INPUT

STRATEGIC MARKET PERSPECTIVE

Use of Internet Appliances in the Corporation, Europe

Internet Opportunities Program

FEBRUARY 1997

Use of Internet Appliances in the Corporation, Europe

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Abstract

Use of Internet Appliances in the Corporation, Europe analyzes market and technology trends for Internet appliances in the corporation. It provides worldwide market forecasts from 1996 to 2001 as part of INPUT's Internet Opportunities Program.

The aim of the report is to identify where, how, and when Internet appliances will be used by corporations, for what applications they will be used, and how likely they are to replace PCs. The report measures the impact Internet appliances will have on the PC market overall over the next five years.

Cost of ownership of Internet appliances is measured and compared with that of PCs in the corporate environment. The impact of Intranets and application migration to the Web platform is also analyzed.

The report contains 76 pages and 41 exhibits.

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Internet Opportunities Program

Use of Internet Appliances in the Corporation, Europe

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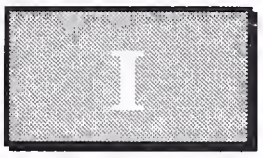


Introduction

A
Objectives and Scope

INPUT views the Internet, including intranets, as the next IT platform for applications. Increasingly, applications are being developed not for specific operating systems or hardware architectures, but for the Internet. This is made possible by languages such as Java, which enable an application to be written only once, yet be available to all Internet-enabled platforms. INPUT uses the term "application migration" to refer to this growing trend.

A new breed of client device has emerged during 1996, as application migration began in earnest. This device type, often referred to as the "$500 Internet terminal", or the "network computer", is designed specifically to run Internet applications and to access information stored on the Internet and intranets.

INPUT calls these devices "Internet appliances". The term 'computer' is too restrictive for all the applications INPUT believes these new devices will be used for. They will be used in the home for general Internet access and will also be integrated into telephones, game consoles, and other information-oriented consumer appliances. They will also be used in the corporation for low-cost information and application access.

This report analyzes and forecasts the market opportunities for Internet appliances in the corporation for the period 1996-2001.

This report can be used by:

- Internet appliance vendors—to identify the most appropriate target markets for Internet appliances and to understand users' purchasing plans, opinions, and concerns

- Software developers—to plan future product development strategy, identify new markets for Internet-based software, and target users most likely to migrate to Internet applications
- User organizations—to identify which functional areas and which users will be most affected by application migration and Internet appliances, to plan future platform deployment strategies, and to compare PC and appliance costs of ownership

B
Methodology

The findings of both primary and secondary research were used to assemble this report.

INPUT interviewed 100 user organizations in Europe during August 1996. The countries included in the survey were (in descending order of sample size): U.K., Germany, Sweden, France, The Netherlands, and Italy. Organizations were asked to comment on a wide range of issues, including: PC implementation, Internet appliance purchase intentions, application usage, support expenditure, and departmental and functional requirements.

In addition to this primary research, this report draws on:

- Other INPUT program research material
- Analysis of information from on-line services and Internet sources
- User surveys of spending on Internet software
- Trade publications, industry trade shows, and vendor literature

C
Related INPUT Reports

Other INPUT reports that address topics related to the subjects discussed here include:

- *Use of Internet Appliances in the Corporation, U.S., 1996*
- *Notes' Survival in the Intranet-enabled Corporation, 1996*
- *Worldwide Internet Market, 1995-2000, 1995*
- *The Future of Web Software, 1995*

II

Executive Overview

A
Applications Will Shift to the Web

Applications today are written with a specific operating system and/or hardware platform in mind such as: Windows, UNIX, OS/400, MVS, etc. There is no reliable way to port applications from one platform to another other than putting in extra development time and resources, and there is no reliable way to distribute one version of software that can be installed and run on all platforms (the Open Software Foundation attempted this with ANDF—Architecture Neutral Distribution Format—but it has not become a widespread standard).

With the introduction of the Web as a cross-platform standard for sharing information on the public Internet and its deployment within organizations for cross-platform private information sharing, many companies have realized that it can be applied to applications as well as information. The cross-platform, Web-based language Java enables an application to be written only once, yet ensures that the application will run on all platforms that support Java.

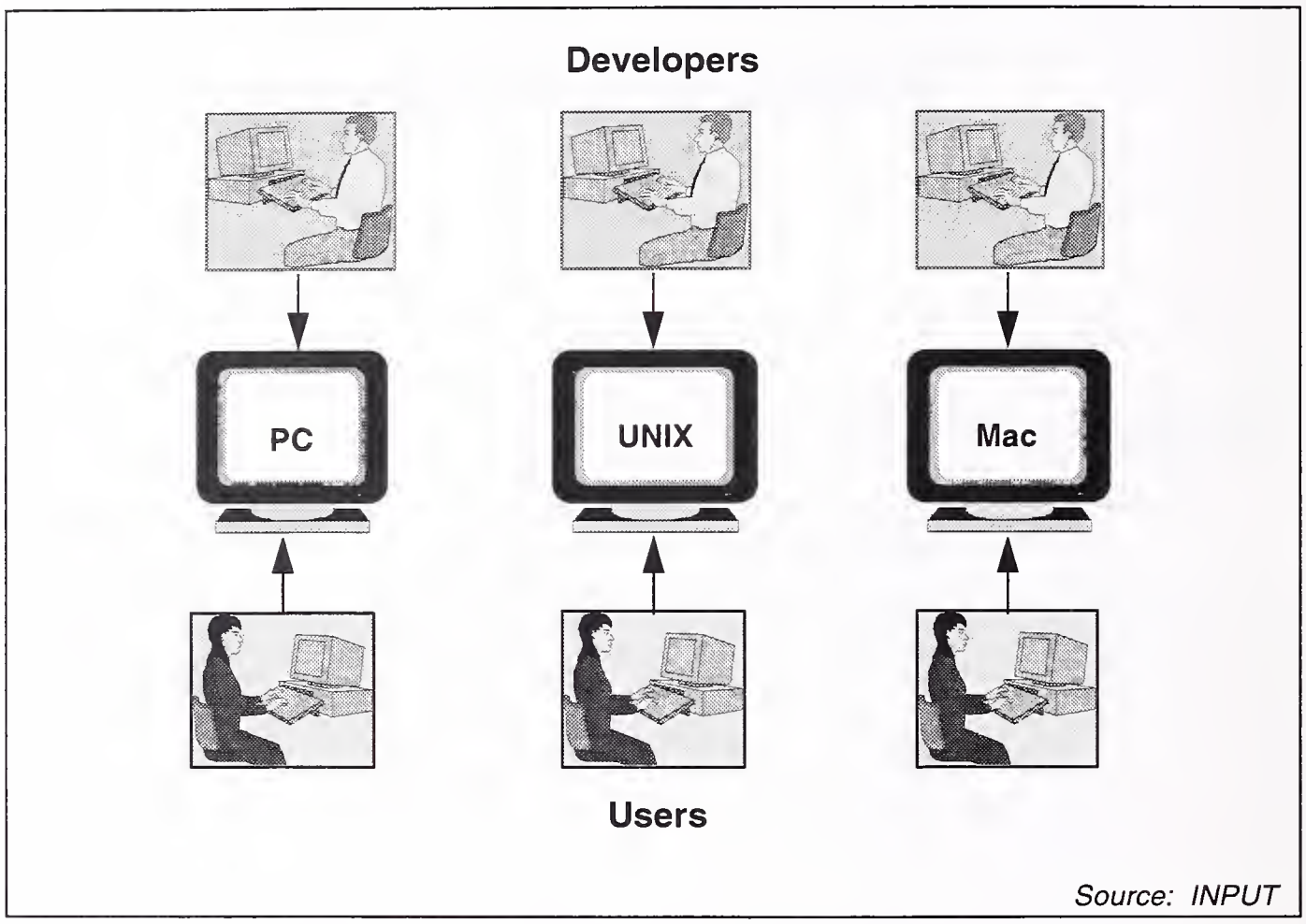
For most applications, Java will cut the considerable resources that software developers have had to expend on porting one application to multiple platforms, supporting users across different platforms, maintaining version upgrades and bug fixes across platforms, and producing documentation for different platforms.

Exhibit II-1 illustrates a simplified relationship between platform, developer, and user—one period of development time per application per platform. Exhibit II-2 shows how an application that has migrated to the Web requires only the same development resource as a single-platform application in today's model, but which can be run by users of all platforms, including the emerging Internet appliances.

An Internet application of this type will even run, natively and unmodified, on platforms that have yet to be designed.

Exhibit II-1

Platform-Dependent Development



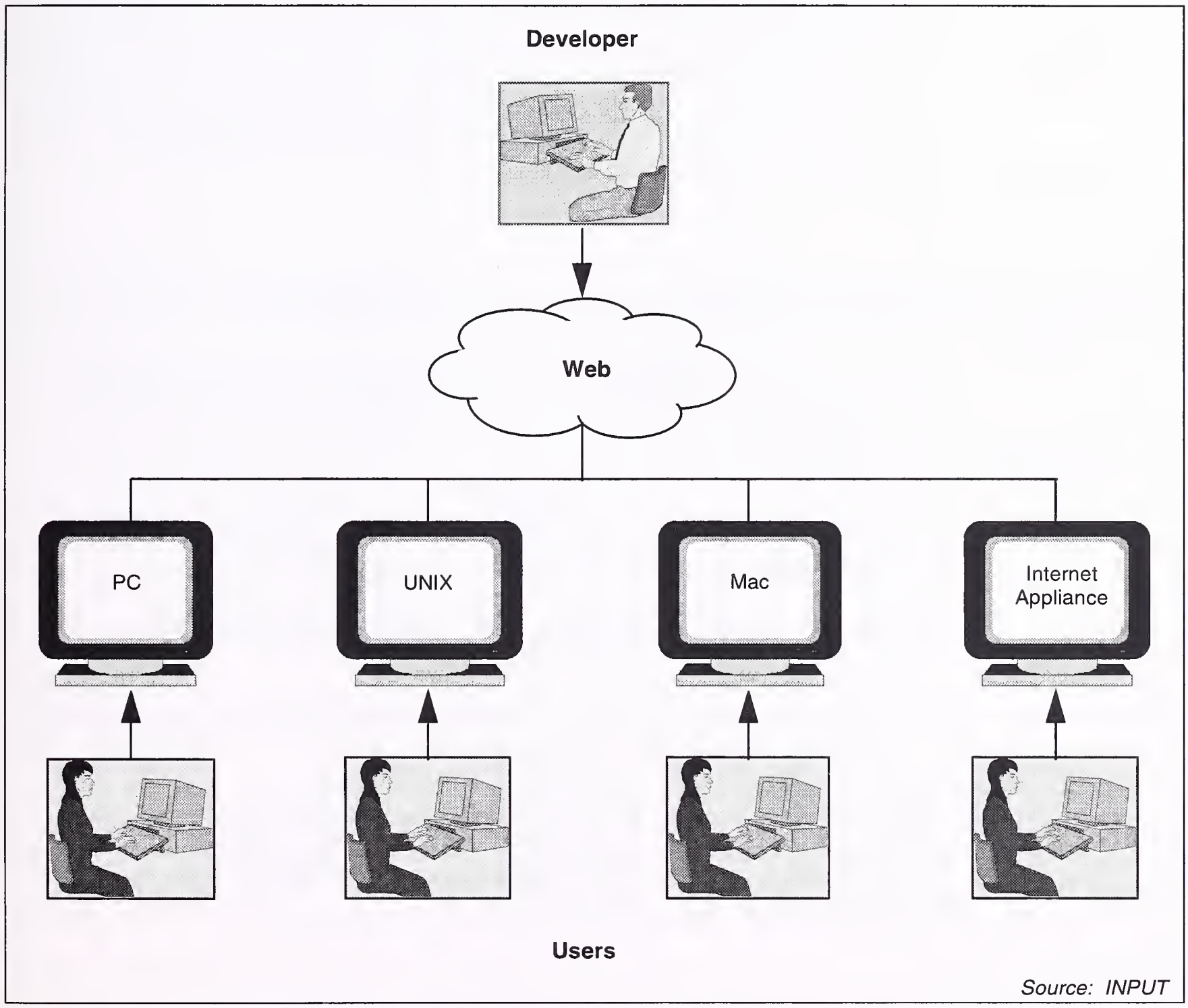
Source: INPUT

INPUT believes that this application migration to the Web is the most significant event taking place in IT today and that it represents the next major platform shift, following mainframes, minicomputers, and PCs.

Appliance migration and the standardization of networks around Internet technology has repercussions in fields other than software development. Systems integration, professional services, and software support are all affected. So, too, are hardware system products. When an application can run on all Internet platforms, and all platforms are Internet-enabled, the choice of platform becomes truly open. An organization is no longer tied to a particular hardware or operating system policy because that organization's applications only run on a limited set of platforms. Companies are able to mix and match platforms and devices according to their users' particular needs, even to the sub-departmental level. A particular type of user performing a particular type of function will use the most suitable device. Choice between similar devices will be made on price, support, and performance, not on restrictive architectural considerations.

Exhibit 2

Platform-Independent Internet Application Development



Source: INPUT

A new breed of client device has emerged during 1996, the year that application migration began in earnest. This device type, often referred to as the '$500 Internet terminal', is designed specifically to run Internet applications and to access information stored on the Internet and intranets.

INPUT calls these devices 'Internet appliances'. Although the most common term for them is currently 'network computer', this is a name that describes only a subset of Internet appliances. 'Network computer' (or NC) is a trademark of Oracle, one of the leading proponents of the new devices, and

refers to a particular style of appliance, governed by a published set of specifications.

The term network computer conjures up images of traditional computers: a box connected to a monitor, keyboard, and mouse. Internet appliances, however, can take any form, from a personal organizer or telephone for use in the home to a traditionally styled desktop workstation for use in the corporation. The key is in the word 'appliance'; considering the range of uses that an Internet device may be put to, it is clear that the image of a 'computer' is a restrictive one.

B

Appliances Will Sell to Information Consumers and Movers

INPUT identifies four categories of information users within a company:

1. Analyzer—One who takes a meta-level view of content for high-level analysis

2. Producer—One who creates and publishes new content and who performs major updates of existing content

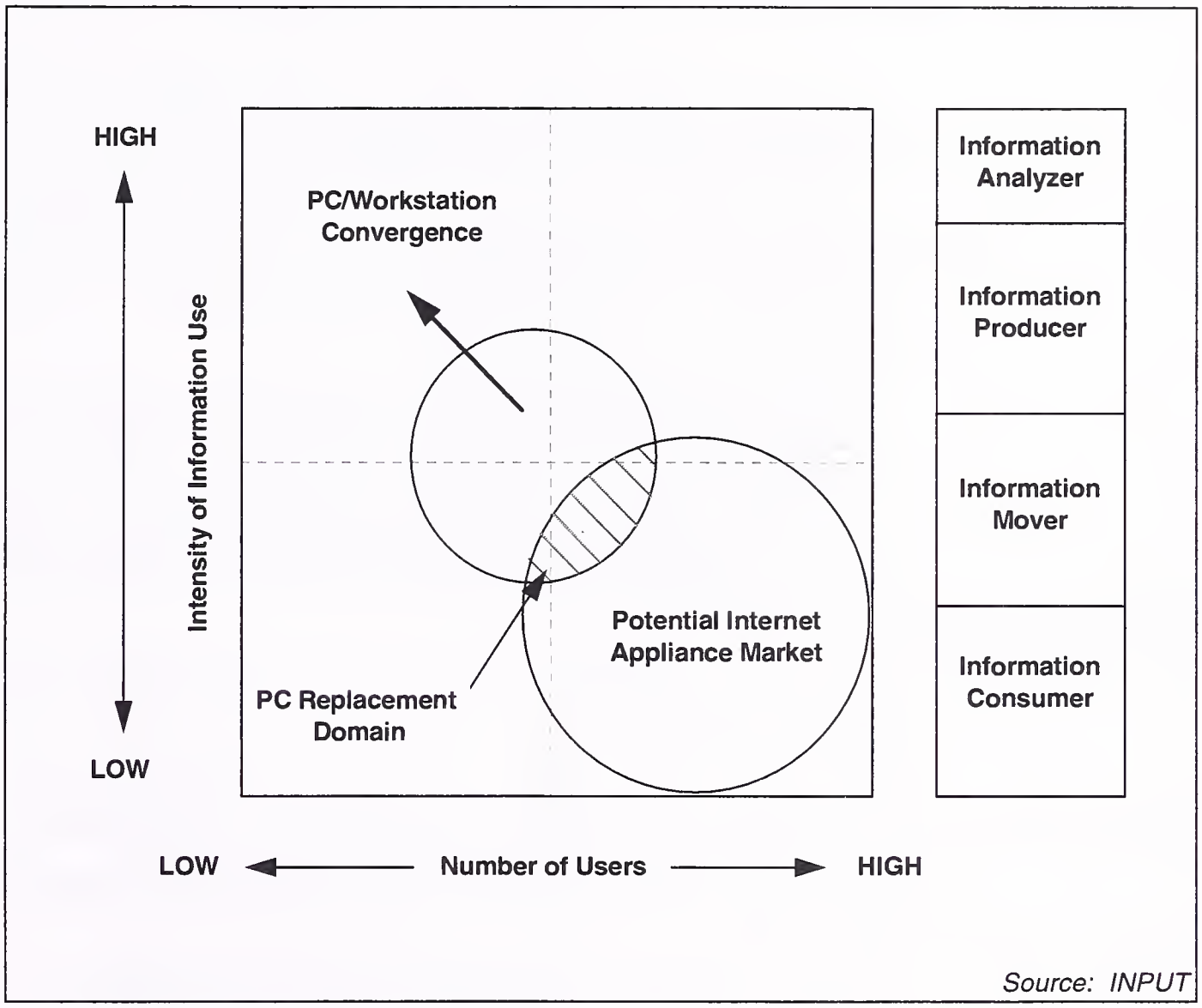
3. Mover—One who views and makes use of information and who is appointed to perform partial updates

4. Consumer—One who views and makes use of information but who does not update or create information

Exhibit II-3 shows who uses PCs today, who will use Internet appliances, and the overlap between the two groups. This overlap represents the groups of users that will potentially migrate from PC to Internet appliance—information consumers and movers.

Exhibit II-3

Devices of Information Users Today



Source: INPUT

Examples of information consumers and movers, the anticipated Internet appliance users, are personnel staff, bank tellers, purchasing officers, inventory controllers, factory floor workers, and sales representatives. None of these examples is traditionally known for its 'power users', who tend to be found more often in the information producer and analyzer groups.

Many information consumers and movers do not currently have a computing device at all. The only viable option is often a PC, and companies cannot justify the considerable expense of not only purchasing but supporting PCs for all staff members.

Internet appliances give computing devices to information consumers and movers who previously had no device, thus creating a new market for appliance vendors. This is in addition to the market opportunity that appliance vendors have for replacing the devices of current PC users.

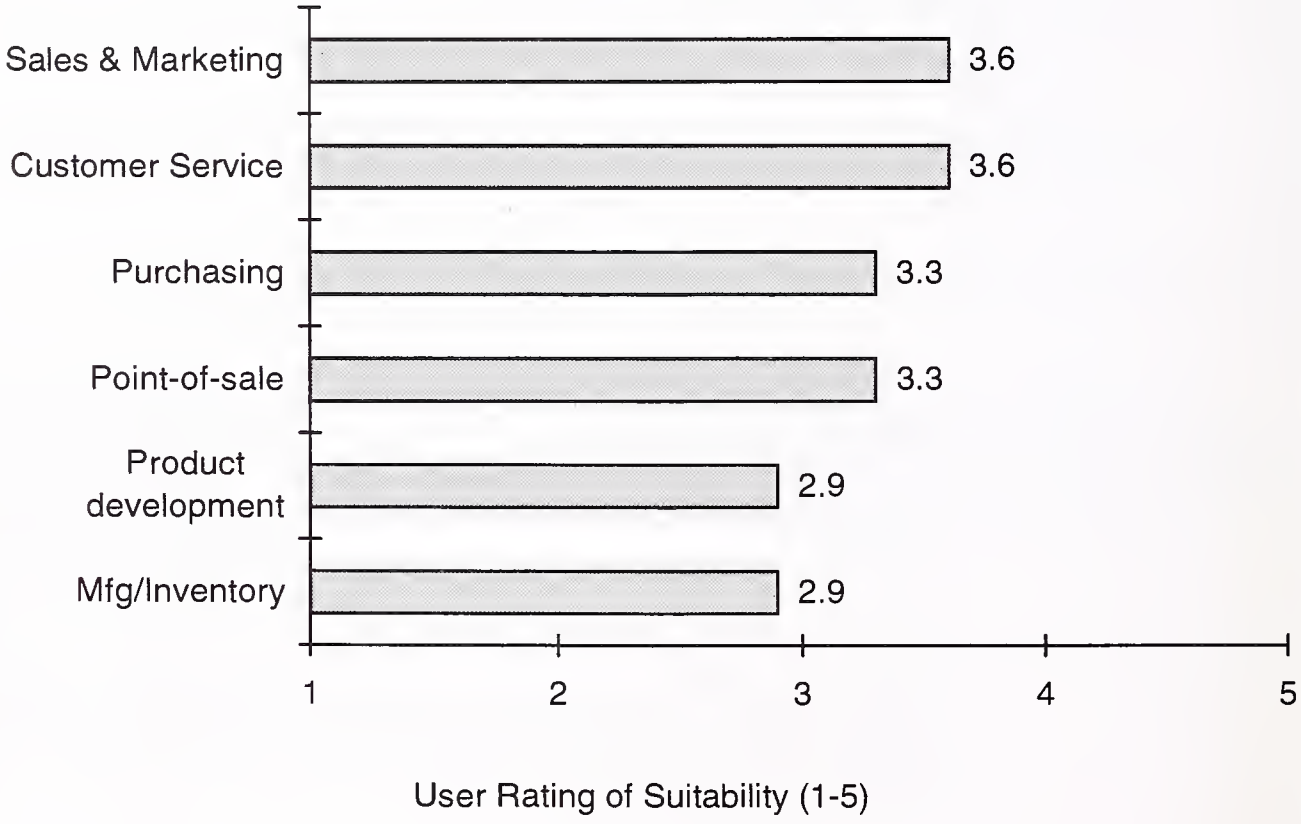
C
Appliance Applications

Enterprise applications suited to Internet appliances include those that involve interaction with customers and suppliers. Sales and marketing and customer service are seen as particularly suitable areas (see Exhibit II-4). These applications are increasingly likely, in an Internet-connected organization, to be tied into the company's Web presence and other Internet activities, to receive feedback from and provide information to customers and partners.

The migration of internal corporate applications from traditional platforms (operating system and hardware) to the Web will take place over the coming years, but many companies have an external Internet presence today. Users of applications that tie together external presences and internal databases and processes are early targets for Internet appliance vendors.

Exhibit II-4

Applications Most Suited to Internet Appliances



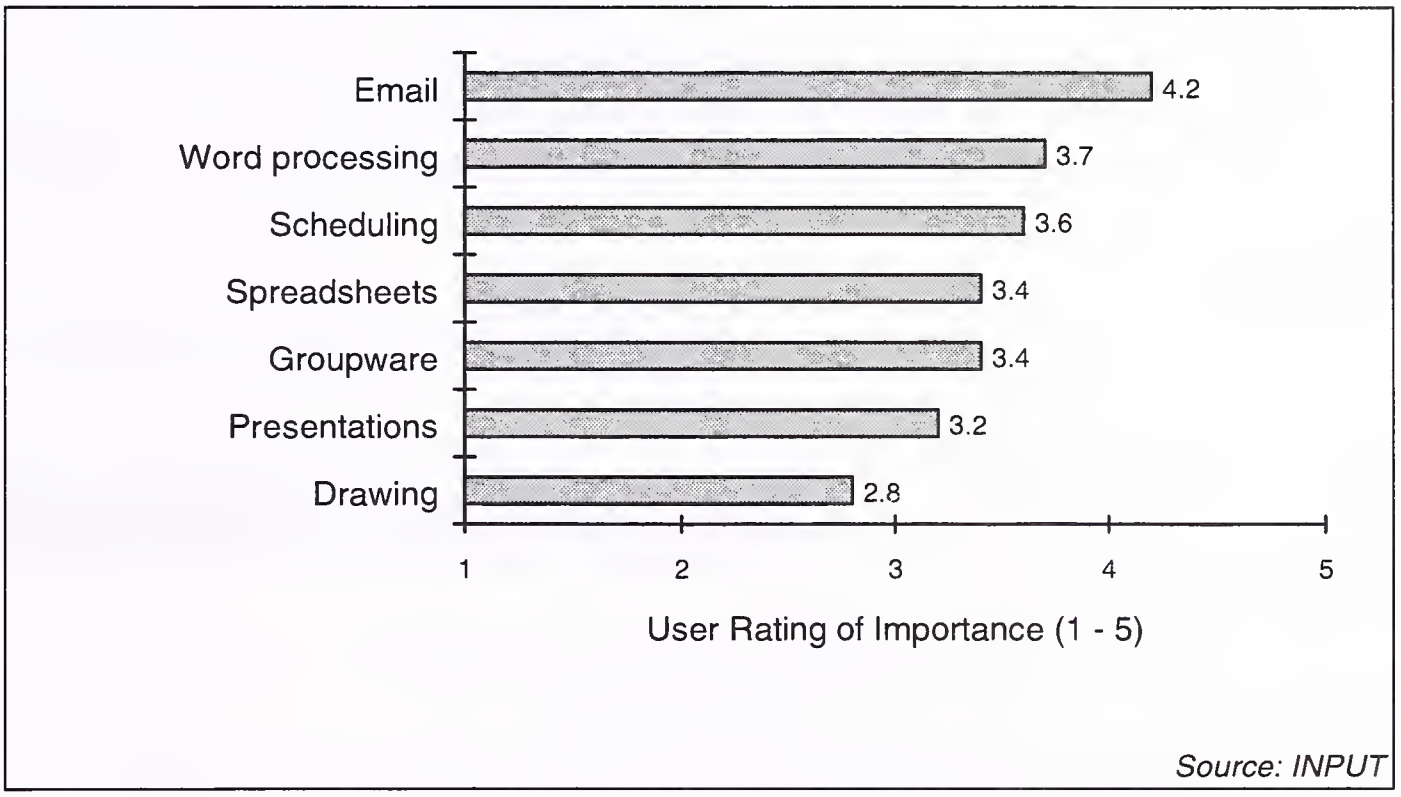
Source: INPUT

Exhibit II-5 shows how important horizontal applications using Internet appliances are to user companies. E-mail, as might be expected, is most important, given its current widespread use; word processing, traditionally a more standalone than networked application, is next most important, with spreadsheets, another traditionally localized application, also rated reasonably highly. The burden of supporting traditionally localized

applications like these takes its toll on IS administrators, and these results reinforce the wishes of users to reduce that burden by shifting them away from the client and onto the server.

Exhibit II-5

Importance of Horizontal Applications



Source: INPUT

D

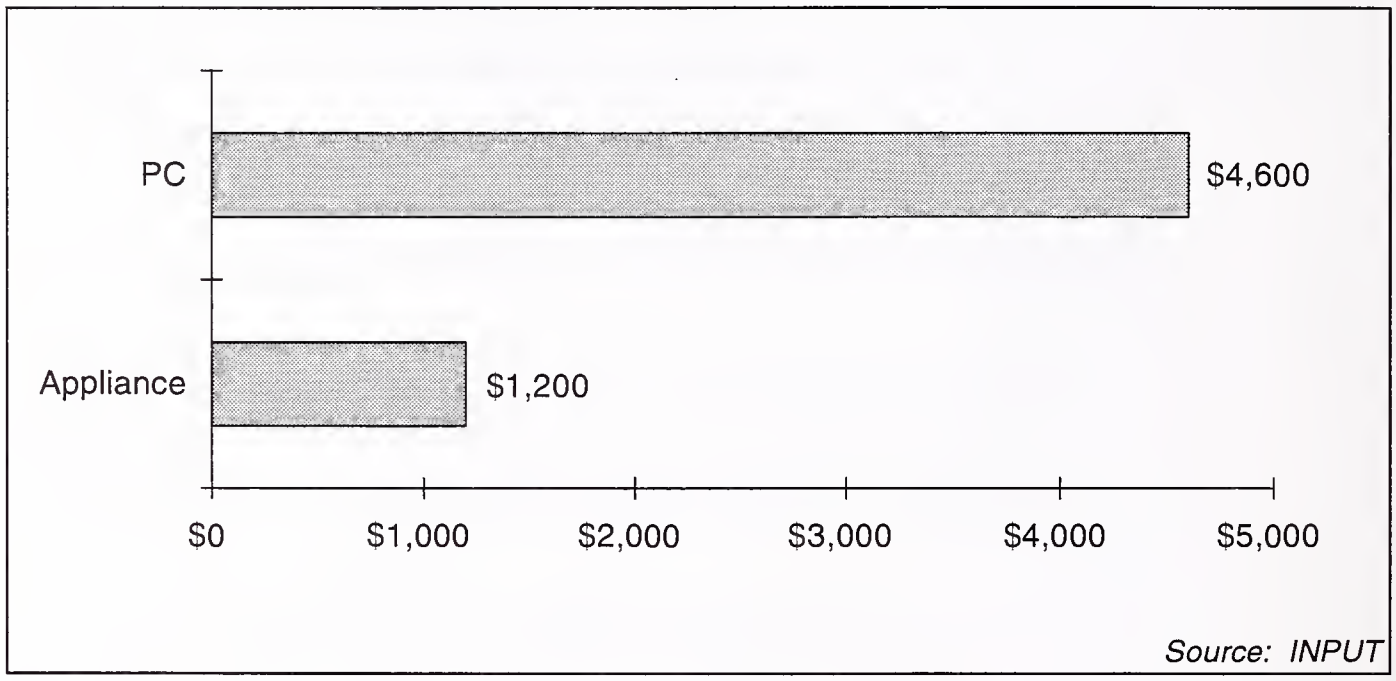
Appliances Slash Support Costs

INPUT estimates that over a five-year lifetime, a PC costs $4,600 per year to support, but an Internet appliance will cost only $1,200 per year (Exhibit II-6).

This huge cost saving will enable companies to give much-needed information access to those who have not previously justified the expense to the company of a PC: information consumers and movers (see Exhibit II-3).

Exhibit II-6

Product Support Costs per User per Year



Source: INPUT

Although Internet appliances cost less to purchase than PCs (they are typically around a third of the price) and are cheaper to maintain, the biggest reason for the difference in support costs is system administrator overhead. One administrator can support only about 25 PCs, but around 100 Internet appliances. Over 80% of PC support costs are accounted for by administrator overhead, including salary, due to the small number of users one administrator can support; this is due to:

- Time spent installing and upgrading system and applications software—operating systems, Internet access software, shrink-wrapped applications, and enterprise application frontends

- Time spent performing routine maintenance—upgrading memory and disks, resetting local configuration files, etc.

Nearly all of this time spent in PC environments is not needed in an appliance environment. Less routine maintenance is needed due to

appliances' simpler architecture and fewer components, but the overriding factor is software support.

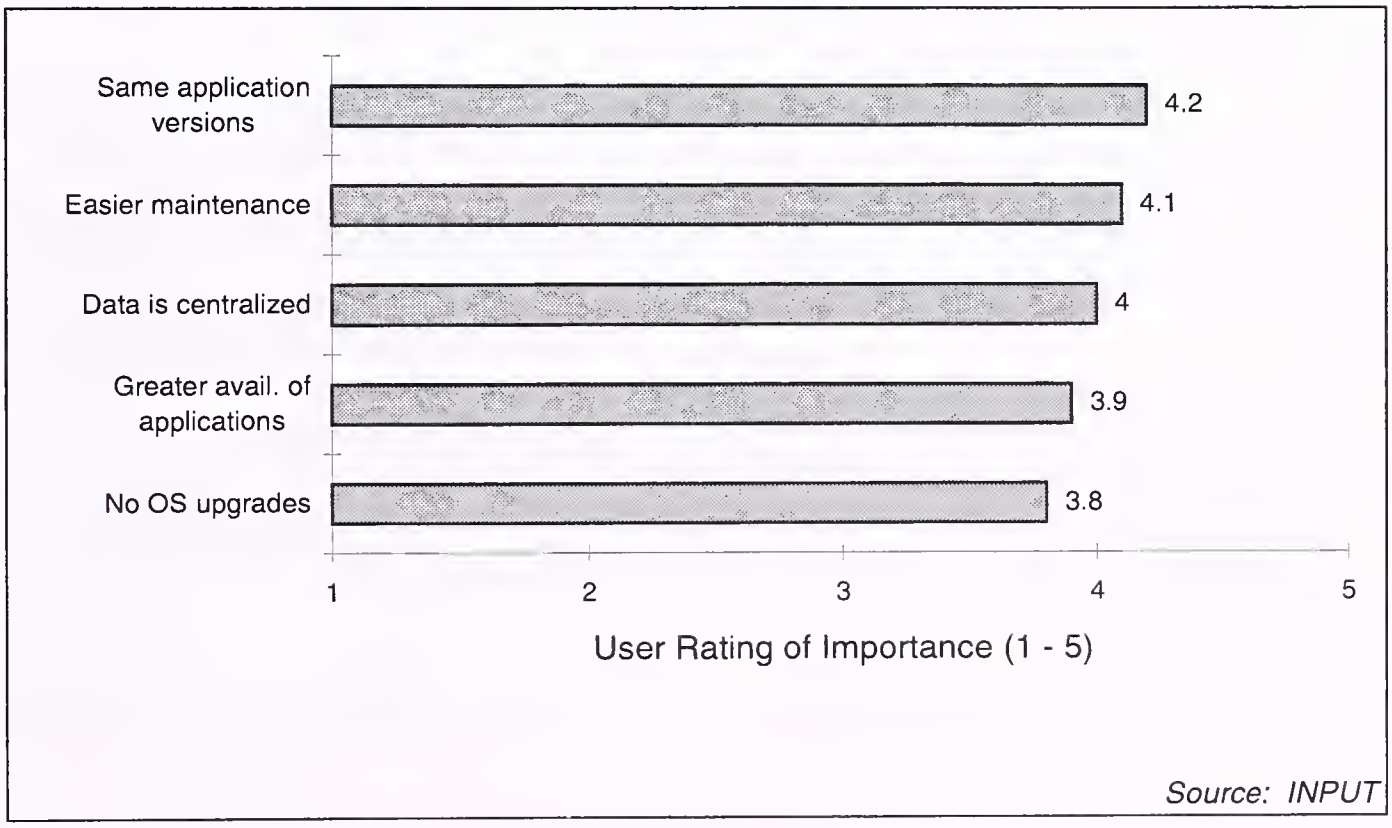
An Internet appliance does not store applications locally, and many will not even store their operating system locally. Apart from a local bootstrap program contained in the appliance's ROM, most or all system and application software would be downloaded from the server as required. All application installations, upgrades, bug fixes, and other revisions are done once, centrally, on the server. Apart from relatively minor hardware issues, a system administrator never again has to visit each desktop and perform an action on individual client devices.

E
Internet Appliance Benefits Outweigh Disadvantages

The benefits of Internet appliances (see Exhibit II-7) outweigh the disadvantages (Exhibit II-8).

Exhibit II-7

Benefits of Internet Appliances



Source: INPUT

The fact that the latest versions of operating systems and applications are available to all users at all times without the need for local software administration is one of the most compelling arguments in favor of Internet appliances over PCs, particularly when one considers the increasing complexity of both operating system and application software. A considerable amount of system administrators' time spent in supporting users is related to local issues such as application version control and local file problems. By

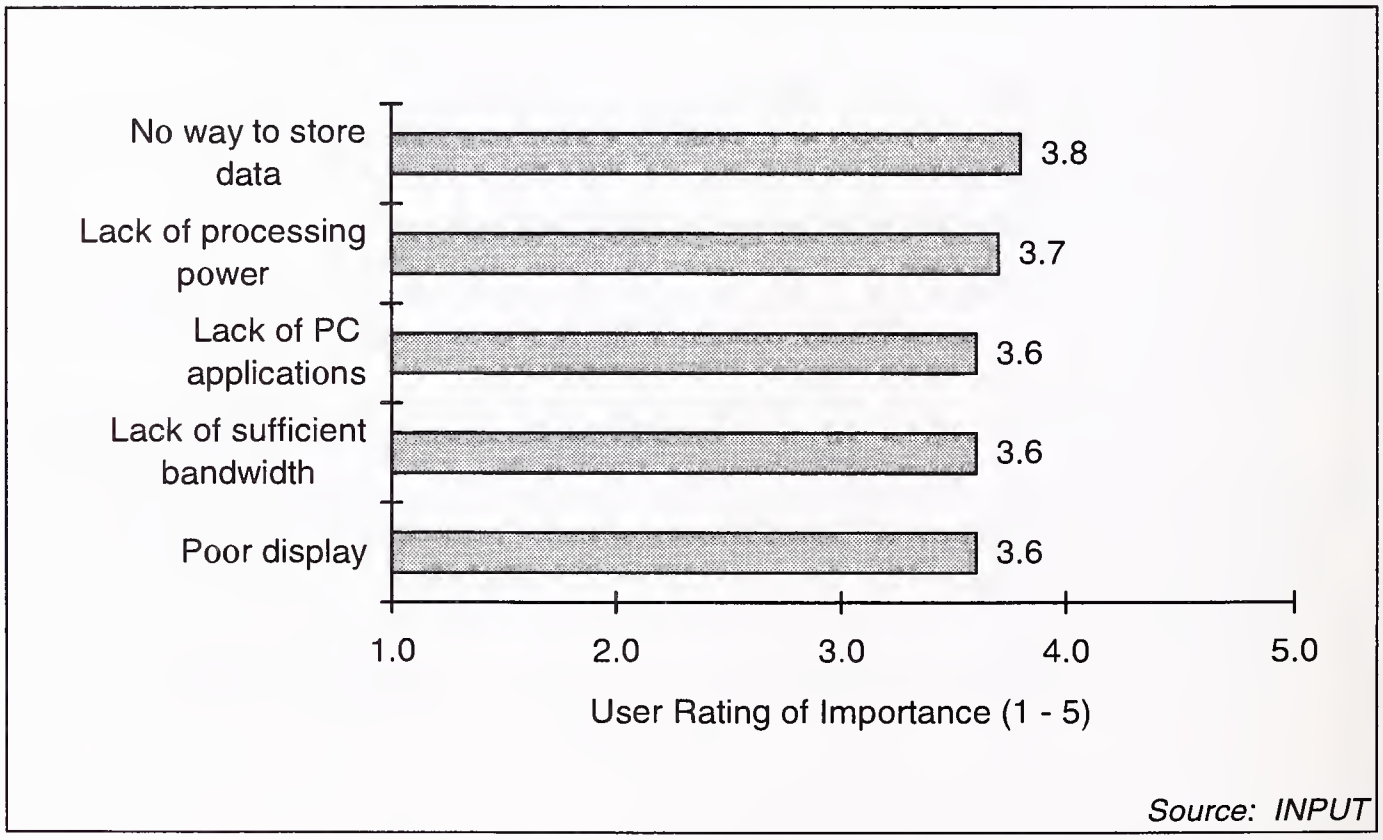
removing local support to let administrators concentrate on server and server-based application support, INPUT estimates that the number of users one administrator can support quadruples, from 25 (PCs) to 100 (appliances). A system administrator who was tasked with supporting only clients could, in certain circumstances, support several times that number.

An appliance is inherently easier and more cost-effective to maintain than a PC. Appliances are not the general-purpose machines that PCs are, and have to support only one internal architecture; PCs have to support a wide variety of components and in many cases contain redundant components. Due to the lower purchase price, appliance maintenance charges can never rise to much more than $300-$500. At that price, it may be as cost effective to replace the appliance with another.

For many of the reasons that centralized applications are favored by IS departments, so too centralized data is seen as less burdensome and potentially cost-cutting benefit of appliances.

Exhibit II-8

Disadvantages of Internet Appliances



Source: INPUT

The centralization of data that the use of Internet appliances encourages is seen as both an advantage and a disadvantage. From the IS department's point of view, it relieves the administrative load and allows a greater degree of configuration and control. From the user's point of view, the benefits may not be as immediately apparent, and users may feel as if they are losing control of their own data.

INPUT believes, however, that most Internet appliances will be sold not to existing PC users who have grown used to a relatively high level of autonomy and private file storage but to users who currently have negligible local computing resources or who access computing resources through a shared terminal. This type of user is likely to be less attached to the personal computing paradigm engendered by the PC environment, and in most cases will not be 'giving up' one environment for the other.

Lack of processing power is seen as a disadvantage of appliances, but a slow processor is not necessarily a design feature of Internet appliances. While they are not designed to match PCs in terms of local hard disk and memory capacity, there is no reason why they need not be driven by a high-power processor, at least matching Pentium performance for example. The primary issue is cost, but companies such as ARM are producing high-performance, low-cost CPUs that, while not offering state-of-the-art performance, better the Pentium on price/performance.

Lack of PC applications is another commonly cited disadvantage of appliances. While most new computer platforms go through the difficult stage of needing application software to sell, but face the problem of software developers being unwilling to write applications for a platform that hasn't yet sold in volume, appliances are different. Appliances do not have to be individually targeted by software developers, as their 'application environment' is the Web, not the operating system or hardware particular to any appliance. INPUT expects software availability not to be a major obstacle, therefore—software is already being written, with PCs and UNIX machines in mind, that will run immediately on any Java-capable appliance.

Supporting existing Windows applications is a different matter, yet one that has already been addressed by the early Internet appliance players. HDS Network Systems, Wyse, NCD, and Boundless (formerly SunRiver Data Systems) have all incorporated, variously, Windows, X Windows, and mainframe application support into their Internet appliances. They realize both the importance of integrating appliances into existing environments and the fact that in any organization today, a 'pure' Internet appliance that included no support for legacy technology would not achieve its maximum sales potential.

The bandwidth issue is a problem for home users, but not for corporations, which already have the bandwidth to support network computing using Internet appliances in place. Network developments taking place include Gigabit Ethernet, which is well suited to supporting IP (Internet Protocol). The greatest use of bandwidth for typical desktop applications is made by such applications as videoconferencing. This type of application is increasing in popularity regardless of intranets or Internet appliances.

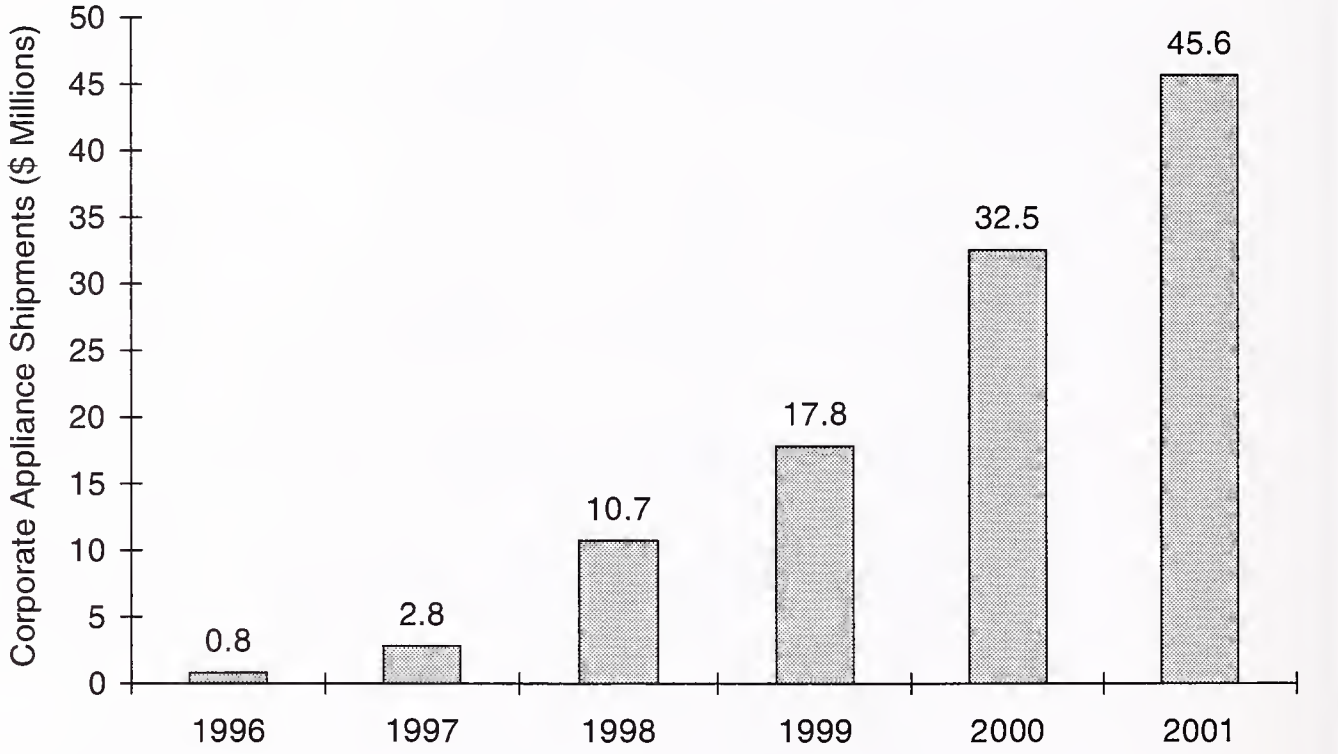
F
Market Forecasts

1. Appliance Shipments, 1996-2001

Shipments of Internet appliances to the corporate market worldwide (see Exhibit II-9) will grow from 750 thousand in 1996 to 45.6 million in 2001, a CAGR of 127%.

Exhibit II-9

Worldwide Corporate Internet Appliance Shipments, 1996-2001



Source: INPUT

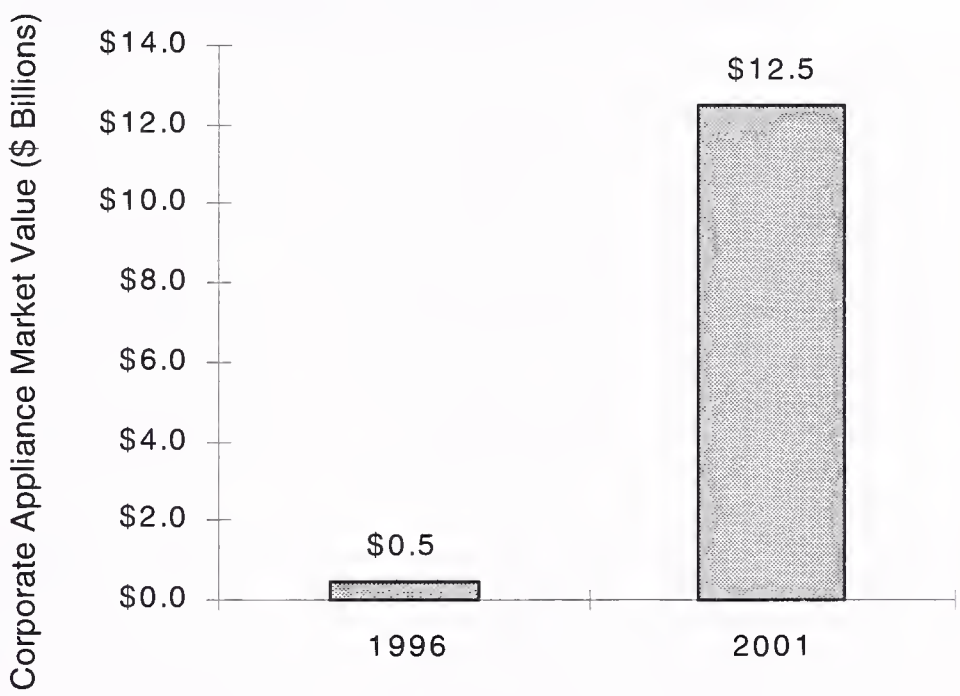
2. Appliance Market Value, 1996-2001

INPUT expects the average price of Internet appliances for corporations to decrease from $500 in 1996 to $350 in 2001. This takes into account volume discounts. The average price of early appliances is around $650 per unit, but this should be reduced to around $500 for bulk purchases. It is through sales of large numbers of appliances that vendors will be able to claim the often-quoted $500 price tag.

Based on the decreasing appliance unit price, the market value for Internet appliances will rise from $500 million in 1996 to $12.5 billion in 2001 (see Exhibit II-10), a CAGR of 90%.

Exhibit II-10

Worldwide Corporate Internet Appliance Market, 1996-2001



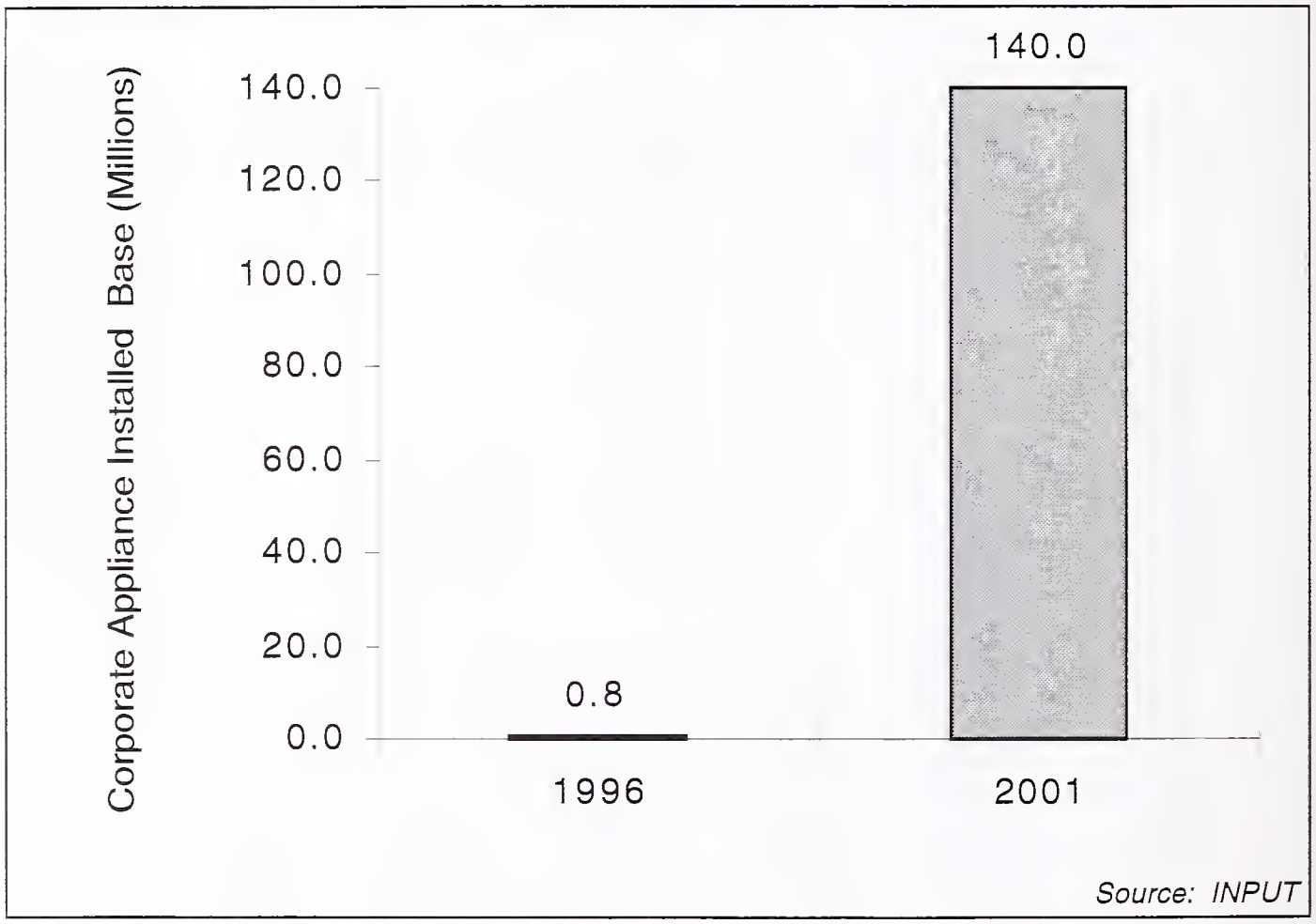
Source: INPUT

3. Appliance Installed Base, 1996-2001

Exhibit II-11 shows the expected increase in appliance installed base worldwide, from 750 thousand in 1996 to 140 million in 2001, a CAGR of 181%.

Exhibit II-11

Worldwide Corporate Internet Appliance Installed Base, 1996-2001



Source: INPUT

G Recommendations

1. Recommendations for Users

The adage "No-one ever got fired for buying IBM" could have been applied equally over the past five years to PCs running Windows. For most general-purpose applications, a PC client environment was a safe bet for an IS purchasing manager, and remains so today. Software is available for nearly every application, technical support skills are in abundance in the marketplace, systems and software integrators are well versed in implementing PC networks, and PCs are perceived as low cost.

Unfortunately for IS managers seeking the easy option, the choice is rapidly becoming less clear cut. Just as minicomputers put an end to the IBM mainframe as a safe bet, and PCs did the same to minicomputers, so Internet

appliances will ensure that a PC-only client strategy will not guarantee an IS manager's security. In other words, the choice is becoming open again.

User organizations will have to bring an evaluation of Internet appliances into their desktop upgrade and purchasing decisions. Not only that, but due to the capital and support costs of appliances, they will have to redefine who in the corporation should be left without a device at all.

Internet appliances are a symptom of a broader issue: application migration (see INPUT's report *Revolutionary Migration of Applications to the Web Platform*, Internet Opportunities Program, 1996). A company that sees no need for Internet appliances has possibly not foreseen the effects of application migration. As applications move away from the operating system-specific or hardware-specific model toward a platform-nonspecific model, as is made possible by Java, for example, so the restrictions placed on the type of client able to be deployed within the company becomes decreasingly important, to the point of indifference.

By no means will all, or even most, existing software be rewritten in the likes of Java within a few years, as we have learned from the mainframe and minicomputer eras. Instead, 'personality' modules will be developed for legacy operating systems that enable applications written for them to be accessed via a standard Internet client. When a company's core enterprise applications can interact fully with any Internet-enabled device, the question immediately arises: "Which device to use?"

The answer will vary according to the type of user—information consumer or information producer, for example—but at the time that a company's applications are Internet enabled, PCs will no longer be the most cost-effective option for many types of user in many departments in many companies.

INPUT encourages user organizations to study the issue of application migration. This shift, which is still in its early days, will have the same magnitude of impact as have other platform 'revolutions' in IT before it. By understanding the effects of migration on its own operations, a company can begin to put Internet appliances into context.

In preparation for future platform redeployment, user organizations should begin identifying which category (as illustrated in Exhibit II-3) their employees fall into and map current PC usage—or usage of no client device—onto those categories. Companies with a population of PC-using information consumers and movers have the most to gain from an Internet appliance strategy.

2. Recommendations for Software Vendors

Application migration to the Web will be the biggest challenge and opportunity facing software developers over the next few years. For a software vendor, the advantages of programming for the Web, as opposed to programming for a particular operating system, are:

- Inherent cross-platform support for all software
- Simplified, low-cost software distribution and support using the Internet
- The opportunity to lead a new market segment
- Rapid, simpler programming environment
- Lower document production and distribution costs

The software industry will begin to move away from the current practice of developing an application for, say, Windows, with ports for UNIX and other platforms only as the market demands. Once an Internet application is written in Java, it will run on any Java-capable client, regardless of the client's underlying operating system. The Web as application platform makes it possible, for the first time, to write software today that will run natively on future hardware and operating systems that have not yet been designed.

The opportunity for software developers is clear: to maximize your potential market, start evaluating the potential for shifting your focus away from any current target operating system or hardware to the Web through the writing of new applications in, and the porting of existing software to, Java. Evaluate your target user and compare with the user categories in Exhibit II-3. Information analyzers will not switch en masse from PC to Internet appliance; neither will most information producers. Information movers and consumers are the target market for appliances, and software vendors that currently develop applications for this market must appreciate the potential both for these users to change platform over the coming years and for the currently untapped market of deviceless users to open up.

3. Recommendations for Internet Appliance Vendors

Identify your target user group. Appliances will not replace PCs for high-end, complex applications, but will both replace PCs and create a new market among single-function users and users with less sophisticated information access and application requirements. Target information movers and consumers, not information producers or analyzers (see Exhibit II-3).

Bring this focus into your marketing strategy and literature—users will not be convinced by vague claims of 'usefulness' or 'decreased support costs', but need to know which groups of employees in which functional areas

performing what kinds of tasks are the most likely to be future appliance users. Be specific in your targeting.

Do not attempt to target both the corporate and home market with the same device, as has been done with PCs. Unless you are developing devices specifically for consumers, such as Internet-enabled game machines, concentrate on the corporate market. While the home market will account for the greatest number of appliance shipments by 2000, most home appliances will not be computer-like devices with keyboard, screen, and mouse, but will be incorporated into telephones, game consoles, televisions, VCRs, and every other form of information-oriented consumer device. Unlike PCs, product design and marketing for home and corporate appliances will be completely different. Home Internet appliances will not take off, in any case, until adequate bandwidth is widespread. For all but the simplest Web browsing, or for e-mail, a 28.8Kbps modem is not fast enough to drive an Internet appliance.

Be realistic in your predictions of PC-to-appliance migration. Even by 2000, Internet appliances will take only around 15% of sales that would have been of PCs. The biggest market for appliances is not in PC replacement, but in an entirely new market: users who currently have no device.

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III

Emergence of Internet Appliances

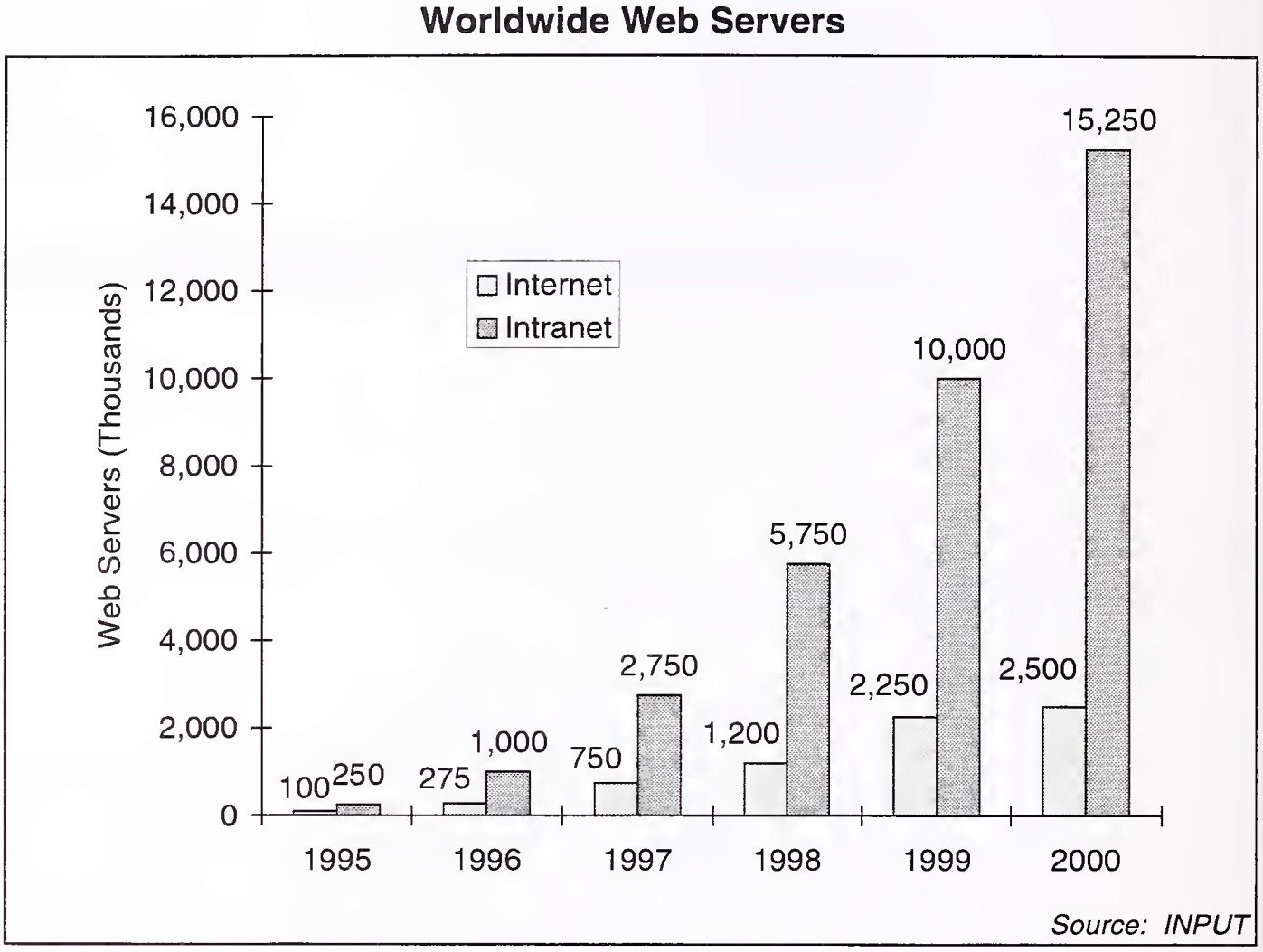
A
Increasing Intranet Deployment

1. Intranet as Network Platform

The Web has become the de facto standard for disseminating information to potential customers on the public Internet. The ease with which information can be published and accessed has caused the Web to be used in the same way for company internal use in the form of intranets, and intranets are, similarly, becoming the de facto standard for internal corporate networks.

If there are any doubts regarding the sustainability of Internet technology and services, consider Exhibit III-1. Internet technology will be used extensively within the corporation as an application development platform as well as an information-sharing environment. INPUT believes that by 2001, over 80% of the sales of Internet-related technologies will be for intranets.

Exhibit III-1



The Internet is particularly attractive for large companies that need not only to give on-line access to their staff, but also to connect their geographically remote offices. Virtual private networks (VPNs) can be implemented via the Internet to connect intranet-equipped offices through tunneling software. This extends the concept of an intranet from a single site to sites connected anywhere in the world with Internet connectivity. (Just as the term 'intranet' arose to describe internal Internet networks, so the term 'extranet' has arisen to describe connections between remote intranets, i.e., company offices, partners, suppliers, or customers.)

2. Intranet as Application Platform

The widespread use of the Internet defines a new software platform that promises to change radically:

- Traditional software structure and architecture
- Software distribution
- How organizations communicate
- Client/server system management and support

The shift from traditional platforms to the Internet platform is occurring today, although only a relatively small number of applications have currently made that shift. Notable current examples of shifting applications include:

- Groupware—specifically the rise of pure Internet-based groupware products such as Radnet's Webshare and the gradual migration of Lotus Notes to the Web

- Databases—Oracle and Informix, for example, have both announced Internet-enabled RDBMSs (both called Universal Server)

- Enterprise applications—SAP announced in mid-1996 that SAP R/3 would follow an Internet development path.

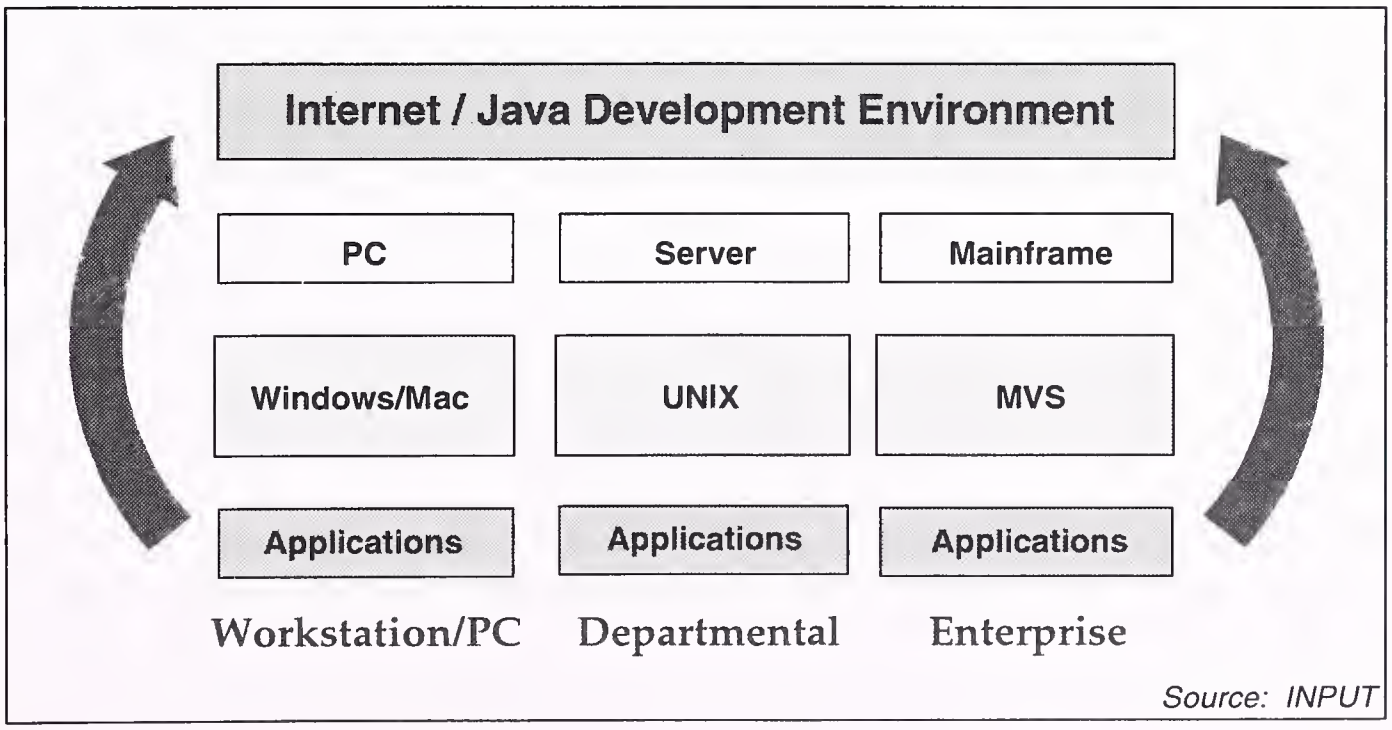
- Personal productivity applications—Corel announced also in mid-1996 the porting of its application suite to Java.

As Web technology matures, applications previously written for specific hardware and operating system platforms such as Windows 3.x/95/NT, UNIX, AS/400, IBM plug-compatible mainframes, etc., will migrate to the Web platform.

Because of the way applications are no longer dependent upon a particular hardware or operating system platform, the Internet changes the way in which applications are developed (see Exhibit III-2).

Exhibit III-2

Applications Developed on the Internet Platform



Source: INPUT

Instead of developing software specifically for every different hardware and operating system combination, software is developed in a language like Java

for the Web environment. This is analogous to the way documents are developed in HTML for the Web environment. Any client platform (combination of hardware and operating system) that can run a Web browser can access both HTML documents and applications written in an Internet language like Java.

As one client software package, the Web client, can be used for many different applications, this saves companies time in developing client software. For a software vendor, the advantages of programming for the Internet are:

- Software is portable to any platform
- The opportunity to lead a new market segment
- Rapid, simpler programming environment
- Simplified distribution and support using the Internet
- Lower document production costs

Internet technology will be used extensively within the corporation as an application development platform, and will continue to threaten popular enterprise applications such as Lotus Notes and SAP.

B
Emergence of Internet Appliances

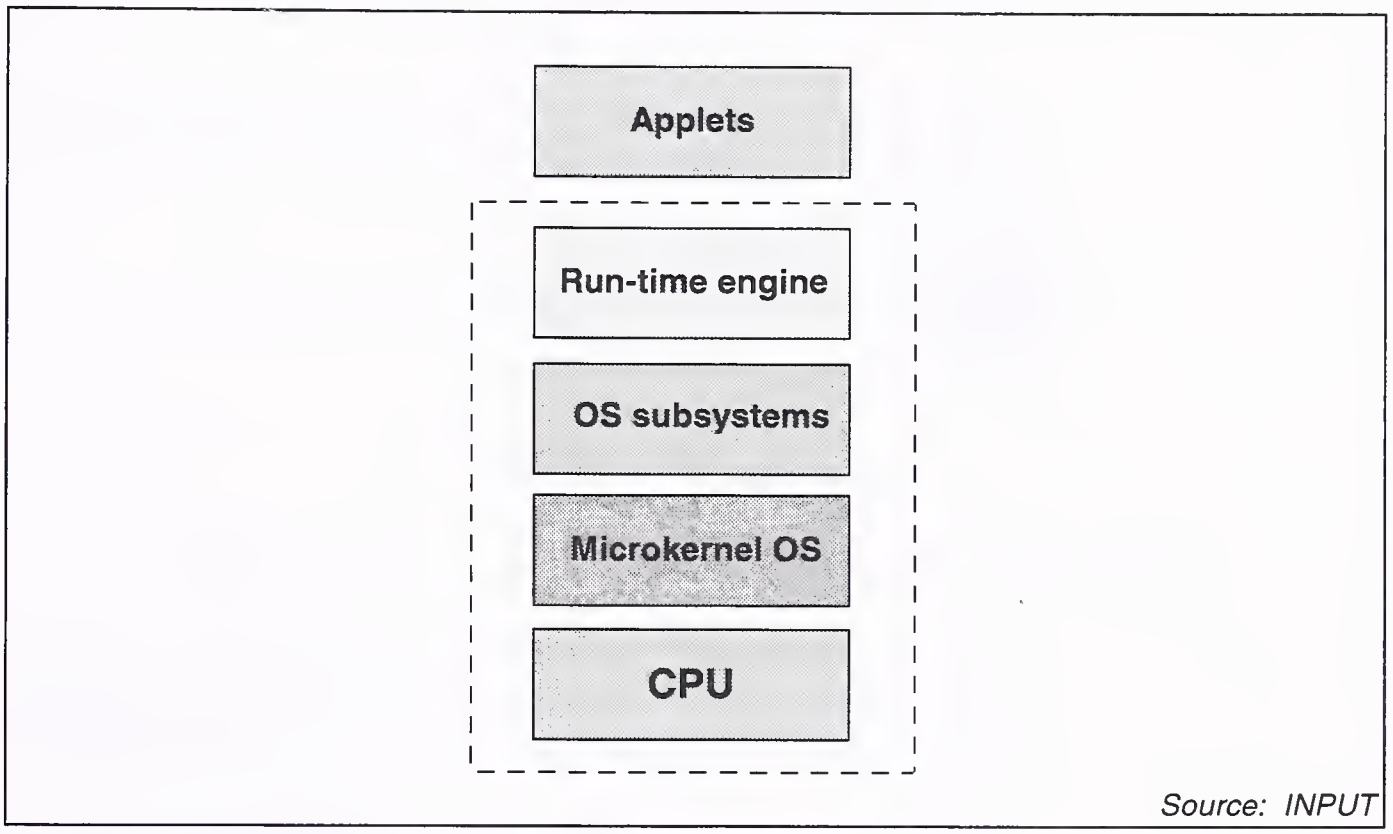
1. The End of Platform Dependency—Opportunities for New Platforms

An Intranet used as a network and an application platform removes software platform dependency—in theory, any Internet application can run on any Internet client. As soon as a user's choice of client hardware and operating system becomes open in this way, the opportunity arises for new types of client platforms, which compete against existing incumbent platforms such as Intel-based IBM-compatible PCs running Microsoft Windows. The Wintel (Windows/Intel) dominance of client platforms is immediately threatened.

Internet applications written in Java will run on any machine for which someone has developed a machine-specific Java environment (See Exhibit III-3). This environment is known as a Java Virtual Machine (JVM), and it interprets a Java byte applet, which has been semicompiled into generic bytecode from the original source, for execution on that particular machine. As soon as a JVM is available for a platform, that platform can run any Java software, within certain practical constraints.

Exhibit III-3

Architecture of an Internet Appliance



Source: INPUT

Note that a Web browser is not a prerequisite for an Internet access appliance. Java applets run within a JVM, and it is currently the case that most JVMs are integrated into Web browsers. For appliances designed only to run applications, not to browse the Web, a JVM could be a standalone component.

Internet turnkey systems include Internet appliances that are stripped-down PCs that connect to the Internet and run Web-based applications. The devices run a microkernel OS and platform-independent software written in an interpreted language such as Java. Users download component-based programs and applets over the Internet or an internal network when they need them. Companies offering or developing Internet appliances or licensing their technology include Acorn Computer, Apple Computer, General Magic, Geoworks, IBM, LSI Logic, Oracle, Silicon Graphics, and Sun Microsystems.

2. Network Computers and Internet Appliances

Since Oracle and Sun first created interest in the concept of a low-cost Internet device, the term 'network computer' has been used as a general descriptor. However, this term tends to conjure up images of traditional computers: a box connected to a monitor, keyboard, and mouse, all crowded together on a desk. Internet appliances can take any form, from a personal organizer or telephone to a traditionally styled desktop workstation. The key

is in the word 'appliance'; by considering the range of uses that an Internet device may be put to, it is clear that the image of a 'computer' is a restrictive one.

Consider home appliances such as washing machines and microwave ovens. Such appliances are widespread among economically developed countries and are successful because they are:

- Good at performing a single function well
- Affordable
- Easy to use
- Efficient on space

An Internet appliance needs to be no harder to use than a washing machine or a microwave oven. It must be as reliable and maintenance-free as any other household appliance if it is to gain acceptance among consumers.

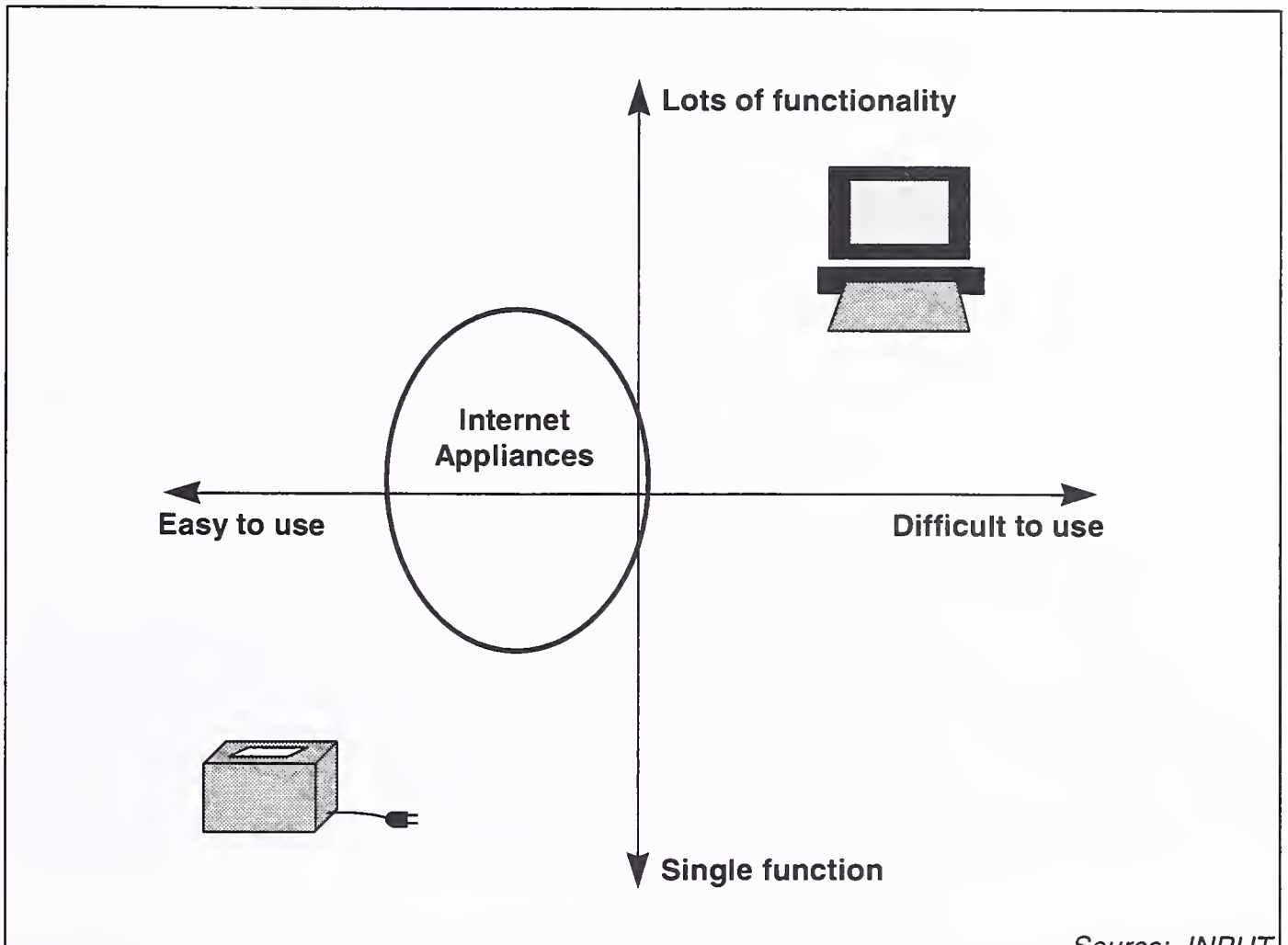
Unlike a PC, most Internet appliances at their simplest will not have a hard drive, CD ROM drive, or preinstalled application software. Instead, users will access software from, and store data on, a network server. The devices will be used for e-mail, word processing, Web browsing, data access, and all other information-based functions.

The simpler the appliance, the more suited it will be to single-function applications. A modern PC is well capable of running many different types of application at the same time, and this type of relatively high-end, multipurpose device will always be required by users who have a genuine need for complex simultaneous functionality.

Currently, however, there are few devices that satisfactorily meet the needs of users who perform only one function, or who require extra functionality only rarely. They, too, typically use PCs even though it is expensive and inefficient for them to do so. Exhibit III-4 shows where Internet access appliances will lie between PCs and consumer devices.

Exhibit III-4

Positioning Internet Appliances



Source: INPUT

C

Advantages of Internet Appliances

1. Ease of Use

An Internet access appliance should be no more difficult to use than a Web browser. While all software has a learning curve, an Internet appliance should require only familiarization, not heavy training. Within the Internet environment, the operating system and other internals of machines are hidden from the user, unlike even modern PCs. Just as a user does not have to understand how a radio functions internally in order to make it work, neither should he nor she be required to understand how an operating system functions in order to make an Internet application work.

A comparison may be made with game consoles. Once switched on, running and installing software is a simple matter of loading a disk or CD and letting the machine do the work. The input device is a simple control pad, and on-screen instructions are (generally) very clear. If the application goes awry, or the user gets into trouble, switching the device off and on again restores the machine to its default state. With a PC, even this simple and intuitive

operation can easily lead to disk or file corruption, throwing the user into further confusion.

2. Ease of Installation

For most devices, users will be able to get started in a few easy steps:

1. Remove from box
2. Plug in power or charge battery
3. Plug in to standard phone socket or LAN connection
4. Switch on power
5. Begin using Web browser

With even packaged PC systems, this ease of installation is extremely rare. Many local settings must be made by the user (such as country, date and time, device drivers, location of temporary file store, and sundry preferences). With Internet access appliances, most of these settings can be made by the machine as soon as it connects to an appropriate server.

3. Affordability

Appliances are optimized to run Java applications and/or a standard Web browser. There is no hardware or software to install, and no operating system upgrades to perform. The user does not have to choose between multiple internal components (such as graphics card, hard disk type, etc.) when upgrading the machine to a faster model, and so avoids the tortuous process of installing and maintaining a mix of often incompatible technology.

In certain areas (display output being the prime example), game consoles outperform the average PC. As they do not have to have local storage devices, a dedicated monitor, or an expensive motherboard and chipset that has to manage a multitude of components, the overall price is lower. With game consoles, however, software is expensive; it can only be supplied in the medium supported by the machine (CD ROM or cartridge), which pushes up manufacturing and distribution costs. An Internet access appliance downloads software from the Internet or an intranet as needed, and this will include free and low-cost software as well as full commercial applications.

4. Lower Maintenance and Support Costs

Internet appliances rely on a server to provide nearly all of their software and data storage. These items do not, therefore, have to be maintained at the client level. Appliance operating systems do not have to include the

complexities required to manage a large number of local resources, and so are themselves simpler to run and maintain.

The standardization of the PC as the de facto client for most applications has meant that the single architecture of the PC must be able to support a huge range of components and application types, enough to satisfy nearly all users. The PC today must be bent into shape for the application the user wants to run. The PC architecture must, therefore, be complex enough to accommodate all users within one box, even if any particular user wants only to run a word processor. The level of support required to maintain a multipurpose device regardless of what it is used for is considerable—INPUT estimates that PC supports costs average $4,600 per year over a five-year lifetime, including system administrator time.

Support costs will be saved primarily on software support. Applications are loaded into memory by downloading them from the network every time the device is used. With Internet appliances, administrators can manage software distribution centrally, while users will always be assured of the latest versions of applications—changes to applications, including bug fixes and upgrades, simply and transparently take effect the next time the device is switched on. With no (or little, noncritical) local data storage, security and backup is handled centrally by the network to further cut support costs.

D
Technology Enablers

1. Processors

It is a mistake to think of an Internet appliance as a slow, old-fashioned device, the dumb terminal of the 1990s. There is no reason, other than price sensitivity of individual products, for appliances not to be powered by CPUs at least as fast as those that power modern PCs. Currently this means Intel Pentium-class chips. For leading-edge PCs, the CPU might represent 15% of total purchase cost. Considering the price of such PCs, this is too expensive for an Internet appliance, which will be priced at around a third the price of modern PCs. If high-end Pentium chips were used in appliances, over 50% of the appliance's cost would be accounted for just by the CPU.

There are many chip vendors investing in foundries for Internet appliance-related processors. Early semiconductor manufacturers interested in Internet devices include Advanced RISC Machines (ARM), Cirrus Logic, Digital, LSI Logic, and Sun Microelectronics.

As the creator of Java, Sun has a special interest in manufacturing appliance-related chips. When Sun abandoned Intel chips in favor of its own SPARC design in the late 1980s, it created a highly successful architecture.

Ten years on, that architecture forms the basis of much of the Internet itself, and is an established and proven technology. Sun is now making processors designed specifically to run Java code. As any code runs considerably faster if executed by hardware as opposed to a software interpreter, any appliance that has a Java chip will perform extremely quickly compared with general-purpose PC chips, even at lower clock speeds.

2. Lightweight Operating Systems (Microkernels)

Microkernel operating systems have been available for many years, but have not made many inroads into mainstream commercial computing. The introduction of Java technology, on the back of Internet application migration, however, has given rise to a new generation of lightweight, microkernel operating systems. Sun is developing JavaOS, for example, which is designed to be fully ROMable for embedded applications and can run with as little as 512KB ROM and 256KB RAM.

Acorn (whose spin-off company, Advanced Research Machines, develops the ARM family of low-cost, high-performance integrated processors) has a long history of efficient processor and operating system design. Its RISCos operating system was introduced, along with the first ARM CPU, in the Acorn Archimedes computer in the late 1980s. The RISCos operating system is, by current standards, very memory-efficient, and both it and the ARM chip are elegant to write for.

Other vendors developing operating systems suitable for Internet appliances include GEOS (Geoworks), Microware, and Diba. In addition, the Carnegie-Mellon University Mach operating system is well suited to Internet appliances, since it was designed from the start as a network operating system.

3. High-Speed Networks

Home workers, SOHO (small office, home office) users, and mobile workers are generally restricted to low-bandwidth connections: 14.4Kbps, 28.8Kbps, or 64Kbps (while a 64Kbps ISDN connection is still regarded as a luxury for the home user, it is only one step up from a modem connection; it is not fast enough for video or for rapid downloading of whole applications, large distributed application objects, or large data files).

Within the corporate environment, however, developments in networking technology are rapidly bringing high-bandwidth applications to the desktop. Ethernet (10Mbps) and Fast Ethernet (100Mbps) are commonplace, and Gigabit Ethernet (1,000Mbps) is in development. High-bandwidth applications such as videoconferencing are encouraging companies to upgrade to high-speed networks regardless of any Internet or intranet

development, and so may be assumed to be in deployment in many companies.

ATM (up to 622Mbps) LAN and WAN solutions are available, although they are expensive, and there remains a question mark over the long-term viability of ATM. Its insistence on establishing a point-to-point connection before transferring data is somewhat at odds with the way the Internet, and, therefore, intranets, work. With the widespread adoption of Internet technology (specifically TCP/IP), INPUT does not believe that ATM will become the standard network environment.

E
Internet Appliance Standards

The overriding standard for Internet appliances intended to fulfill the role currently performed by desktop and portable PCs in the corporation is the Network Computer Reference Profile, developed by Oracle, Sun, Netscape, IBM, and Apple. The Network Computer Reference Profile specifies what a network computer (these vendors' term for an Internet appliance that fulfills the role of a PC) should be capable of and what standards it should support.

It should be noted that 'network computer' is a trademark of Oracle. It appears below abbreviated as "NC". The NC Reference Profile as published by the above vendors as follows:

- The following resources guidelines:
  - Minimum screen resolution of 640 x 480 (VGA) or equivalent
  - Pointing device
  - Text input capability
  - Audio output
  - Persistent local storage not required
- Internet Protocol—NC devices participate in an IP-based network and will support IP as an underlying protocol. Specific hardware attachment to the network is not specified.
- The following IP-based protocols:
  - TCP—the Transmission Control Protocol creates a stream-based network above IP. Secure connections, if supported, are provided by the Secure Sockets Layer (SSL).

  - FTP—The File Transfer Protocol allows NC-branded devices to exchange files using the popular FTP protocol. This is required only for NCs that implement either a local or distributed file system and support file transfer.

  - Telnet—Telnet is a standard client/server protocol that enables character-based terminal emulation access to remote hosts. This is required only for those NCs that support a character-based console access to remote hosts.

  - NFS—Network File System supports distributed file systems for NC devices. NCs that do not implement a distributed file system need not implement this protocol.

  - UDP—The User Datagram Protocol is utilized by NFS and enables end-to-end application-specific communications.

  - SNMP—Simple Network Management Protocol enables NC devices to participate in a network-managed environment.

- The following boot and configuration options:

  - DHCP—To simplify administration and installation, Dynamic Host Configuration Protocol enables an NC to boot itself over the network, to dynamically acquire an IP address, and to transmit configuration information over the network.

  - Bootp—enables an NC to boot over the network

- The following World Wide Web standards:

  - HTML—HyperText Markup Language is the publishing format for WWW sites (including CGI).

  - HTTP—HyperText Transfer Protocol allows browsers to communicate with remote Web servers and servers to communicate with NCs.

  - Java Application Environment

    - The Java Virtual Machine and runtime environment

    - Java class libraries

- The following mail protocols:
  - SMTP—Simple Mail Transfer Protocol
  - IMAP4—Internet Message Access Protocol Version 4
  - POP3—Post Office Protocol Version 3
- The following common multimedia formats:
  - JPEG
  - GIF
  - WAV
  - AU
- Security features supported through emerging APIs:
  - Optional security standards
    - ISO 7816 (smart cards)
    - Europay/MasterCard/Visa specifications

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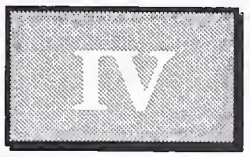


The Reality of PCs

A
One Size Does Not Fit All

With today's client/server architectures, the only client hardware option for most companies is the PC. Yet with the extravagant support costs, few companies can afford to extend clients beyond those desktops where mainframe terminals resided twenty years ago.

Internet access appliances can potentially be used by more people than can PCs, not because of their functionality but because of their lower purchase and support costs. For example, an Internet appliance could be put on a receiving dock, providing access to open purchase orders. In electronic banking, an Internet appliance could provide the functionality required in a kiosk. Neither application is ideally suited to a PC.

Popular operating systems and applications continue to become increasingly complex, more processor-intensive, and more capacious, and corporations are forced to upgrade their hardware. Yet few organizations can afford this continual upgrade cycle year after year, and the cycle is not slowing down. Neither is the initial investment in a modern PC decreasing—it remains at around $2,000 in the U.S., and is typically more elsewhere.

1. Difficult to use

Although companies have been marketing PCs as easy-to-use devices which affordable by everyone, the reality is that PCs are still difficult to use and expensive. Even some PC manufacturers agree—Stan Shih, chairman of Acer, has said that owning a PC "is too expensive, too difficult to use, and too sophisticated for most people." The need to integrate many different types of components from many different manufacturers for many different types of users has not resulted in an 'open systems' utopia, but in a maze of compatibility matrices and upgrade options.

The PC is not intended to be a single-function device, but a multipurpose generic architecture that has to be coaxed into shape to be able to run a required application. Unlike dedicated devices, therefore, PCs are not immediately usable by those unfamiliar with them. Difficulties encountered by users include learning a complex operating system, including learning which elements they need and which they don't, installing and upgrading operating systems and applications, fixing bugs, and configuring to connect to the Internet.

2. High Support Costs

Today's companies require that more users access valuable data and information, but companies cannot afford the administrative staff to support those extra users. In a common three-tier client/server architecture, approximately 25 users can be supported per administrator. As companies move from traditional client/server architectures to TCP/IP networks connecting servers to Web clients, 100 users can be supported per administrator, and this figure could rise to 1,000 in certain environments.

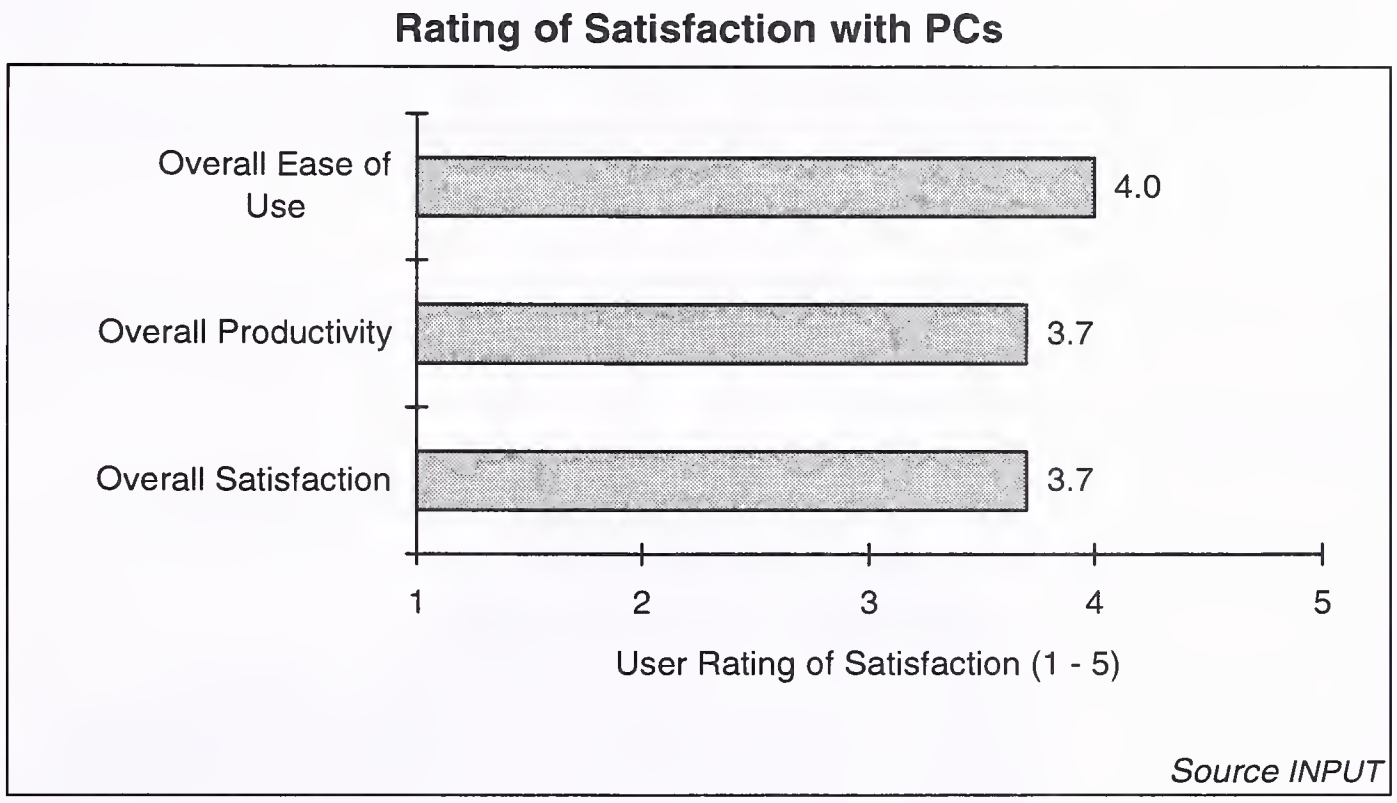
MCA Inc. estimates that it spends around $5,000 per PC per annum on overall support. With nearly 6,000 PCs within the organization, the total PC support cost per year is nearly $30 million.

That level of expenditure on client support is unacceptable to many organizations, and several large PC-using companies, including MCA, are taking part in Internet access appliance trials. Their objective is simple: to cut the massive support costs involved in maintaining a PC environment.

INPUT estimates average PC support costs at $4,600 per machine per year, close to the MCA figure, but estimates Internet appliance support costs to be only $1,200 per machine per year. The difference is almost entirely accounted for by the greater number of clients each system administrator can support—i.e., a company using Internet appliances needs fewer administrators.

B
User Satisfaction with PCs

Exhibit IV-1



INPUT asked respondents to rate their satisfaction with their PCs for ease of use, productivity, and overall satisfaction. Overall, the ratings look reasonable for PCs:

- Ease of use—Although general-purpose devices such as PCs may be good for productivity, they tend to be less easy to learn and use than more specialized devices. A PC running Windows is capable of fulfilling many different roles, but is less easy to learn for the beginner than is, for example, a personal organizer with a simple, dedicated interface. Nevertheless, survey respondents rated PC ease of use highest.

- Overall productivity—The PC industry has had many years in which to mature and develop highly functional applications, and users have had the same time to adapt to the PC environment. Given that most users have long since settled in to the PC environment, it follows that they have found ways to maximize their productivity.

- Overall satisfaction—It could be argued that what one hasn't had, one cannot miss, in which case users may be so used to the PC model that they lack the experience to compare it with other platforms.

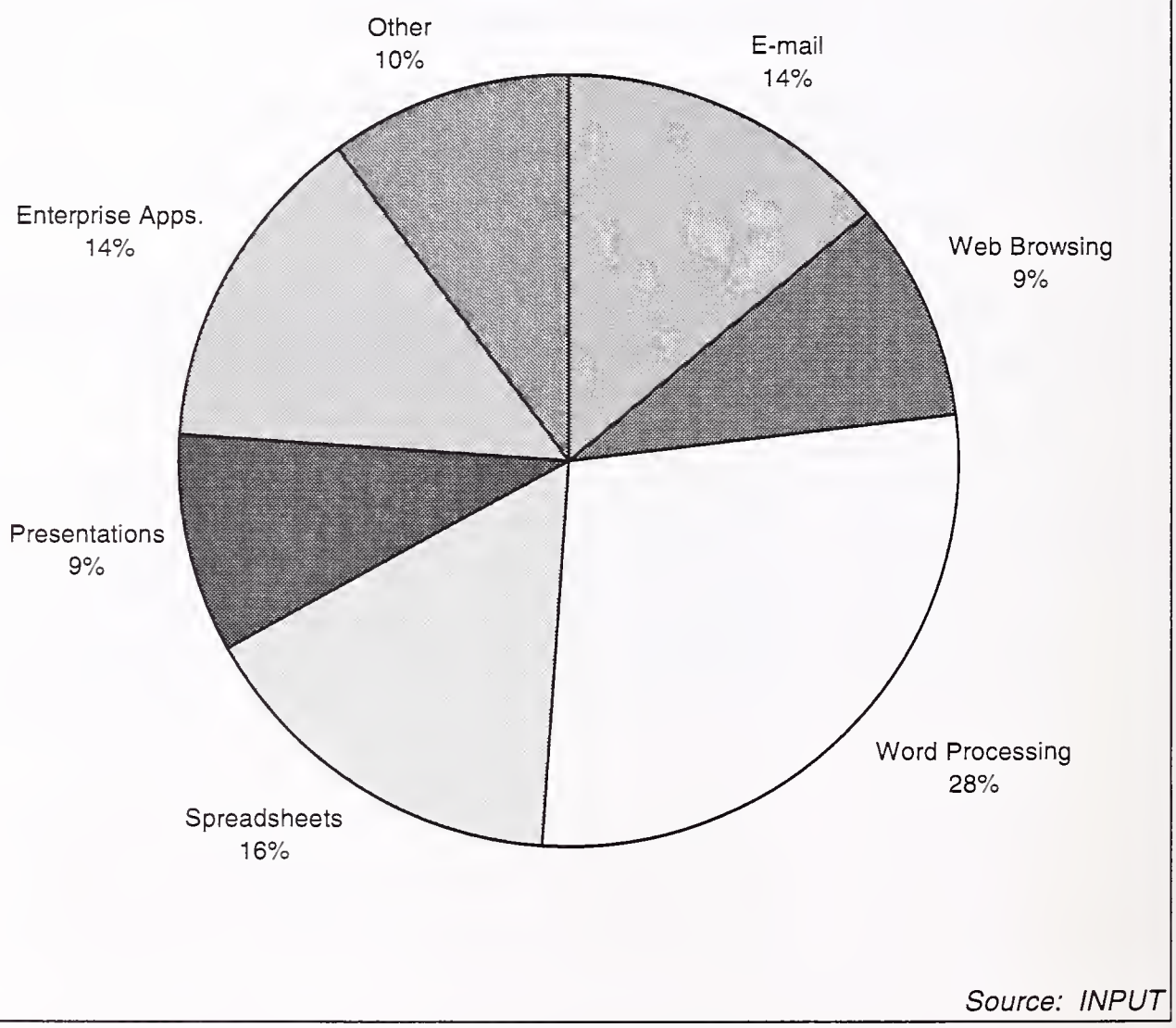
C
Usage of Personal Computers

Although corporations continue to spend millions of dollars annually to support PCs, the reality is that users spend around half of their time with PCs reading and composing text and browsing the Web (see Exhibit IV-2). Overall, 23% of users' time is spent accessing either intranets or the Internet (14% in e-mail and 9% using the Web). Word processing accounts for the most use, at 28%.

Despite the graphical nature of operating systems like Windows, 42% of PC usage is fundamentally text based (14% e-mail and 28% word processing).

Exhibit IV-2

PC Use by Application



Source: INPUT

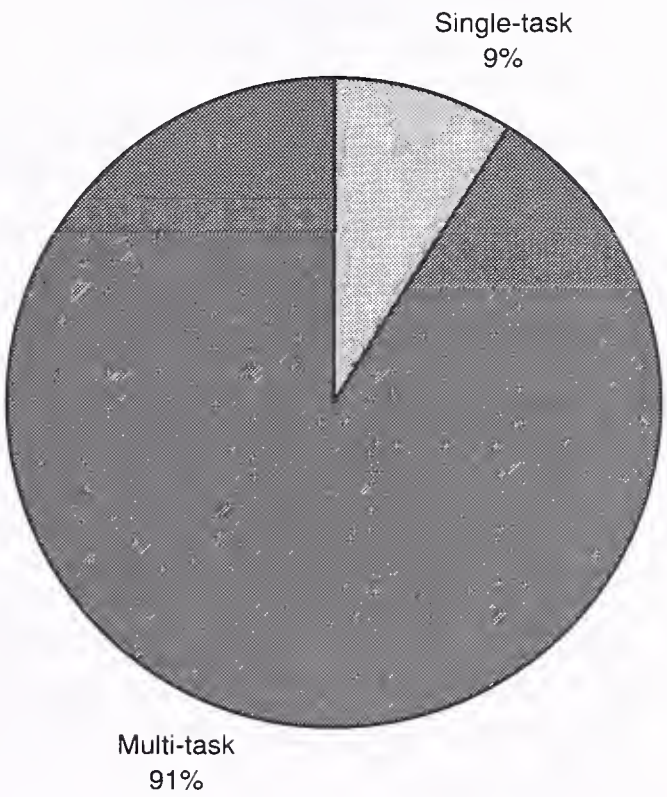
Internet appliances will not replace all PCs. They will not even replace a high proportion of PCs in the medium term. Appliances are best suited to users who perform a small number of tasks, or whose technology needs are not particularly sophisticated—"information consumers". Users with more sophisticated needs, for example those who create information and/or

perform analysis on information—"information producers"—are far less likely to migrate to an appliance.

To identify what proportion of current PC users fall into the target group for appliance vendors, INPUT asked user organizations for details of user types. Around one-tenth of users (9%) use their PC for only one task (see Exhibit IV-3) and are ideally suited to a Internet appliance. Examples include stock taking, ticket reservation, and other order-processing applications.

Exhibit IV-3

PC Use by Task

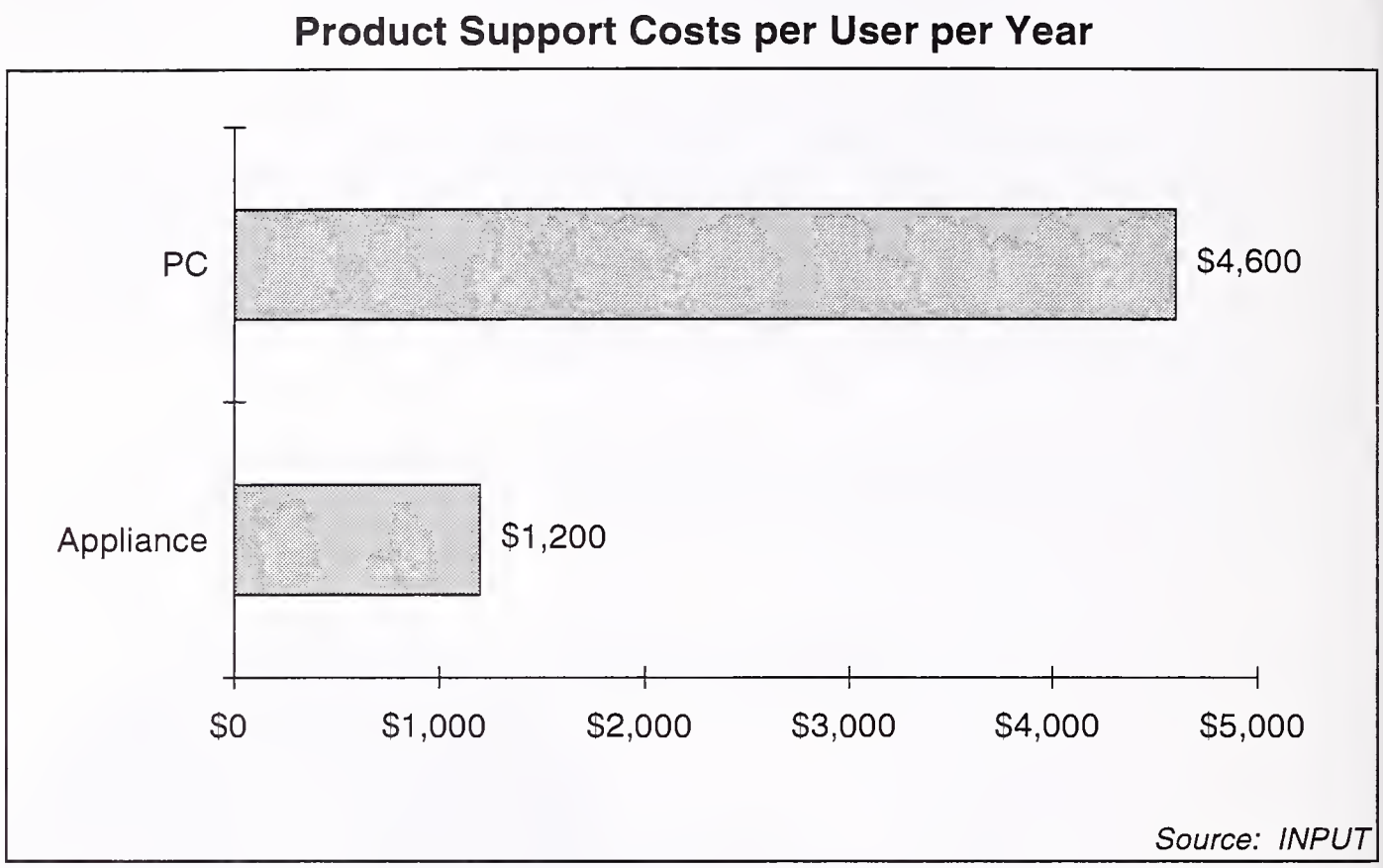


Source: INPUT

D
PC and Appliance Cost per User

INPUT estimates that over a five-year lifetime, a PC costs $4,600 per year to support, but an Internet appliance will cost only $1,200 per year (see Exhibit IV-4). This huge cost saving has considerable implications for companies currently faced with increasing PC support costs. On average, for every PC user a company moves to an appliance (assuming a nontrivial number of migrants), it could save around $3,000 per year in support costs.

Exhibit IV-4



Internet appliances cost less to purchase than PCs ($500 as opposed to $2,000, for example, although initial products are priced higher) and they cost less to run and maintain at the hardware level.

The overriding factor in this enormous difference, however, is system administrator costs. One system administrator can support only about 25 PCs, but around 100 Internet appliances. Over 80% of PC support costs are accounted for by administrator overhead, including salary. This cost takes into account:

- Time spent performing routine maintenance—upgrading memory and disks, repairing file corruption and undeleting files, undoing users' accidental settings, etc.

- Time spent installing and upgrading applications software—shrink-wrapped software such as word processors and enterprise application front-end software. This includes installing new software, installing bug fixes, and upgrading to newer versions.

Nearly all of this time spent in PC environments is not needed in an appliance environment:

- Routine maintenance—Internet appliances need less routine maintenance than do PCs; not only do they contain fewer components, having no disk or disk controller, but they are much less complex, due to not having to support a huge variety of components within one case and one architecture as PCs do.

- Installing and upgrading applications software—This is where the biggest cost savings will occur in an appliance environment. An Internet appliance does not store applications locally; many will not even store their operating system locally. A minimal appliance would contain a small bootstrap in static or flash ROM, which would load the latest version of the microkernel operating system and the latest version of the Java virtual machine (JVM) or other application environment from the network. A more fully featured appliance might store the microkernel operating system and the JVM locally in flash ROM, to allow fast bootup and regular upgrades. Either way, the machines are server-centric. All application software is downloaded from a server. All application installations, upgrades, bug fixes, and other revisions are done once, centrally, on the server. Apart from relatively minor hardware issues, a system administrator doesn't have to visit each desktop and perform an action on individual clients ever again.

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V

Corporate Use of Internet Appliances

A
Types of Information Users and Devices

INPUT defines four types of information users (see Exhibit V-1).

Exhibit V-1

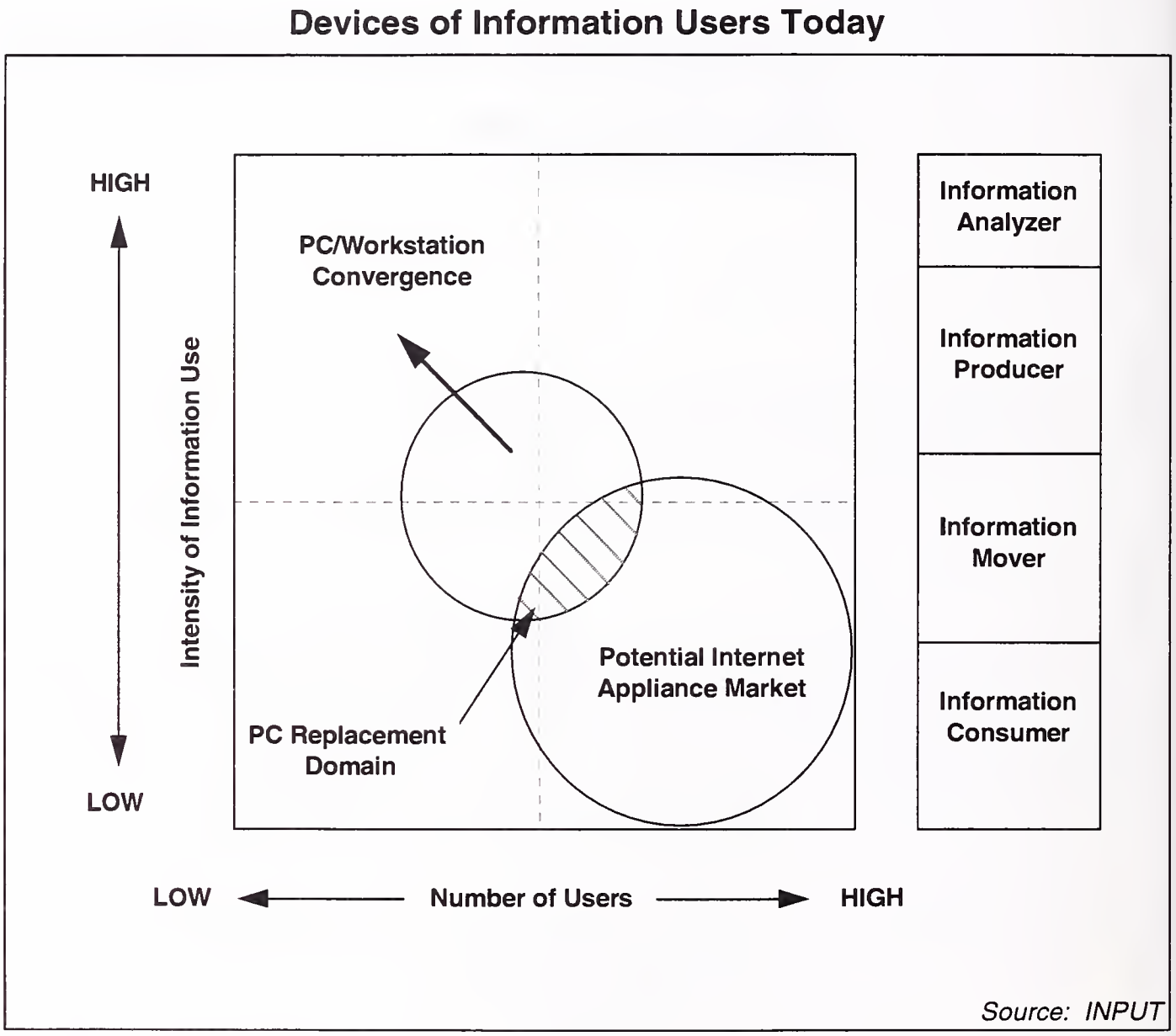
Information Users

User	Description	Examples	Likelihood of Using Appliance
Information analyzer	One who takes a meta-level view of content for high-level analysis	Financial analysts, accounting, R&D	Very low
Information producer	One who creates and publishes new content and who performs major updates of existing content	Marketing, HR, technical authors	Low
Information mover	One who views and makes use of information and who is appointed to perform partial updates/approvals	Middle managers, bank tellers	High
Information consumer	One who views and makes use of information but who does not update or create information	Purchasing, factory floor, sales, executives	Very high

Source: INPUT

Exhibit V-2 illustrates, in terms of the definitions given in Exhibit V-1, by whom PCs are used today, by whom Internet appliances will be used, and the overlap between the two groups. This overlap represents the group of users who will potentially migrate from PC to Internet appliance.

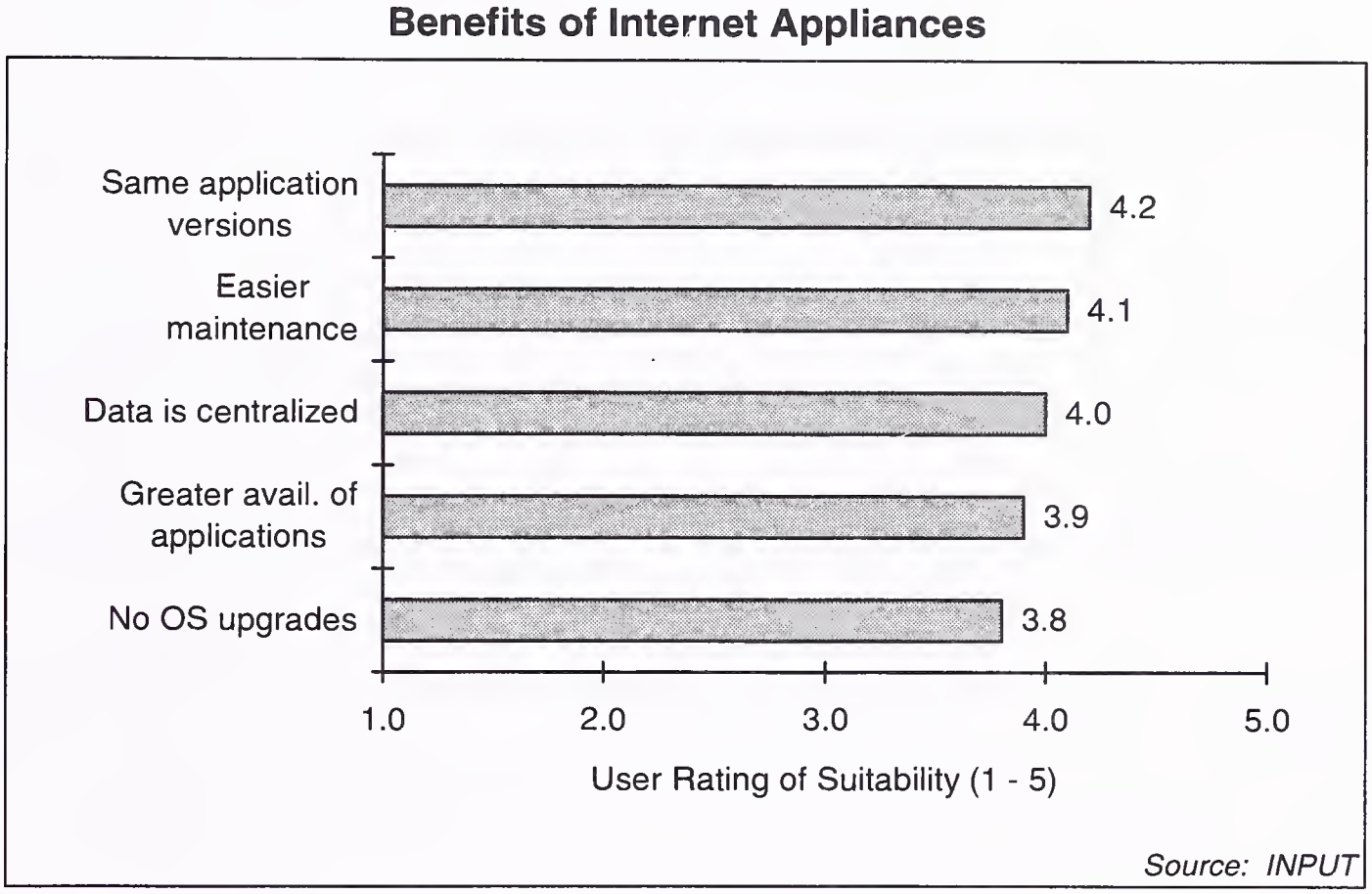
Exhibit V-2



B
Benefits of Internet Appliances

Potential users of Internet appliances see the benefits of such appliances (see Exhibit V-3) as outweighing the disadvantages.

Exhibit V-3



1. Application Support

Two significant benefits were brought up relating to application software: 'same application versions' and 'greater availability of applications'.

The first point, that of the latest version of an application being available to all users at all times without ever having to perform local software administration, is one of the most compelling arguments in favor of Internet appliances over PCs. INPUT estimates that one system administrator can support 25 PC users, but in an appliance environment, one administrator can support 100 users. A considerable amount of system administrators' time spent in supporting users is related to local issues, for example: desynchronized versions of locally stored applications, erroneous local application settings, and mislaid, corrupted, or deleted local files. By removing most local support, administrators' time is freed up to concentrate on supporting the application, rather than each individual user.

Internet extensions to intra- and inter-enterprise applications lead to more complexity. Intranet systems will continue to push the limits of reliability.

Once a system becomes stable it will be extended and modified, leading to new problems. Hence, reliability is expected to continue to be an issue over the next five years, providing excellent opportunities for services and products that can troubleshoot distributed applications.

2. Easier Maintenance

An appliance designed for a limited number of functions, or one that relies on most of the administration being carried out on a server, is inherently easier and more cost-effective to maintain than a fully functional, general-purpose PC. If a PC is only used for one task, it will contain a variety of internal components not necessarily relevant to the task being performed. For example, a user who performs only data entry directly to a server does not need a local storage capability, yet his or her PC will contain a hard drive, floppy drive, controller, and related software drivers. If such components are present in a device, they will be used, regardless of whether they are required for the user's job, and will have to be maintained.

In addition to the increased ease of maintenance of an appliance is the lower purchase cost. When a $2,000 PC needs a nontrivial amount of upgrading or repair, there is little an organization can do but to carry out the necessary work. Yet the organization is left with an aging system that is likely to require further maintenance during the rest of its life. If a low-cost Internet appliance is used, the cost of performing nontrivial maintenance may actually approach the cost of replacing the appliance.

3. Centralized Data

The principal benefits of centralized application software and operating systems apply equally to centralized data. The primary benefit is less or no time spent by administrators solving problems at the user's desk.

4. Operating System Support

Nearly as important as removing local application software support is removing local operating system support. The two issues are closely related, and to the user they may be indistinguishable. The effect of supporting operating systems is as great on systems administrators' available time as the effect of supporting applications, if not greater: PCs are able to run applications stored centrally, but not operating systems.

Over the past few years, operating system upgrades have not been as important an issue as they are today, in PC environments. Windows 3.1x was the common standard, and there was no viable alternative for organizations with a Microsoft operating system policy. With the introduction of Windows 95 and Windows NT Workstation, administrators

are again faced with a potentially highly mixed operating system environment.

As all PC operating systems are firmly set in the local environment, all operating system support necessitates visiting each user individually. An appliance, however, might store only bootstrap code locally, and might download the full operating system (or, equally likely, a microkernel operating system) from a server.

As with application software, the benefit to IS departments of a server-based software environment is a dramatic decrease in time spent supporting individual users.

C
Disadvantages of Internet Appliances

1. Disadvantages Perceived by the Negative

Respondents who were critical of Internet appliances (those who stated they would not find them useful) gave the following reasons:

- Too little functionality
- PCs are good enough as general-purpose machines; see no need to change
- Company does not use Internet applications; uses traditional PC or client/server applications only
- Lack of available applications
- No local data storage
- Processor performance and available bandwidth
- Extra maintenance incurred by adding another device
- Security risks

INPUT believes that most of these concerns can either be answered today, or will be resolved in the near future, and would expect a decrease in the above types of responses if awareness of the underlying issues of Internet appliances was greater.

a. Too Little Functionality

The concern over Internet appliances being 'single-function' devices is misplaced, in INPUT's opinion, and is analogous to an early PC skeptic criticizing PCs for being limited to DOS. The underlying point is that the Internet, to an Internet appliance, is a means, not an end. Just as DOS is a means to run PC applications, so is the Internet a means to run, for example, Java applications. There is no reason for there not to be as many Java applications over the coming years as there are DOS or Windows applications.

b. Lack of Available Applications

Availability of applications certainly is a current issue. Like most new computer platforms, only those supported by a wide range of applications succeed. A new platform that gets caught in the unfortunate position of needing applications before it will sell, but for which software developers won't write applications until it has sold in volume, will not succeed. Internet appliances are less likely to fall into that trap, as software is not tied to any particular hardware platform.

However, the success of Internet appliances is dependent upon the number of applications migrating to the Internet platform. If enterprise applications migrate from client/server platforms, or if they're even simply connected to a Web front end, then appliances will sell to information consumers and movers in the corporation. If applications, such as word processors and spreadsheets, migrate from PC platforms to the Internet platform, appliances will take a significant amount of sales away from PCs, as information producers and analyzers find they can use the same applications using Internet appliances.

While the purest Internet appliance would be based solely on Internet standards, the first appliances to be released are a hybrid of PC, X terminal, and network computer technologies. For example, appliances already available from HDS Network Systems, Wyse, NCD, and Boundless Technologies (formerly SunRiver Data Systems) support, variously, Windows, X terminal, and mainframe applications, as well as including Java and Web capabilities.

c. Security Risks

There is still considerable concern over the potential security risks encountered when using the Internet, and this perception has been perpetuated by some people when discussing intranets. The reality is that much of this concern is unfounded and is based on misreporting of security incidents and received wisdom.

Laying aside the matter of how secure or insecure the Internet itself is (INPUT believes that the issue is not the availability of security technology but the standardization and acceptance of that technology), there is no reason in most cases for an intranet populated by Internet appliances to be inadequately protected.

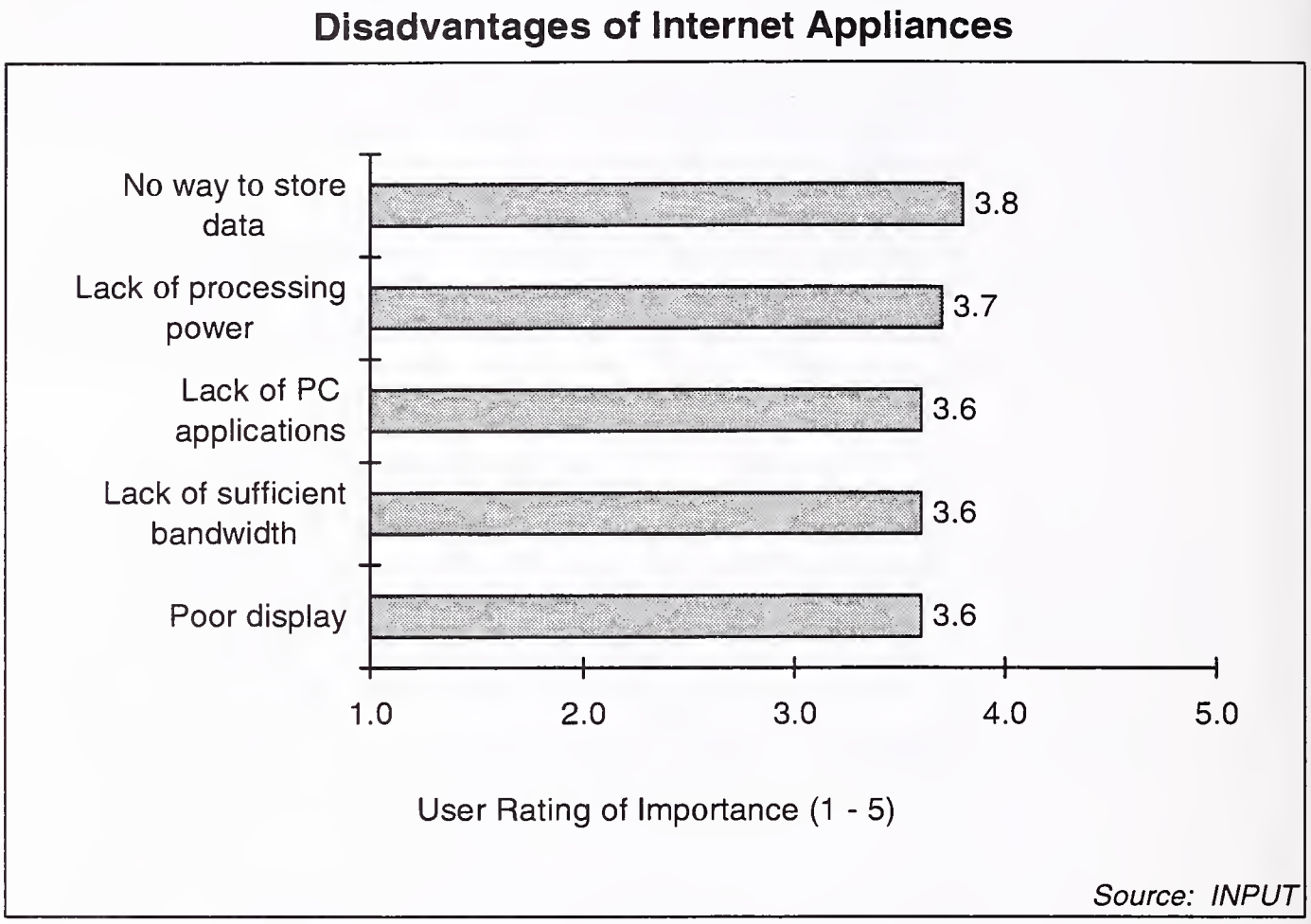
The greatest security risk is represented by poor security policies and unscrupulous employees, not by unauthorized external access—witness the cases of passwords being shared among employees or displayed in full view of others, for example.

PCs are notoriously prone to virus and Trojan horse attack. The primary reason for this is the insecurity of many popular PC operating systems, notably the unfettered access they give of system and application files to any program. Many other operating systems, such as UNIX, do not allow the same level of freedom and are correspondingly less open to attack. However, an Internet appliance that does not contain local disk storage goes even further in resisting viral infection—like a personal organizer or game console, such an appliance is restored to the same state each time it is switched on, regardless of previous activity. Additionally, an appliance based around a Java Virtual Machine is protected further by the strict program containment policies inherent in the JVM.

2. Disadvantages Perceived by the Positive

Exhibit V-4 shows the disadvantages of Internet appliances stated by positive respondents (those who stated that Internet appliances would be useful).

Exhibit V-4



Again, some of these perceived disadvantages can be answered today, and others may be resolved in the future.

a. No Way To Store Data

The benefits of 'centralized data' were rated at 4 out of 5 by respondents (see Exhibit V-3), only slightly higher than the 3.8 rating given to this issue when presented as a disadvantage. As discussed earlier, the benefit of centralized over localized data storage to a company is considerable in terms of system administrator time spent supporting users.

b. Lack of Processing Power

A slow processor is not necessarily a design feature of Internet appliances. Though appliances are not designed to match PCs in terms of local hard disk and memory capacity, there is no reason they can't be driven by a high-power processor, at least matching Pentium performance, for example. The primary issue is cost, but companies such as ARM are producing high-performance, low-cost CPUs that, while not offering state-of-the-art performance, better the Pentium on price/performance.

c. Lack of PC Applications

As stated above, early Internet appliances from HDS, NCD, Wyse, and Boundless support Windows applications. Other vendors' appliances aimed at replacing PCs in corporate client/server environments will also include Windows application server support and X emulation. The ability to integrate any new platform into an existing environment will be demanded by users as a prerequisite, and Java-only appliances will lose out to devices capable of running existing applications.

d. Lack of Sufficient Bandwidth

For home use, lack of bandwidth is the critical barrier to Internet appliance adoption: a modem or even ISDN connection is not fast enough to support real-time downloading of distributed objects to run applications.

Within companies, the bandwidth to support network computing using Internet appliances is already in place. Ethernet, providing 10Mbps, is the common standard, and Fast Ethernet (100Mbps) is being rapidly deployed. Through the use of such technologies as Fiber Channel, the next order of magnitude will be available soon—Gigabit Ethernet (1,000Mbps).

Internet applications will be built using component objects that are downloaded only as necessary. This will entail less network load than applications which are downloaded in their entirety over the network to each user as he or she accesses them. The greatest use of bandwidth comes from applications such as videoconferencing. These applications are increasing in popularity regardless of Intranets or Internet appliances.

e. Poor Display

Most Internet appliances for use in the home will connect to a television. In the corporate environment, however, they will use a dedicated monitor like any PC or other terminal. The network computer standard specificies VGA as the minimum display requirement, providing 640 x 480 resolution (see *Internet Appliance Standards*, Chapter III). Although this is not high resolution, it is adequate for many data entry tasks; many PC users still use this resolution for all their applications.

Once again, a fundamental difference between Internet appliances and PCs arises. A PC is a general-purpose device and were there to be a defined standard resolution for all PCs, it would have to satisfy all users and all applications. Certain Internet appliances will fit certain users and applications, and there will be a market for appliances that support high-resolution graphics just as there will be a market for many other types of appliances. There is no evidence on which to assume that Internet appliances for use in corporations will provide inadequate display capabilities. The

network computer standard is flexible enough for a graphics-oriented appliance vendor to develop a suitable product in response to demand.

D
Appliance Features

Exhibit V-5 shows the importance attached to basic elements of an Internet appliance. The most important element, inevitably, is a network connection; we may comfortably assume that this will be a central component of every Internet appliance aimed at the corporate market.

The network connection prerequisite aside, the most important features of Internet appliances are also those that are promoted by appliance proponents: low cost, low maintenance, and durability.

Maintenance in this context relates to maintenance of the device itself, not to the support of application software. As discussed above, Internet appliances require less hardware maintenance as they contain fewer (sometimes redundant) components, and may even be cheaper to replace than to maintain in certain circumstances.

Cost is of significant importance to users, and the most consistently quoted feature of appliances is their lower purchase cost. The fabled $500 price tag has just about been achieved by Wyse with its early Winterm appliances targeted at both home and corporate users, and initial products from HDS, NCD, and Boundless are not considerably more expensive, starting at around $700. INPUT expects appliance prices to fall as second-generation products appear, partly in response to user demands for a significant price differential between appliances and PCs.

Exhibit V-5

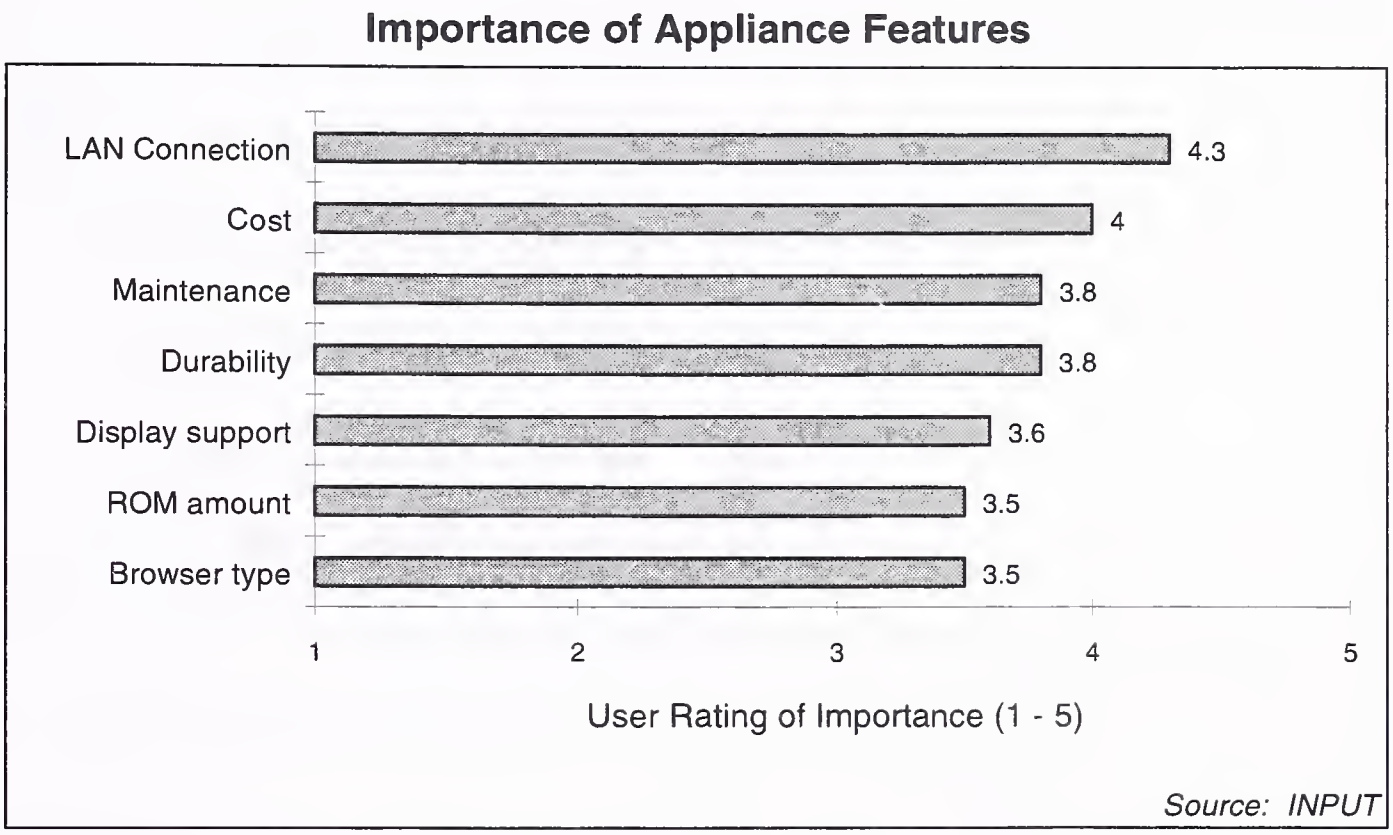
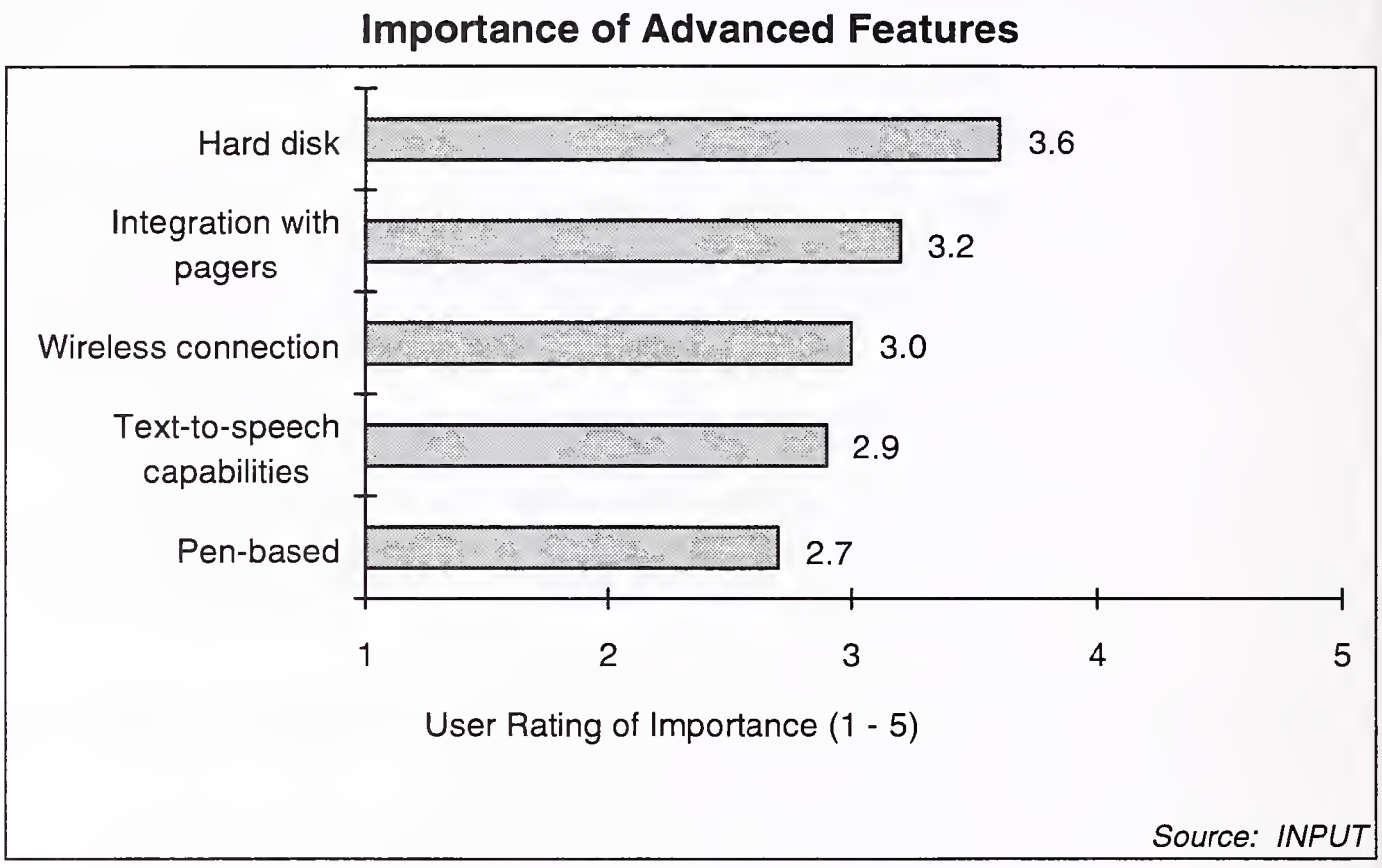


Exhibit V-6 shows the importance of advanced appliance features. Note that all advanced features are considered less important than basic features, even including local hard disk support.

Due to the nature of Internet appliances, INPUT considers a hard disk a nonessential, advanced component for an appliance. Despite the claims by a number of PC-related vendors that a client machine will not succeed without a local storage capability, the inclusion of a hard disk in an Internet appliance is not rated as particularly important by user organizations—3.4 out of 5.

Wireless communications, including support for pagers, was rated as less important still, and features still in their infancy for mainstream PC environments, text-to-speech and pen computing, are considered least important.

Exhibit V-6



E

Appliance Applications

Enterprise applications most suited to Internet appliances are those that involve interaction with customers and suppliers, according to the user organizations interviewed (see Exhibit V-7). Sales and marketing, and customer service are seen as particularly suitable. These applications are increasingly likely, in an Internet-connected organization, to be tied into the company's Web presence and other Internet activities, to receive feedback from and provide information to customers and partners.

A customer service application may use an Internet-based workflow system to feed input from a Web page accessible to customers into a customer service database. The workflow application would prioritize, coordinate, and schedule tasks among customer service personnel who would interact with the application via a Web client. As well as dedicated applications, customer service is already taking place over the Internet through e-mail, on-line knowledge bases, and FAQs, all of which can be accessed easily with an appliance.

Exhibit V-7

Applications Most Suited to Internet Appliances

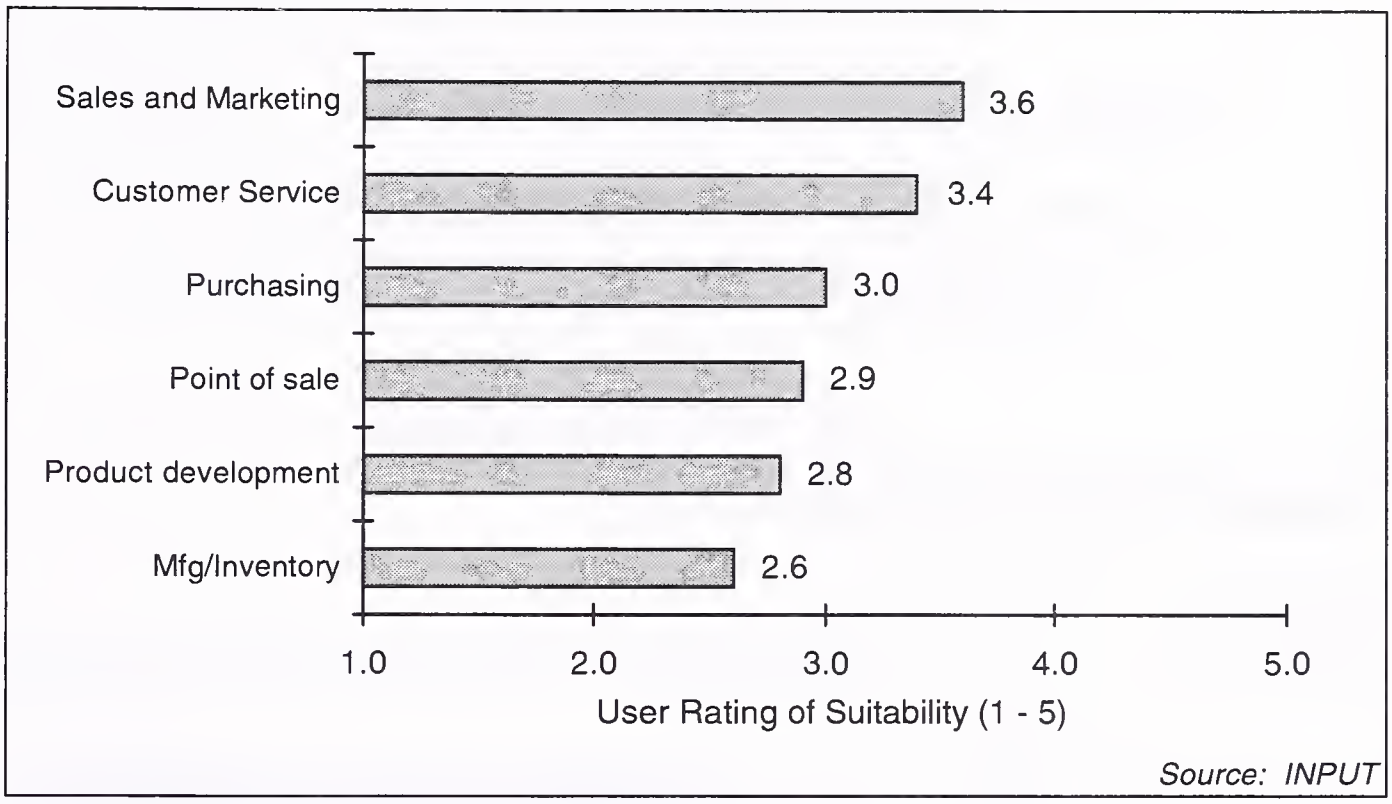


Exhibit V-8

Importance of Horizontal Applications

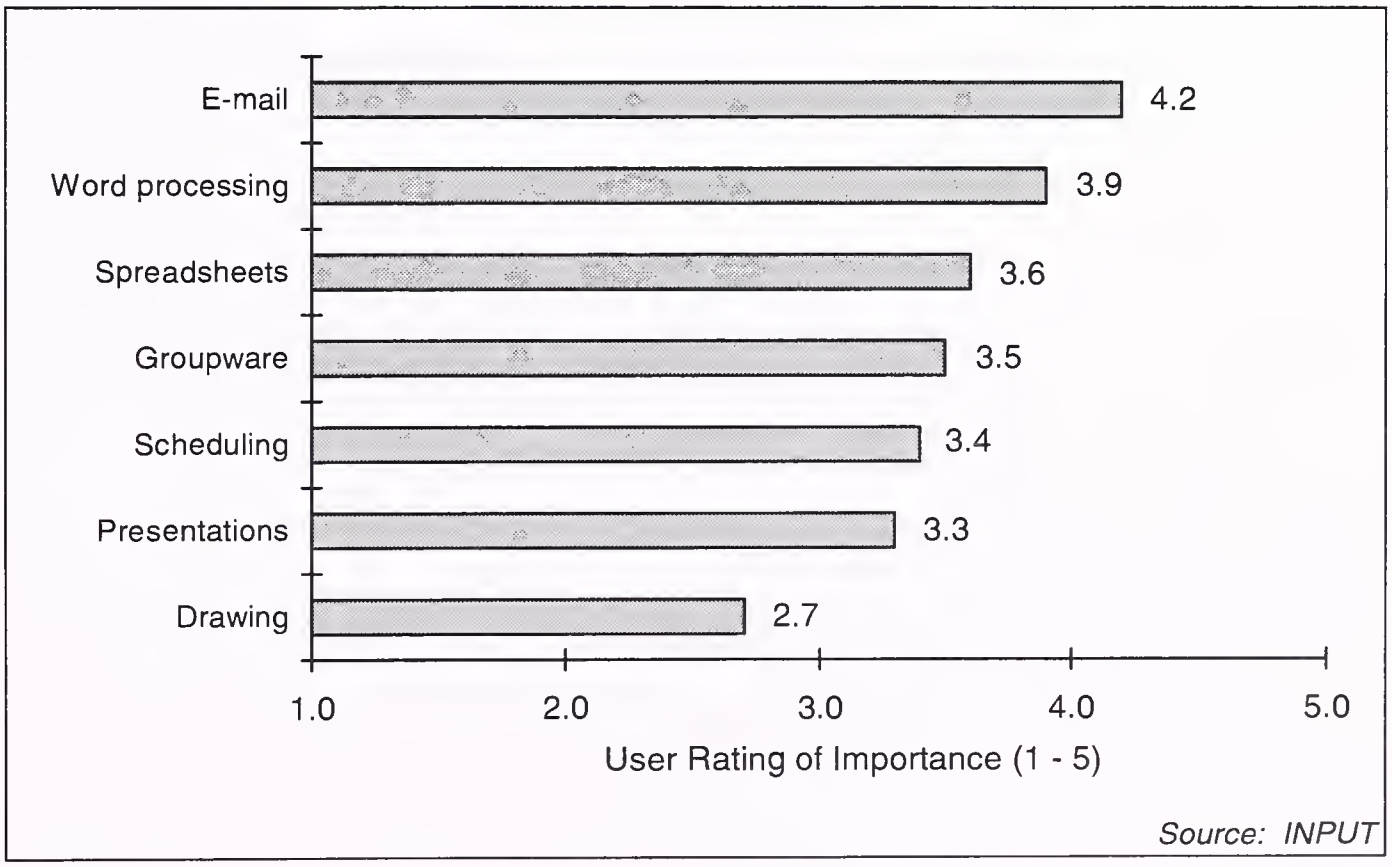


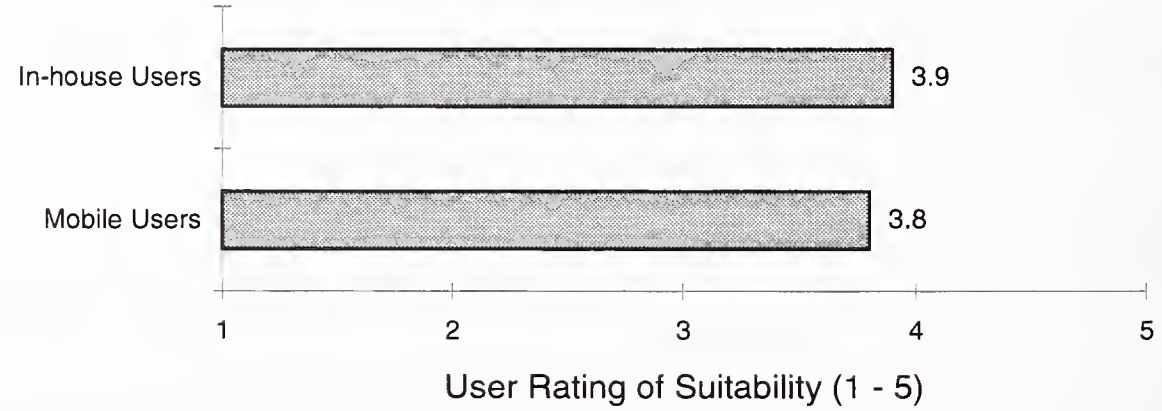
Exhibit V-8 shows how important horizontal applications using Internet appliances are to user companies. E-mail might be expected to be most important, given its current widespread use, but word processing and spreadsheet applications, traditionally more standalone than networked applications, are next most important. The burden of supporting traditionally localized applications such as these takes its toll on IS administrators, and these results reinforce the wishes of users to reduce that burden by shifting them away from the client and onto the server.

F

Types of Internet Appliance Users

Exhibit V-9

Suitability of Internet Appliance by Location in Company



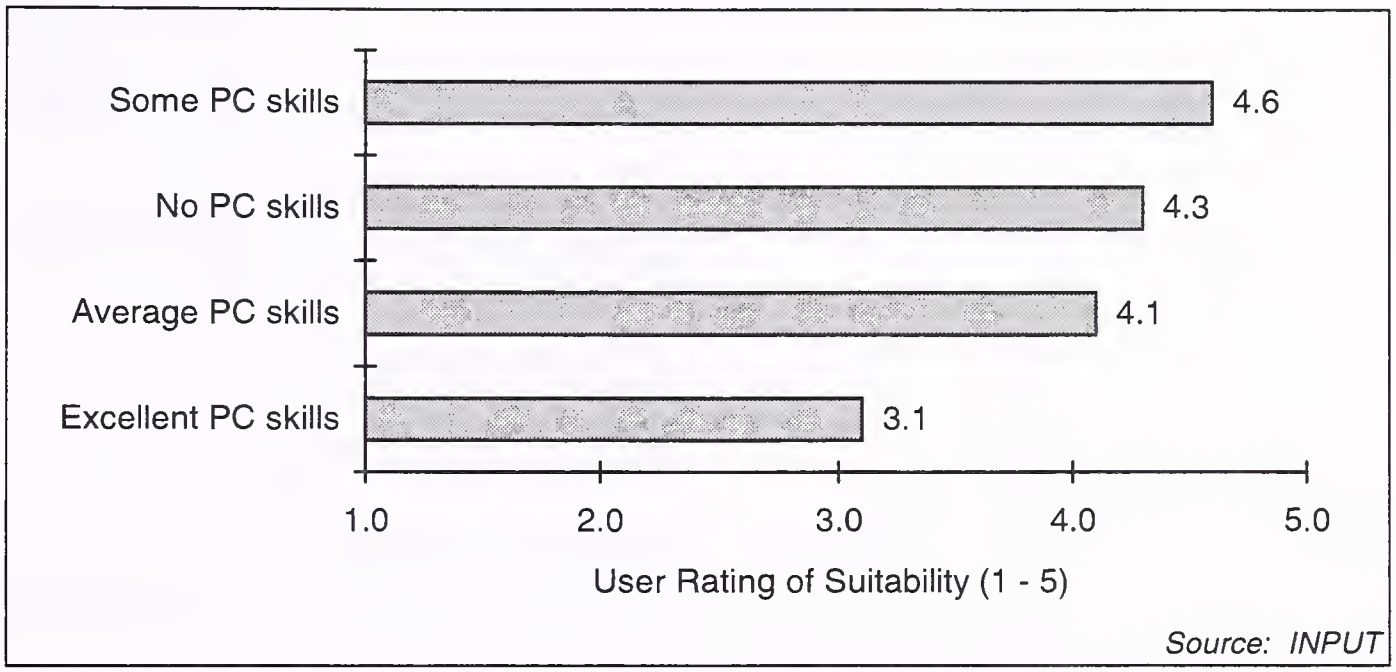
Source: INPUT

Technical managers surveyed were asked to whom they would provide Internet appliances. The most often cited type of employee was a member of the marketing staff. Other commonly cited types of users included:

- Sales
- Managers
- Research/reference
- Mobile workers

Exhibit V-10

Suitability of Internet Appliance by Skill Level

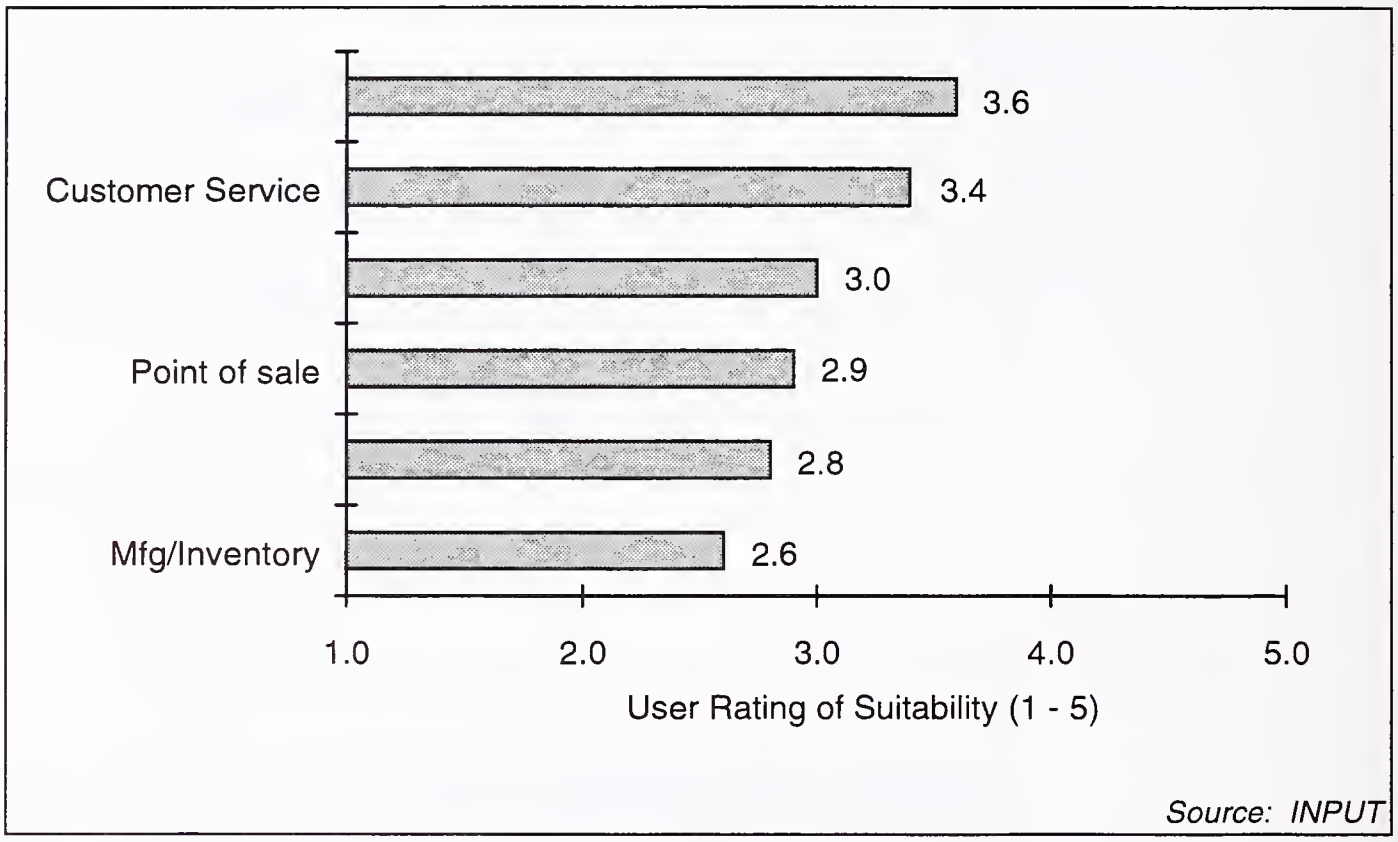


Source: INPUT

IS managers interviewed were also asked to describe the skill level of users most likely to benefit from an Internet appliance. The most commonly cited attribute was that the user would be "less sophisticated". Other commonly mentioned factors included:

- Repetitive tasks and data entry
- The old and the young (for the home market)
- Front-line workers or 'worker bees'
- High need for sharing data

Exhibit V-11



The anticipated use of appliances by functional area closely mirrors the applications users expect to see appliances put to (see Exhibit V-7).

VI

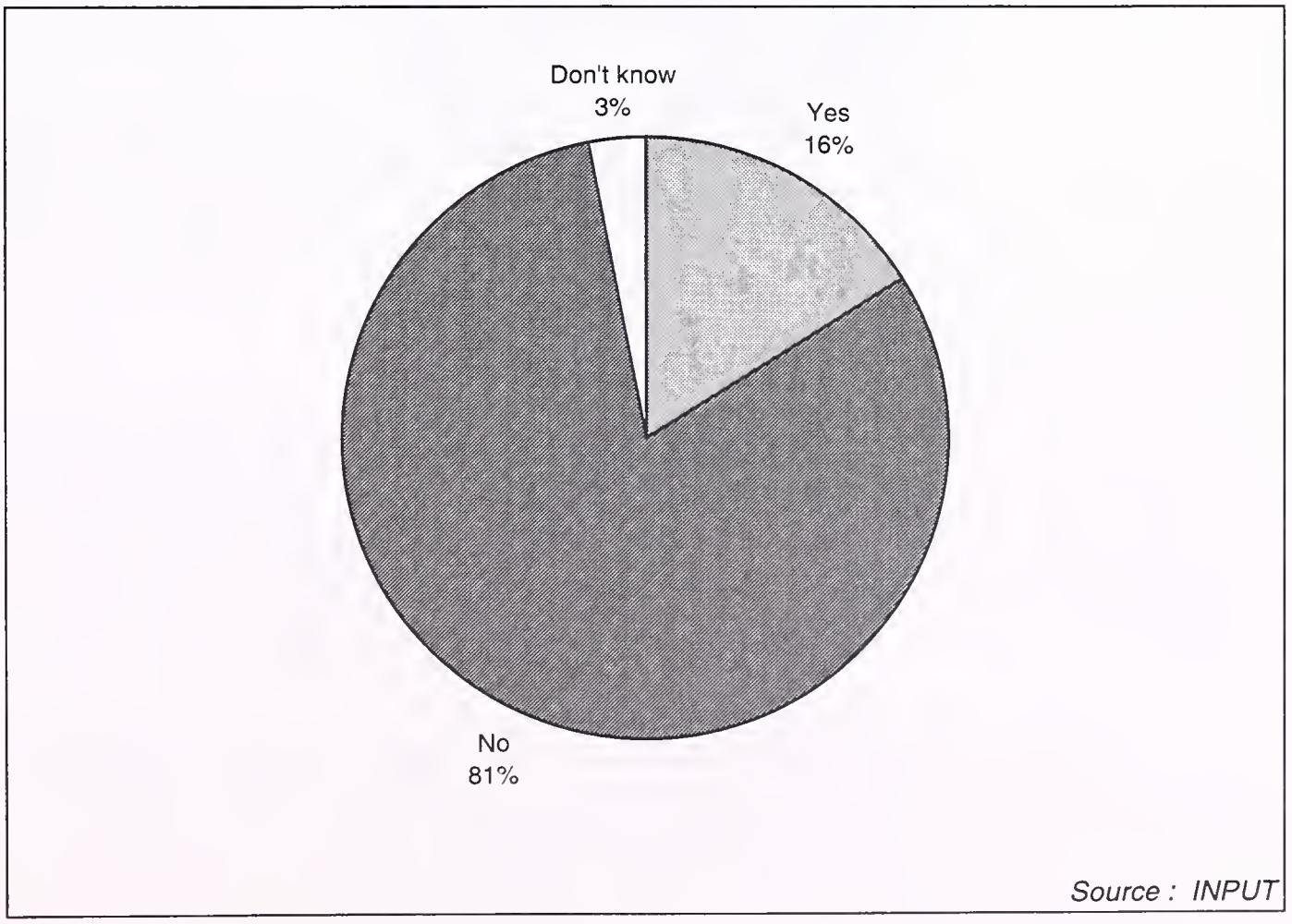
Market Forecasts

A
The Appliance Threat to PCs and Portables

Unless Internet appliances fail utterly in the market, they will affect, negatively, sales of PCs and/or portables. To find out how big this threat to PC and portable sales is, INPUT asked user organizations for their views and their purchasing plans. Results of these queries are shown in Exhibits VI-1 and VI-2.

Exhibit VI-1

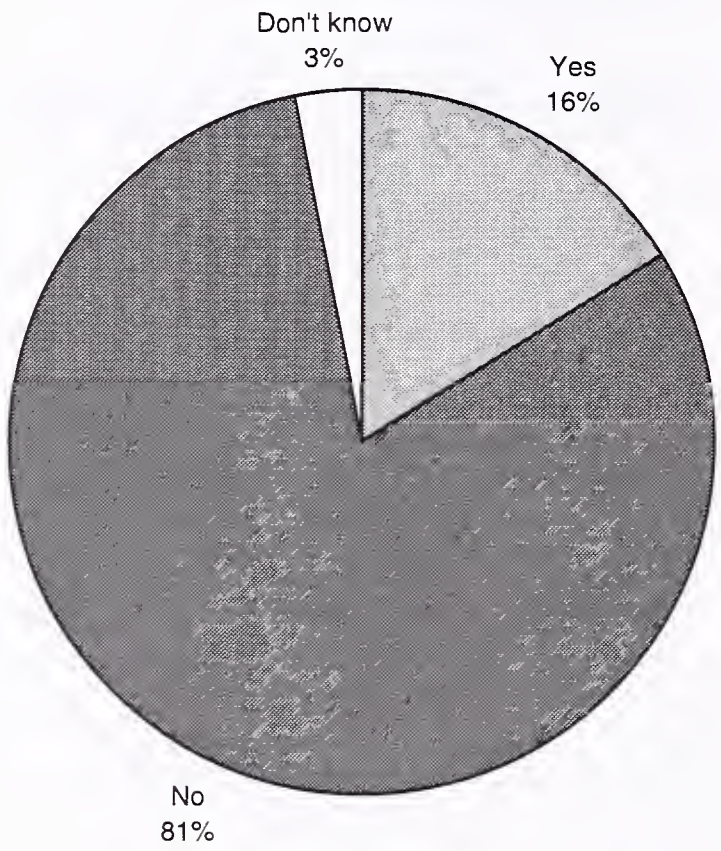
Appliance Threat to PC Sales



Source : INPUT

Exhibit VI-2

Appliance Threat to Portable Sales



Source: INPUT

Sixteen percent of respondents believed that Internet appliances will detract from sales of both desktop and portable PCs. INPUT expects, however, that desktop PCs will suffer more through migration to Internet appliances than will portables, and this expectation is reflected in users' responses in the US (see companion report *Use of Internet Appliances in the Corporation, U.S.*). The reasons for this include:

- The majority of mobile workers do not use any access device today, so there is less of a market from which to take away. Therefore, mobile workers represent an entirely new opportunity for Internet appliance vendors. For example, most corporations cannot afford to equip their entire sales force with portables, but might be able to afford less expensive and lower maintenance Internet appliances.

- Internet appliances depend to a great extent on the network behind them for their applications and data. As intranet bandwidth is in much greater supply than Internet bandwidth, Internet appliances will initially succeed when they are used totally within the corporate environment. This precludes much of the use of portables, and appliances will not make

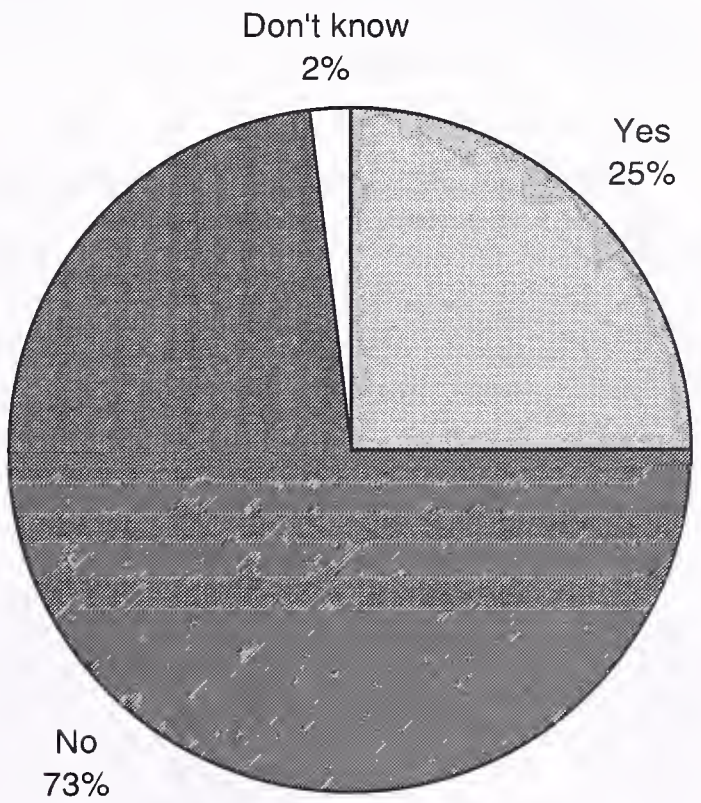
serious inroads into portables' territory until significant bandwidth improvements to the public Internet are made.

B
Intended Appliance Purchases

Among all respondents, those that said they would buy Internet appliances during the next four years are illustrated in Exhibit VI-3.

Exhibit VI-3

Intended Appliance Purchasers, 1996-2000



Source: INPUT

The actual number of users buying appliances may be higher than the indicated 25% above—not to replace PCs throughout the enterprise, but initially on an experimental level, followed by departmental deployment where appropriate, such as within customer service and sales departments. Taking experimental and departmental purchases into account, this figure will be nearer 40% by 2000.

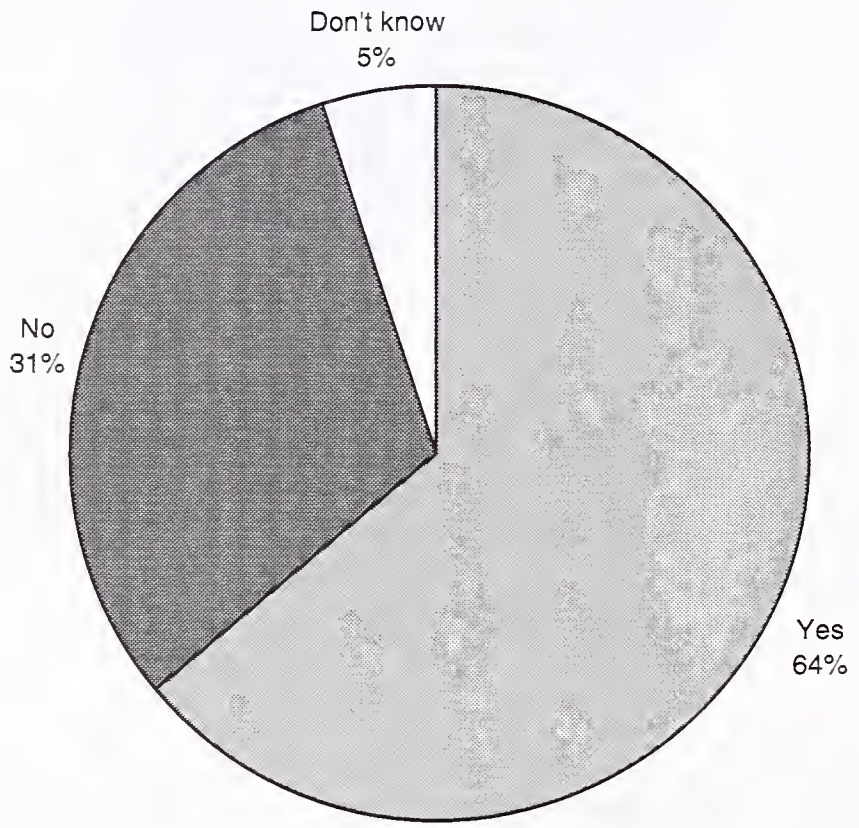
Internet appliances are still new and the subject of much hyperbole. Consequently, not every IS manager is completely aware of all the issues surrounding them, or of all their potential benefits. The messages they receive from the suppliers of their existing equipment (PCs and current dominant PC operating systems) are, in general, negative about Internet

appliances. INPUT believes this has a negative effect on users' current perceptions about appliances, and expects this will change as awareness is heightened and as case studies of corporations using appliances successfully become widely reported.

Among users who expressed the opinion that Internet appliances *would* be useful, the figure for those intending to buy them over the next four years is inevitably much higher (see Exhibit VI-4). Still, around 30% of technical managers who believe appliances will be useful will not buy them, according to their current perceptions. Again, INPUT expects the number of those who do buy appliances to be increased—among interviewees who saw the usefulness of appliances, INPUT expects the proportion of those who buy appliances on an experimental or departmental level to be nearer 75% by 2000.

Exhibit VI-4

Intended Appliance Purchasers (Positive Respondents), 1996-2000



Source: INPUT

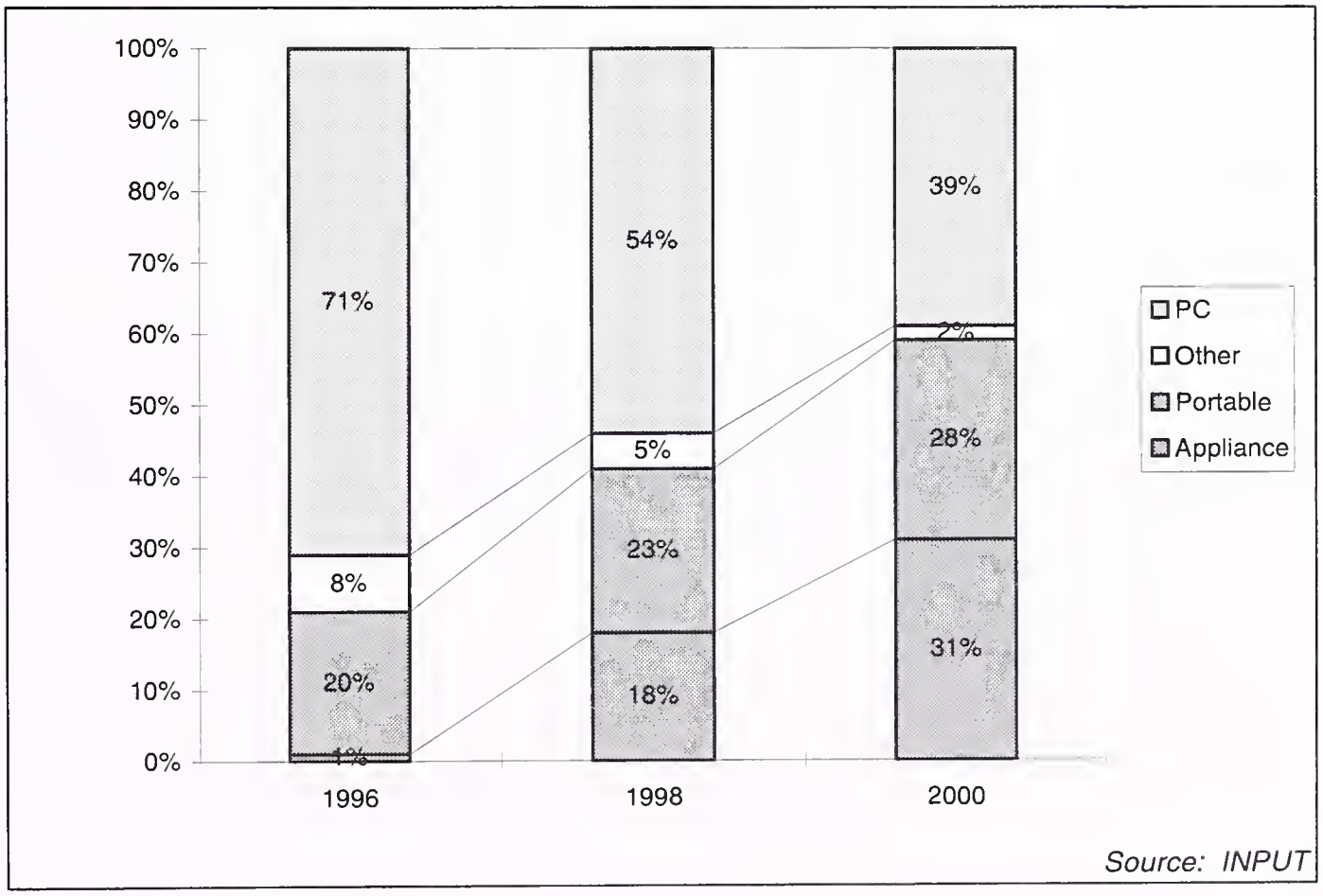
C
Intranet Access by Device Type

IS managers were asked what devices they felt would be used to access corporate intranets over the next four years. Desktop PCs will clearly lose their position as the dominant form of internal network (specifically intranets in this instance) access device, dropping from representing 71% of intranet users in 1996 to 39% by 2000.

Internet appliances by 2000 will account for nearly as many intranet users as will desktop PCs, and portable PCs will claim a growing share of intranet access. Other platforms, including mainframe terminals and X terminals, will decrease in popularity rapidly from 1998. These types of device are easy targets for Internet appliance vendors and will be among the first devices to be replaced.

Exhibit VI-5

Corporate Intranet Access by Device Type



Source: INPUT

INPUT believes that by 2000, 20% of client device shipments that would have been PCs, had Internet appliances never existed, will be Internet appliances instead.

The PC market is certainly not going to be nullified by Internet appliances overnight, nor within five years. However, while only a fairly small percentage of would-be PC sales will go to Internet appliances overall,

certain types of users will switch almost totally from PCs to appliances. Information consumers in an intranet-enabled corporation will find it difficult to justify using a PC. Instead, an increasing number of information consumers (tending to 100%) will use Internet appliances.

Many information consumers do not have any client device today and make do with printouts on request and/or traditional paper-based systems. Though appliances will capture this market, they will also make inroads into that of existing PC users. As we saw in Exhibit IV-3, around 9% of employees are currently using a PC to perform a single task. These tend to be information movers or information consumers. In recognition of the considerable inefficiency and cost wastage thus engendered, these users who are information movers will also switch from PC to Internet appliance.

Intranets are gathering momentum in corporations as the default network environment, and INPUT believes that by 2001, the breakdown of intranet access devices shown in Exhibit VI-5 will be very similar to the breakdown of all network access devices; i.e., most company networks will be intranets.

Applying that to the ratio of PC to Internet appliance shown above (with the assumption that nearly if not 100% of PCs in the corporation will be networked), we can draw the conclusion that the ratio is a near-accurate portrayal of all client devices in corporations. This means that in 2000, around 39% of all clients will be desktop PCs and around 31% will be Internet appliances.

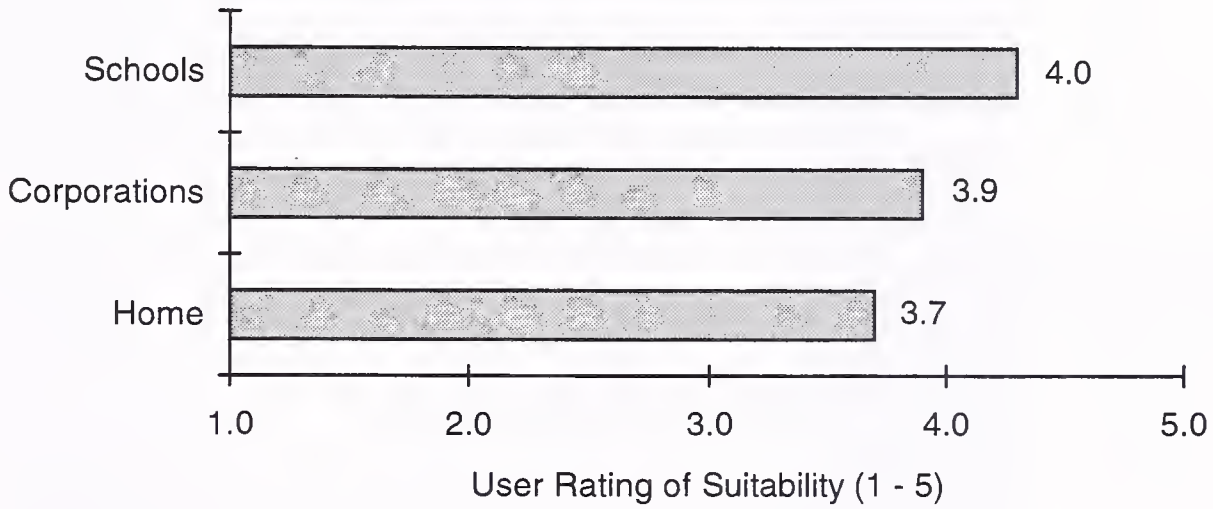
This may initially seem at odds with the claim above that only 20% of would-be PC sales will go to Internet appliances, but the increased share held by appliances is accounted for not only by PC-to-appliance migrants, but also by users who previously had no device at all. Those users will account for 75-80% of appliance users.

D
Internet Appliance Market Segmentation

The initial opportunities for Internet appliance vendors include the corporate, school, and home markets (see Exhibit VI-6).

Exhibit VI-6

Suitability of Internet Appliances by Market



Source: INPUT

1. Schools

Schools are primarily concerned with cost, both purchase and support—they currently cannot afford to provide computers to all pupils, all classes, or even all departments. They frequently recycle PCs within the school to maximize the number of computers available, but this incurs problems of system and application software compatibility and the inadequate performance of older PCs running new software. ISPs are working with schools in certain countries to provide Internet access, but without enough devices to share among pupils, the benefit is reduced. Internet appliances would allow schools to provide many more devices and, due to the nature of diskless devices and Java Virtual Machines, would meet security requirements.

2. Corporations

Corporations, as discussed throughout this report, are interested in appliances in order to furnish all their employees with server access devices appropriate to each employee's role and to cut support costs. Markets for appliances include, for example, bank branch offices that need simple computers for Internet-based applications and enterprises with existing client/server applications such as order entry, sales support, and inventory control.

3. Home

The home market, though not the subject of this report, will account for the greatest number of Internet appliance purchases in the next five years. Most appliances for the home will not be computer-like devices with keyboard, screen, and mouse, but will be incorporated into telephones, game consoles, televisions, VCRs, and every other form of information-oriented consumer device. Eventually, other types of consumer appliances, such as cookers, washing machines, refrigerators, and heating and lighting systems, will be Internet-enabled and controllable remotely, although this is a much longer term trend. The bandwidth issue, which is the greatest obstacle to short-term take-up of home Internet appliances, will be resolved first in the U.S., with cable modems and campus (or 'neighborhood') shared networks.

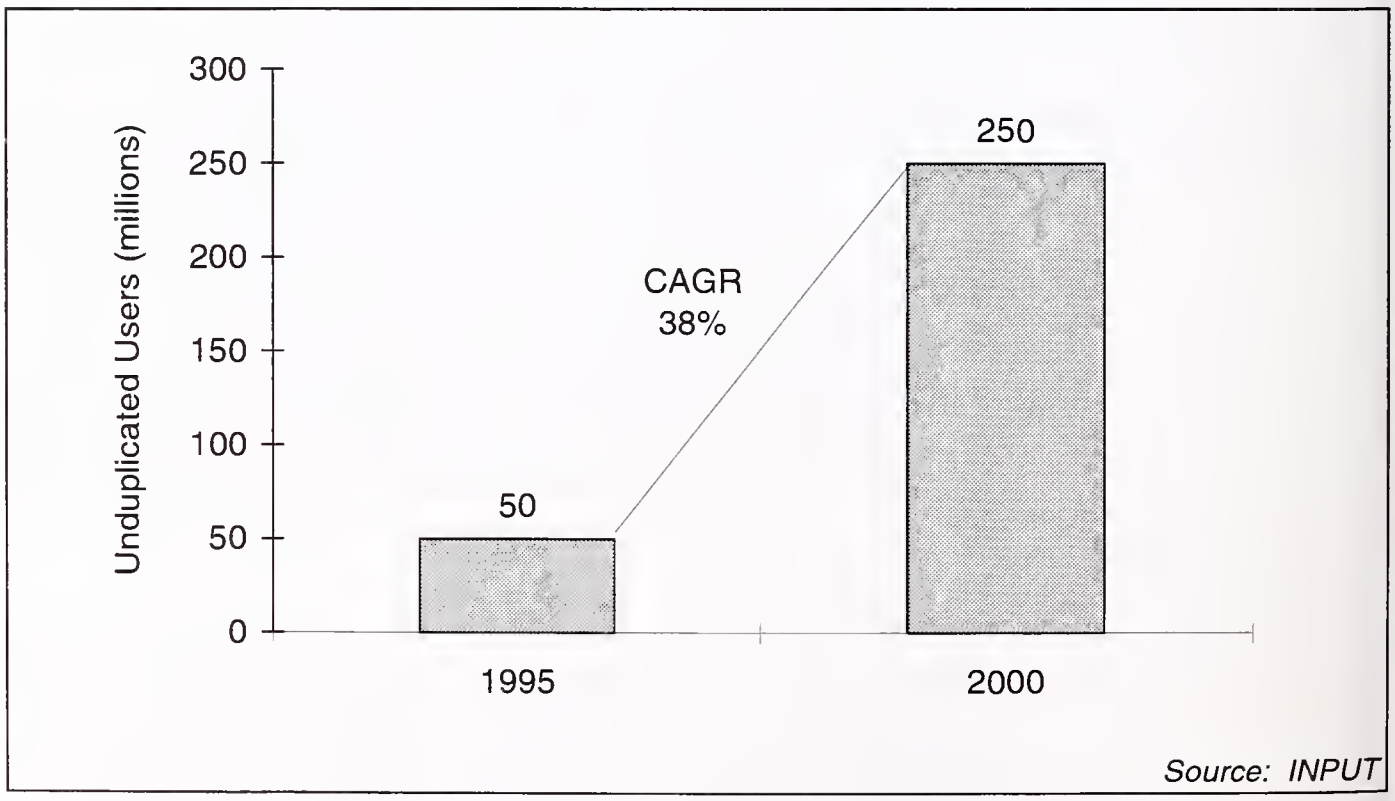
E
Forecast Assumptions

1. Number of Internet Users

Estimates of the Internet market size were created by estimating the number of unduplicated Internet users worldwide. The worldwide number of Internet users will grow at a CAGR of 38%, from 50 million in 1995 to 250 million in 2000 as shown in Exhibit VI-7.

Exhibit VI-7

Worldwide Number of Internet Users, 1995-2000



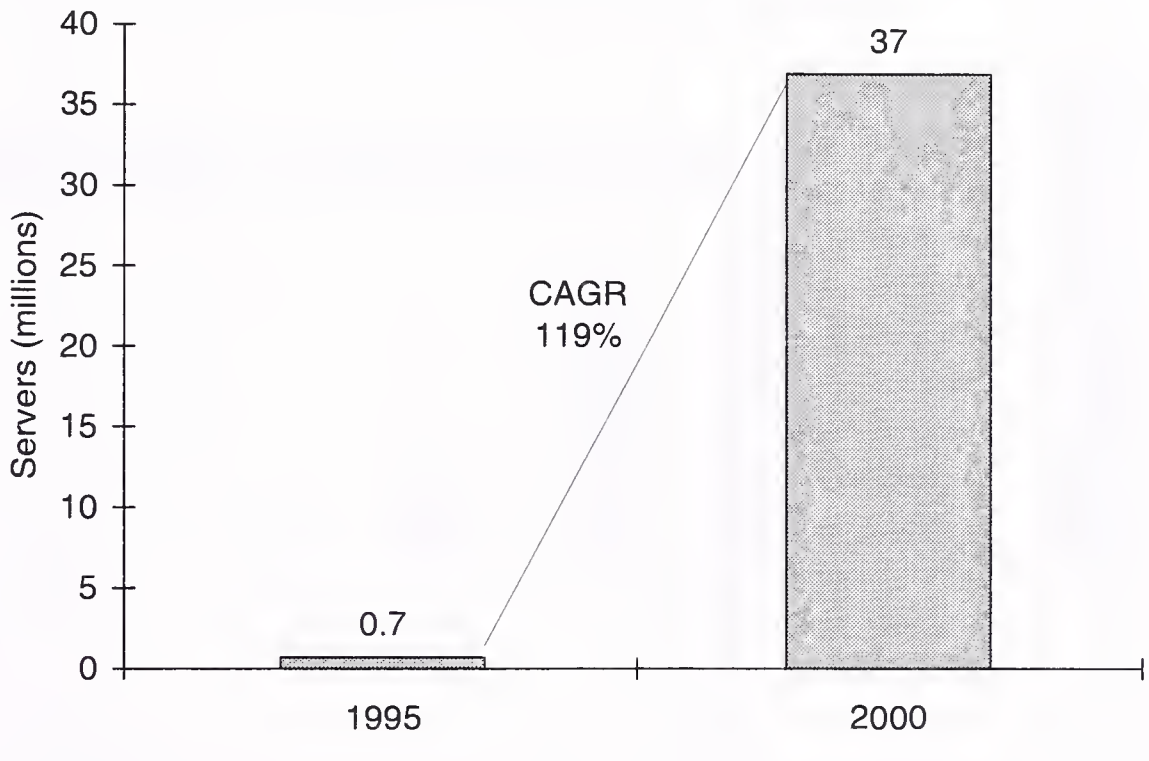
Source: INPUT

2. Number of Internet Servers

The worldwide number of Internet servers will grow at a CAGR of 119% from 742 thousand in 1995 to 37 million in 2000 as shown in Exhibit VI-8.

Exhibit VI-8

Number of Internet Servers Worldwide, 1995-2000



Source: INPUT

3. Measurements Used in This Forecast

INPUT forecasts user expenditures on software, hardware, and services. For some categories of Internet software and hardware, forecasts of the market size were made by determining software and hardware vendor revenues and marking up the prices paid by users according to distribution channels. For other categories of Internet products, data from INPUT's previous research in its Internet Opportunities, Client/Server, and Market Analysis Programs was used.

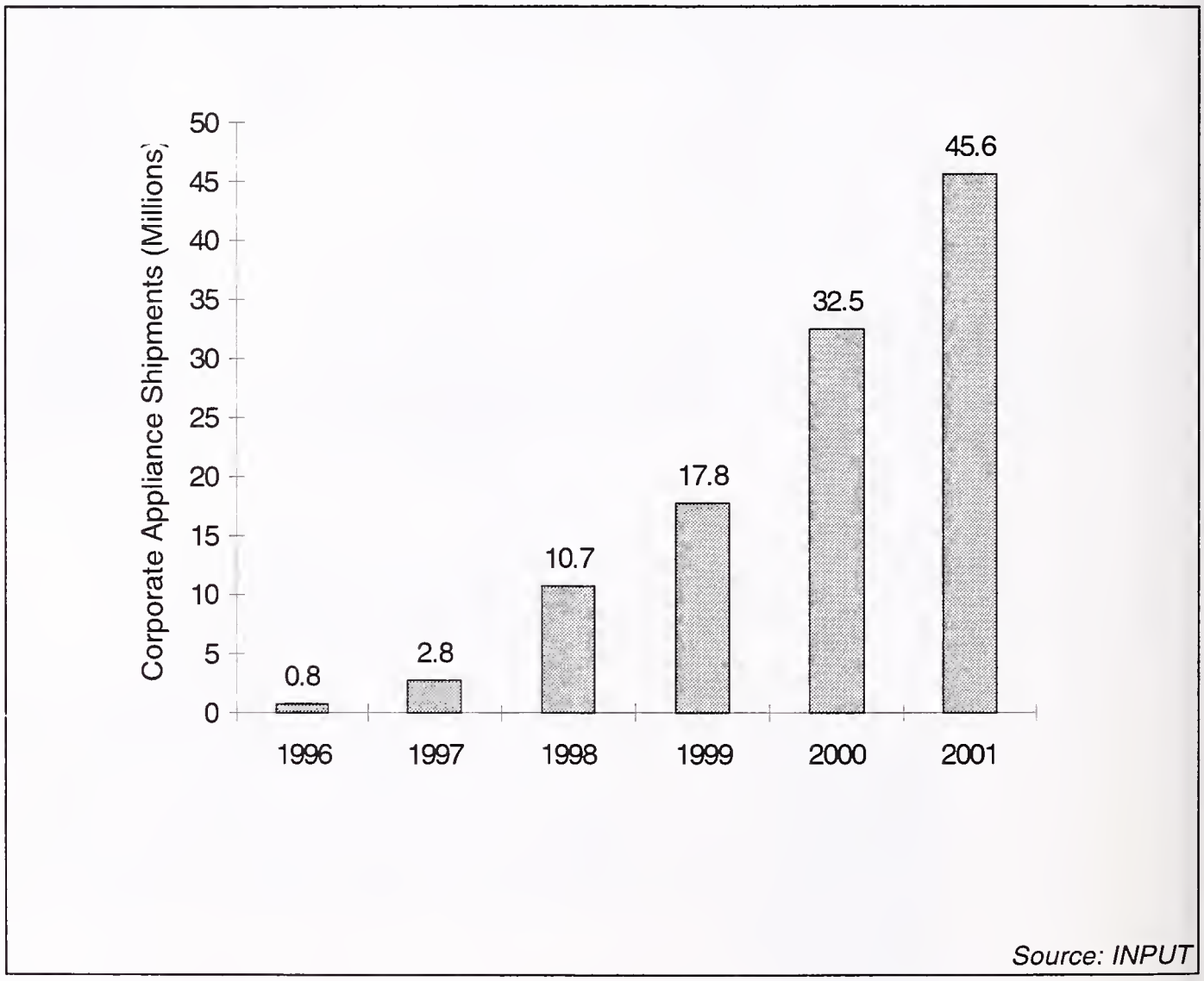
F
Worldwide Corporate Internet Appliance Market Forecasts

1. Appliance Shipments, 1996-2001

Shipments of Internet appliances to the corporate market worldwide (see Exhibit VI-9) will grow from 750 thousand in 1996 to 45.6 million in 2001, a CAGR of 127%.

Exhibit VI-9

Worldwide Corporate Internet Appliance Shipments, 1996-2001



Source: INPUT

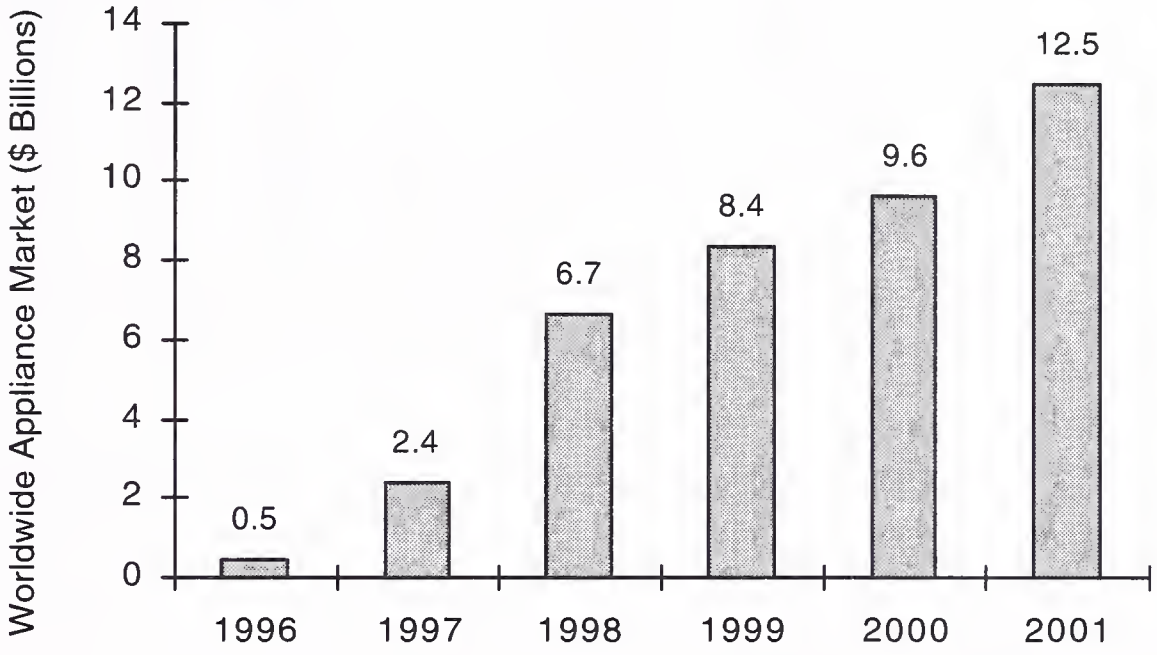
2. Appliance Market Value, 1996-2001

INPUT expects the average price of Internet appliances for corporations to decrease from $500 in 1996 to $350 in 2001. This takes into account volume discounts. The average price of early appliances is around $650 per unit, but this should be reduced to around $500 for bulk purchases. It is through sales of large numbers of appliances that vendors will be able to claim the often-quoted $500 price tag.

Based on the decreasing appliance unit price, the market value for Internet appliances will rise from $500 million in 1996 to $12.5 billion in 2001 (see Exhibit VI-10), a CAGR of 90%.

Exhibit VI-10

Worldwide Corporate Internet Appliance Market Value, 1996-2001

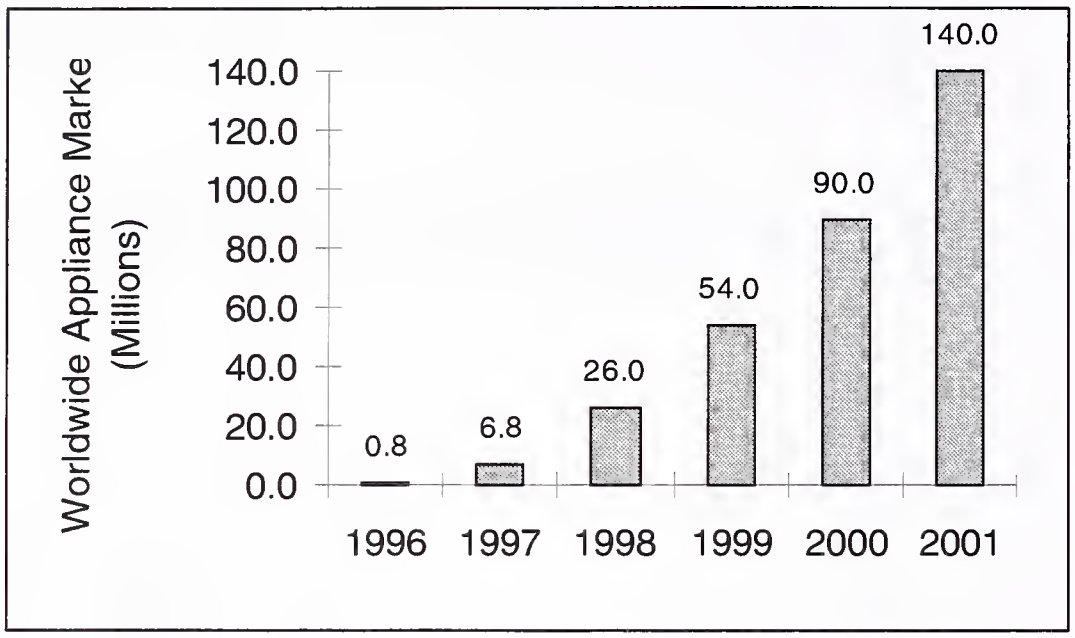


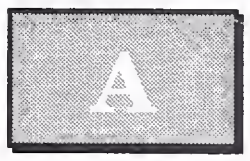
Source: INPUT

3. Appliance Installed Base, 1996-2001

Exhibit VI-11 shows the expected increase in appliance installed base worldwide, from 750 thousand in 1996 to 140 million in 2001, a CAGR of 181%.

Exhibit VI-11





Definitions

This chapter provides definitions of vocabulary used in the report.

Glossary

More definitions can be found in INPUT's *Definition of Terms*.

Agent	An agent is a set of instructions that can carry out tasks automatically. It is usually written in a high-level language script and may run across a network to send messages or find information.
API	Application programming interface —this provides specifications for programmers.
Applet	A small application that may be embedded in another application, for example Microsoft's MS Graph is a graph program used in the MS Excel spreadsheet and the MS Powerpoint presentation package.
Client	When used in client/server refers to the computer platform accessed by a user, such as a PC, workstation, portable, or Internet appliance.
Component	Component refers to a software component, a piece of software with documented interfaces that a programmer can use to build an application.
CORBA	Common Object Request Broker Architecture

Departmental server	A server priced as the minicomputers in INPUT's Definition of Terms. Examples are a high-end PC or an SMP UNIX server.
Development Environment	Set of software used by programmers for developing applications that typically consists of compilers, debuggers, visual editors, profilers and performance optimizers.
Development Tools	Short for "application development tools".
Distributed System	A system that runs across multiple computers.
Enterprise Server	A server priced as a mainframe in INPUT's Definition of Terms. Examples are an IBM-compatible mainframe or a large SMP server of comparable price. These machines are often clustered.
Firewalls	Hardware and/or software solutions that prevent data from entering or leaving a network. They are most commonly used to protect corporate LANs from the Internet. They protect what may leave a corporate network and also what may enter it.
Framework	A specification or implementation of software that can be used to build an application. It may consist of classes and methods. Motif and the Common Object Request Broker Architecture (CORBA) are examples of frameworks.
Gateway	Software that connects one environment to another. It often translates formats and routes code from one application to another.
GUI	Graphical User Interface – a windowing system such as Microsoft Windows or X-Windows with Motif that displays graphical objects on a display.
HTML	Hypertext markup language—a language for document formats; a dialect of SGML.

Http	High transport transmission protocol—a protocol to move information between a web server and a client on the internet.
Internet	A publicly available network based on TCP/IP protocols that supports electronic mail, web sites and other communications solutions.
Internet Appliance	The term used by INPUT to describe a client device that is used primarily to access the Internet/Intranet. These devices typically include hardware, a simple operating system, email and web browsing software.
Intranet	A private network that uses Internet technology, for example an internal TCP/IP network with browsers and web servers.
LAN	Local area network.
MacOS	The operating system for the Apple Macintosh.
Messaging	A general term that describes communication that stores and forwards information. It may also support queues of objects waiting for an event in a network. An example of messaging software is electronic mail or software that supports on-line information services.
Microkernel	An OS architecture in which the system is built around a core set of software known as the microkernel. The microkernel need not necessarily be small. The Mach kernel used by NeXT is an example of a microkernel-based OS, as is Apple's Copland.
Middleware	Middleware is connectivity software that links clients and servers. It is systems software. Further information can be found in INPUT's report, *Middleware: Is DCE the answer?* Some companies include databases and visual development tools as middleware; these are not included in INPUT's definition of middleware.

Online services	Services that provide users with on-line access to information, like America Online, CompuServe, Minitel, NiftyServe, Dialog, Lexis/Nexis.
OODBMS	Object-oriented database management system.
Open systems	In this report it describes systems that can run on multiple UNIX and/or Windows operating systems, rather than proprietary environments like VMS (even Open VMS) or MVS (even with POSIX compatibility).
OpenDoc	A component software standard managed by Component Integration Labs that was originally established by Apple, IBM and Novell.
Operating environment	Modern term for operating system plus its application development tools.
OS	Operating system.
PDA	Personal Digital Assistant—a handheld small computer with personal address lists, organizer information, etc. An example is Apple's Newton.
Platform	This is the software or hardware on which an application program runs.
Port	Verb as in *to port* or *porting*. To move software from one platform to another; for example if Windows NT is moved to run on Digital's Alpha-based computers it is ported to run on the Alpha environment.
Program	The term is meant to include a wide range of possible constructs including scripts, loadable modules, etc. in addition to the traditional definition of an application or utility.
Reseller	An individual or company that resells a product. They may or may not change the product to add value. See VAR.

ROM	Read only memory—used to store information that needs to be readily accessible in a computer. In an Internet appliance it may contain the entire OS.
SGML	Standard generalized markup language—a language defined by IBM and others for document formats, it is used by the government and manufacturing organizations as part of the CALS standards.
Suites	Sets of applications or packages. Office suites typically consist of a word processor, a spreadsheet and a database or electronic mail package.
Three-tier	A C/S architecture consisting of three logical parts of the system: a client, an application logic server and a data/information server. This may be distributed across three computers, or the application logic and data may reside on the same machine, but be logically separate. This model enables data sources and databases to be swapped in and out of the system more easily than in the two-tier model, where the data and application logic may both be stored in the same database.
Two-tier	A C/S architecture where there is client and server. Business logic either resides in the client portion of the application software or in the server.
URL	Universal Resource Locator—a string that describes an entity on the Internet. For example, "http://www.input.com" describes the URL for INPUT's web site.
VAR	Value-added reseller - a reseller that adds value to software or hardware by customizing it, adapting it for a specific market segment, integrating it, porting it to a new environment or adding software to it.
Videoconferencing	Communications between two sites in which each site sees and hears information from the other. The information may be captured from a computer screen or camera. It may use videoconferencing equipment or a camera on a PC. Communications

	may be via high speed phone lines or private networks.
Visual Development Tool	
	This is the software needed to build an application. It may include a visual editor, a forms designer, a report writer, a compiler, an interpreter, a debugger or a source code control system that enables programmers to share coding tasks.
WAN	Wide area network.
Web	The World Wide Web.
Windows	Used in this report to refer to Microsoft's Windows if it starts with a capital letter. If it starts with a small letter then it may refer to any software that controls the windows on a computer screen. A window may also be the window seen on a computer screen.
Workgroup	A networked group of computers or people that share information. Typical sizes range from a few individuals to about 100 people.
WWW	World Wide Web.