sun Microsystems, 1996-2000

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers</td>
<td>59.0%</td>
<td>64.0%</td>
<td>65.0%</td>
<td>63.0%</td>
<td>62.5%</td>
</tr>
<tr>
<td>Workstations</td>
<td>35.5%</td>
<td>36.5%</td>
<td>32.0%</td>
<td>25.0%</td>
<td>24.0%</td>
</tr>
<tr>
<td>Service</td>
<td>36.3%</td>
<td>35.4%</td>
<td>39.3%</td>
<td>41.1%</td>
<td>37.0%</td>
</tr>
<tr>
<td>SunSoft</td>
<td>80.0%</td>
<td>80.0%</td>
<td>78.0%</td>
<td>69.0%</td>
<td>60.0%</td>
</tr>
<tr>
<td>JavaSoft</td>
<td>80.0%</td>
<td>90.0%</td>
<td>83.0%</td>
<td>65.0%</td>
<td>55.0%</td>
</tr>
<tr>
<td>Sun Microelectronics</td>
<td>55.0%</td>
<td>60.0%</td>
<td>60.0%</td>
<td>60.0%</td>
<td>60.0%</td>
</tr>
<tr>
<td>Corporate Gross Margin</td>
<td>44.7%</td>
<td>49.8%</td>
<td>52.1%</td>
<td>51.9%</td>
<td>51.5%</td>
</tr>
</tbody>
</table>

1 http://webopedia.lycos.com/Operating_Systems/operating_system.html
4 GNU was a “recursive” acronym that stood for “GNU is Not UNIX.”
10 This section draws heavily on Johnston, C, M. Rukstad and D.B. Yoffie, “Microsoft, 2000,” HBS case #N1-700-071, February 14, 2000, pp. 4-5.
12 Kehoe, L., “Java ruling likely to have bearing on Microsoft antitrust case: Louise Kehoe on the preliminary finding on Sun’s charge that its rival ‘polluted’ its technology to tie it to Windows system,” Financial Times, November 19, 1998, p. 4.
18 Op Cit 6, p. 11.
21 This section draws heavily on Langowitz, N. and S.C., “Sun Microsystems, Inc. (A).” HBS Case No. 686133.
23 Ibid.
24 Ibid.