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Emerging Technologies Planning Guide

1993 Edition

November 1992

**U.S. Department of Energy
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DOE-Wide Project Support Branch

Partners in IRM Planning and Technology Implementation

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Analysts: Geno Zomparelli, Technology Assessment
Bill Remmert, Technology Assessment

Concurrence:
Donald G. Bradley, AD-251.4
DOE-Wide Project Support Branch

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For more information concerning this guide contact Donald G. Bradley,
DOE-Wide Project Support Branch, (202) 586-8227.

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Emerging Technologies Planning Guide

Executive Summary

Information system technology enhancements during the next five years are expected to provide some of the most significant individual and organizational work improvements ever made in the office environment. This guide is an aid to planning these technologies and assessing their roles in improving the effectiveness of Headquarters programs. Their implementation will cost-effectively support Departmental operations and the National Energy Strategy. At the heart of this process is an understanding of the relationship which exists between technology introduction and the planning, budgeting and acquisition process. The 1993 edition of this guide covers the 1993-1997 time frame.

Implementation of many of the emerging information systems technologies is a long process requiring an understanding of technology relationships and careful planning to insure the availability of required technologies at the appropriate time.

One of the key objectives of this document is to provide an understanding and description of how technologies, if planned for and properly applied, will lead to enhanced individual and organizational productivity improvements. We are entering an era in which the ability to achieve some mission objectives will be largely determined by a carefully structured sequence of technology introductions, each built on preceding ones. This requires planning to insure that no critical element is missed.

In this guide, key emerging technologies have been organized into eight sections with emphasis placed on functionality rather than technology. We do not see technology as an issue for its own sake, but as a critical element in supporting the ability of individuals and organizations to achieve greater performance. Many examples are included to assist readers in understanding the practical applications of specific technologies and their interrelationships.

In a few instances, program offices may not directly select or request a specific technology described in this guide. However, an understanding of the impact a technology has on the issues involved with planning will permit improved discussion with ITSO and, thereby, help insure that the technology base which is developed will meet the requirements of future program operations.

The coming information technology environment will be much more interconnected and complex than the largely stand-alone environment developed during the past decade. Networking and connectivity have rapidly become critical requirements. Many of the technologies being developed for the information systems architectures of the future will both serve and require this system of interconnections. Standards will be far more critical; and the interaction of hardware components and software systems will be necessary.

Accordingly, you are invited to review the 1993 edition of this document with a view to including appropriate emerging technologies in your organization's planning, budgeting and implementation process .

Introduction

The 1993 edition of this guide covers technologies which we believe will be critical to DOE program offices during the 1993-1997 time frame. It is organized into eight major sections. Most sections emphasize application functionality rather than specific technologies. The goal is for readers to understand the relationships between both the role which specific technologies will play in enhancing the performance and capabilities of organizations and the interrelationships between these technologies.

The ultimate goal, of course, is improved technology planning, budgeting and implementation strategies. As such, this is more than a technology guide. We believe, in a fundamental way, that information system technology can enhance the capability of both individuals and organizations to support the National Energy Strategy and public policy. The ever increasing reliance on information and the need to bring the power of information to bear on problem solving means that information systems performance becomes critical in the overall mission/performance equation. This guide provides one element for assisting the necessary planning to that end.

Concept

The approach is to relate, not only emerging technology directions, but more importantly, to put the pieces of the puzzle together to stimulate long-range thinking and planning concerning information system issues.

Planning Requirement

There is a simple critical fact associated with information systems technologies. They are becoming vastly more powerful and capable than those we have implemented over the past decade. However, this change comes with a price. They are also becoming much more complex and interrelated. This places a heavier burden not only on planning, but on long-range planning. The capabilities, which the emerging systems will deliver, will be powerful, indeed, but their successful implementation cannot be done rapidly or through a series of short-term actions. Users who fail to accomplish the required planning and budgeting may discover (later) that they are unable to assure short-term acquisition and implementation of critical information system components to help achieve desired individual or organizational improvements.

An example of this situation has occurred a number of times during 1992. Organizations have outlined specific project needs for which workgroup technology (see Section 4.0) is available and well-suited to handle the requirement. Nevertheless, these requirements could not be serviced because local area network systems are required and the planning and implementation for these capabilities had not been accomplished. In addition, graphical user interfaces

and advanced operating systems were also required and neither of these had been planned.

Methodology

The eight sections of the guide cover a series of inter-related topics. As noted above, establishment of relationships between elements of the technology infrastructure is critical. We have provided many examples of client capabilities which can be effectively achieved with specific combinations of technologies.

The guide covers a considerable amount of mildly technical information for many of the technology topics. To assist the user in identifying specific points regarding both key issues and planning strategies, two specific visual cues are utilized throughout the guide:

- The "key" symbol, shown here, is used to indicate that the text in the shaded box summarizes the relevant points of the section that follows. The key box tells the reader the central point of the section.
- The "planning guidelines" symbol, shown here, is placed at strategic locations in the document to highlight the important issues related to planning. The planning box summarizes the main points of the preceding section and relates these points to critical planning issues.

These symbols are like milestones in the document. They help the reader connect the technologies, which are described in more detail in the main body of text, with critical planning issues.

It is recognized that this guide will not be the only source of information for clients to evaluate technology in support of their information systems planning. The guide, however, is designed to heighten an understanding of the need for integrated technology planning.

A Word About The Information Systems Future

The technology base we outline has a fundamental direction. It is to support the desktop of the individual DOE employee. The capabilities and technologies which are planned and developed will affect each employee and, therefore, each organization. This presents both a set of unique and difficult challenges, as well as, a set of opportunities and potential rewards.

The challenge is to understand the mission requirements of both the individual and organization, while planning technologies to meet, as yet, unstated

operational needs. If this challenge is met successfully, the rewards of improving the capabilities of individuals and organizations to meet DOE's diverse missions can be gained.

We should not underestimate either the kinds of requirements which will be presented, nor the ability of clients to adapt to new technologies. We frequently look at the ways in which work is currently being accomplished and limit technology planning solely because it "just isn't something the user needs right now". We should not underestimate future requirements on the basis of today's activities.

Accordingly, let us examine some of the emerging technologies which will be central to the operation of DOE in the future.

1.0 Basic Technologies

End user desktop computers in the 1993-1997 time frame will process data at rates approaching mainframe power. Unlike mainframes, they will be easier to use with powerful new operating systems and graphical interfaces. These computers will be capable of performing many new types of functions and processing vastly expanded data types. Many of the new functional capabilities can only be performed with these new systems. This section highlights key emerging technologies that will be used to build the new desktop.

Advances in personal computer (PC) technology seem to follow a cause and effect pattern. As PCs advance, processors get faster, hard drives get larger, and the amount of memory considered minimum increases. Improvements in one PC technology can pull at another area to catch up. Let's look at some of the basic technology advances, in hardware and software, which are improving PCs, and some emerging tools that will soon be available.

1.1 The New Desktop Environment

A GUI (Graphic User Interface, pronounced "goeey"), utilized in Windows, OS/2 and the Macintosh, can help make the computer environment more intuitive and friendly to users. Pictures communicate complex concepts very quickly. GUI applications are easier to learn and use than DOS character based applications because they provide a greater level of visual feedback.

1.11 The Mouse Interface and Beyond

GUI software demands an interface tool that allows the user to move the cursor from one place directly to another. The GUI environment made the mouse the standard tool it is today. However, as some computers leave the desktop, other interface tools may replace the mouse.

Touch Screens let users move the cursor around by placing a finger on the screen. Touch screens will become more widely used with palm-top portable PCs. Before committing budget dollars to touch screens, determine if touch screen software will meet your requirements.

Trackballs have the ball facing up, like a mouse on its back. They clip on to the side of portable PCs, and can be used where a mouse would not be practical.

Pen-based Computer Interface: Pen-based applications are now being used with portable computers. Most pen applications are based on forms: fill in the box, check off items, and draw lines between items. Writing information into PCs will require better accuracy than is presently available. We expect it to be several years before pen-based PC writing is practical.

1.12 Object Linking and Embedding

Operating system level technologies are emerging which make it possible to link information from several source applications into a single file or to include pieces of information (objects) from one application into another. These applications provide users with new ways to group unlike types of data (graphic, text, picture, sound, voice, video etc.) from different sources into a single file.

Object Linking and Embedding (OLE) provides the user with an easy way to integrate more information. Let's summarize some of the terminology related to OLE.

Object: An *object* is information such as text, graphics, and charts created in one application and pasted into another. Objects point to the *application* that created them. Double clicking on an object will start the application that created it, and display the object's contents for modification.

Linking : When data is copied from one application and pasted into another, it is linked by pointers to the original data file. If the original source file data changes, all files that have a link to that data will be automatically updated.

Embedding is the process of inserting an object into a document. By double clicking on an object the content is displayed and the application that created it is started. When an object is embedded *and* linked, it will bring up the source application, and source document for editing. An embedded object may appear as a graphic icon or it may be a "snapshot" of the actual information.

Compound Documents contain a variety of data formats, e.g. text, graphics, voice, sound, etc. These are created using cut, copy, paste, insert and OLE commands. (See Section 5.1 for more detail.)

Business Audio will allow users to insert voice messages, music or other sound objects into documents, spreadsheets, drawings, and E-mail messages. A spreadsheet with a voice annotation may be indicated by a highlighted cell. Double clicking on the cell plays back the message. In 1993 and beyond, business audio will become common to the PC user.

Voice Recognition will become a standard PC tool after 1994. *Single word* voice recognition is available now. Through a microphone and software configuration, users can teach their PCs to respond to single word commands. *Continuous speech recognition* will allow users to *speak* to their PCs. However, continuous speech recognition is far more complex than single word recognition. We do not recommend speech recognition as a near term planning goal.

Multimedia is a term that includes several of the interface elements discussed above. It incorporates hardware and software that will allow users to integrate audio (sound, music, and voice), image, full-motion video, animation, graphics and text.

1.13 Desktop Operating Systems

No PC component is more critical than the operating system (OS). The fundamental capabilities of the computer to perform the tasks we seek to accomplish are largely controlled by the OS. This issue becomes even more critical as we move from the DOS OS to next generation systems which will control our computers and new types of tasks over the next several years. This section reviews some of the terms related to operating systems, and some of the products becoming available.

32-bit OS Support: CPU and bus manufacturers have produced hardware capable of moving data in word sizes of 32-bits. To take advantage of the 32-bit word size of 80386 chips and above, and 32-bit bus architectures, operating systems capable of moving data 32-bits at a time are required.

Pre-emptive Multitasking: This means that the operating system controls programs and processes by allocating *time* to processes as needed. Operating systems that can not *pre-emptively multitask* make programs periodically stop processing while another program is given a turn to process. Users of a pre-emptive multitasking system will obtain much smoother operations. For example, display of a video clip in a multi-media application while a file prints or a document communicates via modem could result in jerky video motion or a complete halt in non pre-emptive systems. However, pre-emptive systems will control the time allocated to each process, permitting continued smooth video action with sound while other processes take place.

Multithreading is similar to having five people look for your lost car keys instead of just one. Multithreading support means that a program can break a task into several subtasks and work on each subtask at the same time. This ability, for example, can be very useful in graphic intensive applications that produce large array calculations.

Virtual Memory Management: creates the illusion of having more memory in a system than is really present. Programs that require large amounts of memory benefit from *virtual memory management*. When the system doesn't have enough physical memory to hold a program or data, the virtual memory manager puts the overflow onto the hard drive.

Multiprocessor Systems: Putting more than one CPU in a system without an operating system able to apportion out the work load would be like adding more drivers to drive the same car at the same time. Multiprocessor systems must coordinate the use of memory, storage and input/output devices.

Portability provides the ability to create a program and run it on various hardware platforms. For example, a portable operating system can be installed on a RISC CPU based workstation and an 80486 based system. The second part of the portability test is that a program written for a portable operating system can run on different platforms (RISC or 80486).

Graphical User Interface: All emerging next generation operating systems, and the software written to run under them, utilize the GUI to give the user control over the computer and applications.

All future hardware at DOE Headquarters will contain 32-bit or higher processors. A next generation 32-bit operating system with at least the features outlined above is essential to effectively utilize the new hardware. More importantly, to permit users to accomplish their requirements, they will need these emerging capabilities.

1.14 Emerging Operating Systems Overview

The major desktop OS manufacturers are headed in the same direction. Multitasking, multithreading and 32-bit support are topping the list of features being offered. Let's look at how closely the graphical user interface operating systems being offered stack up against each other. Seldom will we need to choose an OS based on one feature alone. We will more likely choose an OS based on sets of features that are required to meet our mission goals. See Table 1-1 for an overview of emerging operating systems.

Planning Guidelines

- ✓ Begin the transition from DOS to a graphic user environment during 1993 and 1994.
- ✓ Budget to upgrade DOS software packages to OS/2 and/or Windows versions.
- ✓ Plan for necessary hardware upgrades.

Table 1-1. Emerging 32-bit Operating Systems

IBM OS/2 2.0	Microsoft Windows NT	SunSoft Inc. Solaris 2.0
Available now for 386/486 and future Intel architectures.	Not expected to be available until 1993.	Derived from well-proven technologies of UNIX.
Component of IBM SAA strategy, firmly established in IBM mainframe operations.	For 386/486 PCs, MIPS' R-Series, DEC Alpha-based RISC machines and possibly other RISC systems.	
Current release is a mixture of 16/32 bit code, specific to X86 processors.	Demonstrated portability between X86 and RISC architectures. Planned Alpha support may allow Windows NT to run on mainframes.	Promised for source-compatible implementation on 386/486 PCs.
No inherent security in file system. Security is currently left to client/server protocols, precluding secure peer-to-peer processing.	Expected to include NTFS, a file system providing intrinsic security and data-protection features. Also audit features sufficient to qualify for federal C2-level security certification.	CS security certified, compliant with POSIX, XPG3, SVID standards.
Planned multiprocessing capability.	Multiprocessing demonstrated on X86 multiprocessors.	Efficient multithreaded concurrence.

1.2 Emerging CPU Technologies

Emerging GUI environments have many advantages. However, to perform adequately, GUIs and their operating systems must have the right hardware. Computers need to retrieve data quickly, and perform complex calculations in order to display graphical information on the screen.

As the richness of a screen display increases, the time it takes to process the necessary information increases. Vendors are finding new ways to increase performance. This section highlights key CPU technologies.

The base level desktop technology at DOE Headquarters today is the Intel 486 processor. At their current price/performance point, plan to shift to these processors over the next 2 years. These computers and the next generation operating systems, GUIs and new applications will go hand-in-hand.

Approximately every two years there is a shift in the power of PC CPUs (Central Processing Unit). At key points in CPU technology, there are advancement leaps. For example, the 8088, 8086, and 80286 chips were 16-bit chips with a limit of addressing only 16MB of memory address space. The move from 16-bit chips to 32-bit chips,

like the 80386, and 80486 increased addressable memory space to 4GB. The next leap in CPU technology will be from 32-bit to 64-bit CPUs. Let's first review some of the 32-bit chips available today, and then look at the 64-bit chips that are emerging.

1.21 The 386 CPU

The 386 computer chip has not been completely eliminated, but it is outdated. Headquarters DOE no longer purchases desktop systems with this chip.

1.22 The 486 CPUs

The major advances of the 486 over the 386 is its speed, memory cache and math operations. The 486 chip can perform at a speed two to four times faster than a 386. Let's briefly review some of the chips in the 486 family.

The 80486DX is a 32-bit microprocessor. It will support all of the hardware and software purchased for use with the 80286 and 80386 PCs. Since the 80486DX CPU includes math coprocessor functions, it does not require the purchase of a separate math coprocessor.

The 80486DXL is a full 80486DX and includes support for Advanced Power Management (APM). To conserve power, APM decides when the CPU should slow down or speed up and when peripherals should turn off and on. It is used primarily in portable computers.

The 80486SX is an entry level 486. It is generally cheaper than the DX version since the math coprocessor features have been omitted. Headquarters DOE does not currently utilize this processor.

The 80486DX2: The 2 on the DX2 stands for Intel's new *speed-doubling* or *clock-doubling* technology. Benchmark tests have shown a 35% performance increase by doubling the speed of instructions processed within the CPU. Plan to request systems with this processor when faster performance requirements are identified.

1.23 The 586 Chip Technology and Beyond

We will bring new power to our desktops as new technology breakthroughs occur in the computer world. PCs require more CPU power to effectively process the new types of data which will be needed to meet the advancing functional requirements of users. These include graphical user interfaces, sound, voice, video, animation, pictures and rich text. Let's look at some of the emerging chips.

The Intel Pentium (586) is expected to be released early in 1993. The Pentium will be a full RISC (Reduced Instruction Set Computing) processor while maintaining 80386/80486 compatibility. It will have a 64-bit data path (2x32-bit words at once), 8K bytes of data cache, 8K bytes of instruction cache, and perform math operations at four to seven times that of a 50MHz 80486DX. This processor is expected to fully handle all of the emerging data types.

The Alpha chip by DEC (Digital Equipment Corporation) may be one of the most important chips in 1993 and beyond. The first Alpha is a 64-bit RISC based chip that will run at 200MHz, processes at a rate of 400 million instructions per second (Mips), and perform over 150 million math operations per second. The Alpha has roughly the power of a Cray-1 super computer on a single chip. The Alpha chip has received great interest in the computer industry. Microsoft will produce an Alpha based version of Windows NT (which is one candidate to become DOE's next generation operating system).

Planning Guidelines

- ✓ The 80486DX is currently the standard processor for Headquarters DOE desktop systems for purchase and installation during 1992 and 1993. Plan to install new or replacement systems containing this chip.
- ✓ Consider network servers or other requirements for Pentium or Alpha based computers during 1993 and 1994.

A Glimpse of the Future:

- ✓ Intel is planning to add video circuitry onto the microprocessor in order to increase display speeds.
- ✓ Intel is already preparing the P6 and P7 chips. They plan to have a 250MHz 2BIPS (billion instructions per second) CPU by the year 2000.

1.3 Bus Technologies

Traffic can cause delays for cars and PCs. When greater traffic levels are predicted, planners prepare for wider highways. PCs have highways for data called buses.

In the next few years, user functionality requirements will mandate faster buses. Traffic levels will dramatically increase on PC buses because of data intensive activity such as sound, video, animation, and high resolution monitors.

If fast PC buses are not planned and implemented, some required functions such as imaging and video may not be possible and user frustration may increase because of system slow downs.

Within a PC, data travels on electronic pathways called buses. Slow bus throughput rates will diminish the performance of even the fastest CPU. Let's look at some of the issues related to bus technology.

A PC's CPU and main system memory have a direct path between them called the *local bus*. Another path, the *expansion bus* (mother board) provides a path for all add-on devices such as disk drive controller cards, internal modems, network cards, video cards, scanners, pointing devices, and so on.

The PC market has supported three expansion bus standards.

- ISA (Industry Standard Architecture)
- MCA (Micro Channel Architecture)
- EISA (Enhanced Industry Standard Architecture)

For several years, the ISA bus has served the majority of PC users well. However, in the very near future, end user requirements will begin to push the throughput limits of the ISA bus. Throughput will be effected by faster hard drives, input devices such as scanners, LAN applications such as client/server systems, and anything that demands massive transfers of data.

In evaluating bus standards, we'll look at throughput. To illustrate the effects of bus throughput on system performance, we'll look at the data flow requirements of video for comparison purposes (also, see section 1.4 below). Data transfer to/from hard drives and LANs is also restricted by bus capability. Table 1-2 shows the data transfer rates of the different bus technologies.

1.31 The ISA Bus

X Headquarters DOE no longer purchases systems with the ISA bus. You should not plan to utilize this bus.

1.32 The MCA Bus

MCA performance rates match those of the EISA. IBM is also promising a faster bus speed for MCA. The following points summarize the performance of MCA.

- ✓ Meets VGA throughput demands
- ✓ Meets Super VGA throughput demands
- X Falls short of Motion Video throughput demands above VGA level resolutions.

Note: The majority of the IBM PS/2s used at DOE Headquarters have the MCA bus, but this may be of little consequence since the CPUs are primarily outdated 80286 processors.

1.33 The EISA Bus

EISA throughput rates will easily support VGA and Super VGA requirements. However, even the EISA bus will fall short when full motion video or animation becomes a requirement. PC manufacturers are discussing a new Fast EISA that may meet throughput requirements. The following points summarize the performance of EISA.

- ✓ Meets VGA throughput demands
- ✓ Meets Super VGA throughput demands
- X Falls short of Motion Video throughput demands when screen resolutions go above VGA.

Note: HQ 486 system purchases include the EISA bus.

1.34 Local Bus

The data path or bus between the PC's CPU (Central Processing Unit) and its main memory is called the *Local Bus*. The local bus acts as a private line (32-bit data path on 386 computers and up) connecting the CPU to other components. When video circuitry is removed from the expansion bus to the local bus, there is a four to eightfold performance improvement. The use of local bus technology is emerging quickly.

Table 1-2. Bus Throughput Capabilities

Bus Type	Bus Data Path Size	Supports Bus Mastering	Maximum Theoretical Data Transfer Rate
ISA	16-bit	1 device	4 to 8 MB/second
EISA	32-bit	6 devices	32 to 33 MB/second
Fast EISA (Future)	32-bit	Yes, number TBD	133 MB/second
MCA	32-bit	15 devices	20 to 40MB/second
Fast MCA (Future)	32-bit	Yes, number TBD	160 MB/second
Local Bus	32-bit	TBD	At 33MHz CPU speed 66 to 120 MB/second

Whether local bus is a more permanent solution for faster bus technology or whether some, as yet unidentified, bus technology will be developed is not clear. However, it is clear that data must be made to move faster through the critical elements of a PC system and the ISA bus is not capable of meeting required performance levels. When considering local bus as a solution, it is important to know that there are two current problems.

X Old systems that don't have local bus circuitry can't be retrofitted to use local bus add-on devices like local bus video.

X Standards for local bus devices have not been fully developed, though some are emerging.

One of the first devices to take advantage of local bus is video. Video circuitry put on the local bus dramatically speeds up video performance. Other devices that need to quickly transfer large amounts of data also become local bus candidates: hard disk drives, SCSI devices, and Network Interface Cards (NICs).

1.35 Bus Mastering

Bus mastered devices have processors and controller chips on the board to manage data flow. Bus mastered devices such as disk drives can run much faster, since the main CPU does not need to continually send control instructions through the expansion bus. For example, the main CPU issues an instruction to retrieve a large image or graphics file. After a bus mastered disk drive controller receives an instruction to retrieve data, control is taken over locally and the main CPU is free to work on another task.

Consider bus mastering devices when planning for systems that require fast throughput, such as, client/server, CD-ROM, and image systems.

Note: EISA and MCA expansion buses provide full support for bus mastering.

1.4 Monitor Sizes and Performance

The graphical user interface (GUI) supports applications which display rich text, graphics, and video. This permits the display of information on the screen in ways similar to or better than in materials which are familiar in everyday use such as, books, memos, reports, newspapers, magazines, etc. However, in order for this type of display to be visually effective, the screen must be sharp, clear and easily readable. Fonts come in many point sizes and with many effects. Continuous on-screen viewing of difficult to read material not only creates an unpleasant experience, but may lead to eyestrain or other health hazards. This means the choice of video components when using a GUI is critically important.

As screen resolution levels increase, monitor sizes should increase. At 800x600 resolution, 60 percent more information is displayed on the screen than VGA's 640x480. However, a resolution of 800x600 on a 14-inch screen will produce characters about 20 percent smaller than VGA, and 1024x768 resolution will produce characters 37 percent smaller. Larger monitors will compensate for the character reduction caused by higher resolutions. Large monitors also provide a much greater area for display of information, making it easier to work with documents, spreadsheets, pictures, data bases and other information. Table 1-3 below shows resolution and screen size suggestions that will produce similar screen character sizes.

Table 1-3. Suggested Screen Sizes		
Standard	Resolution Level	Monitor Size
VGA	640 x 480	14 inch
Super VGA	800 x 600	15 to 17 inch*
Super/Enhanced VGA	1024 x 768	17 to 19 inch*
*Note: Larger size is recommended for prolonged use.		

1.41 Video Performance Boosters

Video Accelerators and Coprocessor Boards

Super/Enhanced VGA screen resolution of 1024 x 768 is becoming a standard for Windows and OS/2 2.0 users. However, the throughput requirements of Super VGA are near the maximum capability of the ISA buses being used in many PCs. Video accelerator and video coprocessor boards are two emerging ways to boost screen performance. These boards are especially effective when placed on a local bus (see 1.34 above).

Video Accelerator boards address the throughput problem by reducing the amount of data transmitted on the bus to re-draw a screen.

Video Coprocessor boards perform the same function as video accelerators. However, the processor on a video coprocessor board is a full CPU processor, and has the greater flexibility of being programmed through software.

1.5 Multiple Processors

Multiprocessor systems will produce a new level of performance as computers use more than one CPU to work either on a single task broken into portions, or on several tasks at the same time. The majority of users will not require multiprocessor power at their desktops.

However, data collection processes, real time systems, and network or client servers will almost certainly benefit from multiprocessor implementations.

Asymmetrical multi-processing systems are beginning to emerge. Units tying numerous 486 chips together have been developed. The DEC Alpha and Intel Pentium (586) chip will also be utilized in this manner. The key, however, is the use of operating systems which support multi-processing. During the 1993-1994 time period OS/2, Windows NT and Novell are expected to provide such support.

Planning Guidelines

Present work tasks may not require the throughput capabilities that are being provided through the emerging technologies. However, requirements to support sound, voice, video and higher screen resolutions will demand faster systems.

- ✓ Plan to implement faster buses in order to prevent work delays caused by higher data traffic levels.
- ✓ Throughput demands will require the performance of a 32-bit bus i.e. EISA, MCA or Local bus.
- ✓ During 1993, plan for either the EISA or MCA bus architecture in all installations.
- ✓ Adding bus and CPU plane together should result in 80486DX CPUs on a EISA or MCA and possibly include Local bus.
- ✓ Improved video is essential to utilize a Graphical User Interface (GUI).

1.6 Communications

We enter data into a computer to store it for later use, and to process it into usable information and knowledge.

Information must be available when and where we need it, or it is useless.

This section will focus on devices which we utilize for entering information into computers, storing it, transmitting it, and printing it.

In the 1993-1995 time frame, PCs that do not have a LAN connection or modem will be the exception. LAN connections at DOE Headquarters are projected to triple over this time frame. Further, locations that do not have available LAN access or need to dial to remote sites and services will make use of modems. This section will aid in planning for communications requirements (see also sections 2.0 & 3.0).

1.61 Network Interface Cards (NIC)

Throughput is a critical issue when planning to implement technologies such as image systems, client/server architectures, complex compound documents, network multi-media and groupware systems. To assure good performance of these systems, plan to use faster LAN cards as the amount of data being sent and received increases. LAN card throughput rates increase as the word size gets larger (see Table 1-4 below).

Table 1-4. Network Interface Card Examples

Card Names	Compatible System	Word Size
3com Etherlink II 3c503	IBM PS/2 models 25 & 30, PCs, XTs, ATs and up	8 bit
3com Etherlink 16 3c507	PC ATs and higher (ISA or EISA buses)	16 bit
3com Ethernet MC	IBM Micro Channel models 50 and up	32 bit
Novell EISA 3200a	EISA bus based systems	32 bit

1.62 Modems

Modem prices have declined sharply in the last year and features that previously could only be found in expensive modems are now available in inexpensive modems. For example, modems and FAX cards are now being joined providing the ability to send and receive FAX messages, as well as normal data.

Modem speeds will become an issue in much the same way as LAN cards, as throughput requirements increase when connecting to graphical applications or transmitting large amounts of data. There are three areas to consider when planning for modems: Signaling Speed, Data Compression, and Error Control.

Modem Signaling Speed Standards

Data transmission speeds of 9,600bps and FAX transmission of 14,400 are emerging as current standards. These provide adequate speeds for many connections to external and internal data sources.

Modem Data Compression Standards

Increasing data compression increases throughput at any given transmission speed. A proprietary standard MNP-5, and international standard V.42bis, provide significant compression and should be the basis for modem acquisitions.

Modem Error Control Standards

Error control increases the accuracy of transmissions and decreases "line drops," "bad lines" and other communication weaknesses. Plan MNP levels 4-10 and/or V.42 standards for error handling.

Lower priced modems may run at 2,400 bit-per second (bps), and offer V.22bis signal modulation with V.42bis compression and V.42 error control.

Higher end modems will have a faster bps rate and use MNP-5 data compression for a 40% throughput increase, and use MNP-4 error control.

1.7 Scanners

Scanners are emerging as one of the greatest time and work savers in the office of tomorrow. Optical character recognition (OCR) software makes it possible to scan text directly into word-processing files, spreadsheets, and database programs. Graphic images and pictures can be added to documents and edited. The table below reviews three scanner categories and their suggested uses.

Table 1-5. Scanner Categories

Type	Black & White	Gray Scale	Color
Handheld Scanner	Spot graphics, line art & logos. Light OCR, Dithered halftones.	Spot graphics, true halftones, B & W photos, light OCR.	Limited color spot graphics, preliminary art, video graphics, light OCR.
Sheet-Fed Scanner	OCR level depends on feeder capacity, sheets only, line art.	Full-page halftones, sheets only, OCR, B & W material.	Full-color graphics, sheets only, OCR, gray scale and B & W material.
Flatbed Scanner	OCR, bound material, precise line art, blueprints, circuit diagrams.	Precise full page halftones, bound materials, OCR, B & W artwork.	Precise full-color graphics, bound material, OCR, color photos, gray-scale and B & W materials.

- Use Hand Held scanners for spot graphics and light OCR tasks.
- Use Sheet-Fed scanners when large volumes of data documents need to be scanned.
- Use Flatbed scanners when input will come from mixed formats, such as bound materials, photos, drawings etc.
- DPI Levels: Scan resolution is measured in dots per inch (dpi). The higher the scanning resolution, the larger the resulting file. Keep the dpi levels down to 100dpi for simple line drawing, and raise dpi levels to 300dpi for most OCR work. Raise the dpi to 400dpi for images to be printed on a photo imagesetter.

1.8 Laser Printers

Laser printers are currently the most effective printing technology and this is expected to remain so for the next 3-5 years. They are fast, inexpensive, provide high quality, fit well in the office environment, handle a wide variety of information forms, and are highly reliable.

The most significant technology break-throughs in the near term for these devices will be increased resolution levels of 600 x 600dpi, or higher, becoming the near-term standard. In addition, 1994 and beyond will see print speeds to levels greater than 20ppm. This will create the conditions to marry the laser printer and copier, especially in networkable devices.

In the laser printer family there are four elements that are included in the more popular printers: Canon engines, RISC processors, Postscript support, and Hewlett-Packard (HP) emulation.

- RISC processors like the Intel 25MHz 80960 RISC microprocessor can often be found in fast laser printers.
- Canon engines can be found in a majority of laser printers. Much of the Canon's popularity is due to its cartridge design with the toner and drum joined together in the same cartridge.
- Postscript font and graphics support will still be important even with the growth of Microsoft's TrueType. You will still want memory resident fonts for non-Windows applications, and Postscript provides 35 internal fonts and superior graphics output. Postscript upgrades for older printers are widely available. You should also have 2MB of memory in a Postscript printer for small documents, and 4MB or more for printing large or graphics intensive documents.
- HP emulation opens the door to a wide variety of application support.

1.81 Color Printing

The price of color printing has kept color out of reach for the majority of users. Prices have steadily declined over the last few years, and plain paper color printers will continue to help prices come down. The following is an overview of the four major color printer technologies.

Wax Transfer printers excel at producing overhead transparencies, and can print large sizes. Since wax transfer printers require special paper, they can be very costly.

Ink Jet printers spray the ink onto the page, and early models tended to result in a blurred image if plain paper was used. Ink jet technology has improved to the point that special paper is no longer needed. Since they use plain paper, the lower cost of using an ink jet makes them a good candidate for becoming departmental or network printers.

Solid Ink printers are new on the market. Solid ink printers use plain paper and can easily mix plain text and color sections on the same page. Like the ink jet, solid ink printers don't produce transparencies as sharp as wax transfer printers.

Dye sublimation printers, also called Dye sub, have existed for several years. Unlike other printing methods, dye sub printing produces continuous tones that show no dot patterns for truly photo-realistic output.

Planning Guidelines

Communications

- ✓ When faster throughputs are required, use NICs with larger word sizes.
- ✓ Look for modems with FAX support software that can run under Windows or OS/2.

Printers

- ✓ Networkable color printers will greatly extend the reach of color printing to users. Consider implementing at least one color printer on each LAN.
- ✓ Expect to implement color printing capability by late 1993.

Scanners

- ✓ Plan to implement at least one scanner on each LAN. Users will be able to scan materials and store the large output files on network drives.

1.9 Data Storage and Retrieval Methods

Data storage and retrieval systems have become cheaper, faster, and smaller over the past ten years. There are several storage device options available to users. This section reviews some of the emerging technologies we can use to store and retrieve data.

The next generation of operating systems, applications, and data size requirements are making a large impact on data storage needs. Hard drive sizes continuously grow, and yet the program and data file sizes used in GUIs and applications quickly fill up available storage space. Storage requirements of 200MB or more appear minimal when considering the amount of space required for emerging operating systems, graphical applications and the space required to store data such as graphics, images, sound, video and text. (See Section 6.54 for more detail)

The tools in the GUI environment are powerful, but they produce large files! The storage requirements for the GUI environment will cause users to quickly outgrow existing internal drives. Over time, expandable storage methods that provide removable or remote media will become a standard workstation requirement. Furthermore, workstations are not islands with data stored only on the hard drive. We need to send data to others. Can we e-mail a 67.5MB video file, or a 20MB graphics page-layout and store it on the LAN or a receiving computer storage device?

Flash memory or non-volatile, rewritable memory is a fast growing technology originally developed for portable computers. The Personal Computer Memory Card International Association (PCMCIA) originally defined the PCMCIA bus card and slot standard for adding memory to notebook/portable computers. Memory cards the size of credit cards fit into PCMCIA slots and provide the system with memory that retains data even when the card is unplugged. PCMCIA memory is unique in that it will store data like a hard drive, and it can be used as RAM memory to run programs. Since Flash memory is less power hungry, weighs less, and is more durable than a hard drive, it may become the storage method of choice for Notebook, Pen, and Palmtop PCs.

Micro Disks are very small hard disk drives. Last year's micro disk drives that used 30 chips and were 1.8 inches high are being replaced this year by 1.3 inch disk drives that use only seven chips. Smaller drives with fewer chips are lighter and use less power. Micro disks win over

PCMCIA in one category: price. Disks are still cheaper than PCMCIA Flash memory. During 1993-1995 we will see competition between PCMCIA Flash memory and Micro Disks.

Note: Hard disk manufacturers have also entered the PCMCIA market by producing micro disks that plug into PCMCIA slots.

Magneto-Optical (MO) drives join laser and magnetic technologies to make the highest capacity and cheapest storage cost per gigabyte. A laser is used to read data and a laser/magnetic head combination performs a write to the removable cartridge. MO drive technology has existed for several years but it has been expensive and half as fast as a hard drive. However, prices have been steadily declining, and access times are very close to hard drive speeds (19ms versus 13ms respectively).

Floptical Drives have existed for several years but still have not become a major market item. However, Floptical drive popularity is growing and they may become the replacement for the current 3.5 floppy drives we have in our systems today. The Floptical drive can read and write to 720K and 1.44MB floppies, and to its own 21MB Floptical disks. Floptical disks look just like 1.44MB disks but come from the manufacturer with an added optical track. Floptical drives are three times faster than a 1.44MB floppy drive, but they are currently not fast enough to replace hard drives.

Very High Density Floppy Drives or VHDF drives look like a standard 3 inch disk drive. Using a special technique, up to 21MB can be written and read on a 3 inch diskette. The drawback with these drives is their inability to read lower level diskette formats such as 720K, 1.44MB, or 2.88MB disks. These drives may be useful for backups or file exchanges with other VHDF drive users.

Planning Guidelines

Over time, expandable storage methods that provide removable or remote media will become a standard workstation requirement.

- ✓ **Plan to implement at least 200MB or more of data storage for workstations that will use sound, voice, video, or animation.**
- ✓ **Coordinate planning with network support staff to use networked storage.**

2.0 Telecommunications

Information delivery is the next critical challenge for information systems planners. Nearly every technology we plan through 1998 must be related to information delivery capability.

A major goal of the emerging information system is to deliver large quantities of both new and existing data and information types to the individual desktop. This not only empowers the individual, but enhances the ability of the organization to accomplish new types of tasks and vastly improve existing operations.

Central to achieving this goal are the telecommunications technologies which will be utilized. Perhaps no technology outlined in this guide requires greater planning to insure its availability, yet it may be that none is less well understood. Speed, bandwidth, protocols, standards and other requirements are critical elements to support many of the other emerging information system technologies.

This section is included in the guide, not because each organization must plan for and implement a telecommunications strategy, but as a foundation for understanding the need to work with ITSO and other organizations to insure that the future telecommunications infrastructure at Headquarters (and links to field organizations) will support functional requirements (expressed through technology planning) which you will implement over the next 5 years. Simply put, if the telecommunications structure does not support your emerging functional requirements, there will be little chance for you to adequately support your organization's information system needs.

Rapid technological innovation is driving a revolution in the telecommunications industry. Wireless communications are eliminating the need for cable connections. Neighborhood antennas and cordless telephones are allowing users to carry phones wherever they go. Digital Signal Processors (DSPs) are affecting the voice processing industry in the same way microprocessors changed the computer industry. Fiber optics cables are providing increasing speed and capacity—making it possible to easily transmit new types of data, such as video and multimedia.

Increasing demands for group interaction and DOE-wide connectivity have contributed to the growth in networking requirements at Headquarters. Users want to be able to exchange ideas and information with their peers, regardless of whether they are located in the next office or in the next city. They also want to be able to access remote information quickly, from their desktop workstations. In this section we will describe some of the most important advances in telecommunications and the impact these innovations will have on the quality and speed of local and wide area network connections at Headquarters. We also describe some of the latest innovations in telephone and video conferencing.

2.1 Data Communication Speeds and Signal Delay

Among the most critical issues in telecommunications are *SPEED* and *signal delay*. We want to be able to send more information at faster speeds. Speed is measured in bits per second, or bps, for digital communications, and Hertz (Hz) for analog (i.e., telephone) communications, while delay is measured in milliseconds. Today, many networks operate at ten million bits per second (10Mbps), but many organizations are starting to specify requirements for client/server, multimedia and imaging applications, which require even faster speeds.

Data is transmitted over a medium called the communications channel. This medium can be twisted-pair wire cable, coaxial cable, or fiber optic cable. Transmission rate refers to how much and how fast information flows through a communications channel. This rate is referred to as the *bandwidth* of the channel. In the future, with data networks, private microwave channels, communication satellites, and optical fibers, a wide variety of channel speeds will be used. Channel speeds will have the most noticeable impact on the performance of networks and network applications.

Table 2-1. Summary of Data Communication Speeds		
Application	Speeds (bps)	Examples
640 x 480 VGA Display Screen	19,200 screen refresh rate	The human eye can absorb 100 million bits per second; 1 million bits per second are required for intelligible images.
Browsing or searching on-line information services	2,400 - 19,200	Humans can absorb information coming in at 4800 to 9600 bps, but they normally respond at 150 bps.
Word processing, text editing	19,200 or more	Humans scan about 250 characters per second.
Telephone channels	9,600 - 14,400	Error correction is needed to compensate for noise.
High-speed printers	20,000 - 50,000	Some laser printers operate at 20,000 lines per minute.
Digital voice channels	56,000	A typical typewritten page can be transmitted in 4 seconds.
High-fidelity sound channel	320,000 - 640,000	Complex digital encoding can reduce the number of bits.
Capacity of a twisted-wire pair	6.312 million	A T1 carrier sends 1.544 million bits per second over wire pairs; a T2 carrier transmits 6.312 Mbps.
Copper Distributed Data Interface	100 million	CDDI is an emerging standard for boosting the capacity of the copper wire pair with repeaters placed at most 400 feet apart.
Fiber Distributed Data Interface	100 million	FDDI is a standard for transmitting over fiber optic cable operating over distances of 62 miles with nodes no more than 7500 feet apart.
Television signals	92.5 million	The ultimate requirement for visual transmission is 50 MHz.
High-speed digital channels	274 million - 1 billion +	The T4 carrier and LD4 coaxial cable transmit 274 Mbps; WT4 waveguide transmits 16 billion bits per second; communications satellites have total throughputs of billions of bits per second; a single optical fiber can carry 1 billion bits per second; hundreds of optical fibers are in a single cable.

2.2 Ranges of Channel Speeds

The range of speeds attainable on a given communications channel will determine the amount and kinds of information that can be sent on that channel. Some of the capabilities of a particular channel relate to such requirements as the need to make a telephone call sound intelligible; some relate to machine needs, such as the maximum speed of printers and display screens; and some relate to channel properties, such as the maximum capacity of a wire pair. These ranges are summarized in Table 2-1 above.

Commonly used high-speed computer printers operate at nearly 1100 lines per minute, which is approximately 20,000 bps. Many line printers now run at 2000 lines per minute, and xerographic laser printers run at speeds in excess of 20,000 lines per minute (400,000 bps). High resolution graphics workstation displays processing images or multimedia information can require from 1Mbps to more than 10Mbps. Telecommunications channels must operate at these capacities to interconnect users through LANs and operate these types of computing equipment. LAN interconnections typically operate at 56Kbps to T1 levels of 1.5Mbps.

Most digital voice channels use pulse-code modulation (PCM) techniques to transmit 56Kbps.

PCM transmission will be nearly universal in the future. Using these channels, a typical typewritten page can be transmitted, in digitized facsimile form, in about 4 seconds. This is a practical speed for interactive information retrieval and electronic mail systems.

The AT&T T1 carrier sends 1.544Mbps over wire pairs. These can be used to transmit 24 telephone conversations simultaneously. The T1 carrier is also commonly used for data transmission, LAN interconnections and video conferencing by many large organizations, including the Department of Energy. High bit rates are appropriate for communication between computers in distributed processing applications for transmission of large quantities of data from one location to another.

Even higher bit rates can be sent over a twisted-wire pair. The T2 carrier transmits 6.3Mbps. Recent technical innovations have increased the capacity of wire pairs to as much as 100Mbps. An emerging standard, called the copper distributed data interface (CDDI), permits 100Mbps throughput on standard copper wire.

There are already many digital channels in existence with high capacities. They will become even more widespread. The AT&T T4 carrier transmits 274Mbps. The AT&T WT4 waveguide system transmits 60 of the T4 bit streams through a single pipe, giving a total throughput of 16 billion bits per second (Gbps). Some communications satellites have total throughputs of billions of bits per second. A single optical fiber is capable of transmitting a billion bits per second, and many such fibers normally are packed into one cable.

2.3 Telecommunications and User Functionality

The underlying telecommunications system is critical to the ability of users to utilize emerging technologies to perform new tasks. The relationship between certain types of functions and the bandwidth and delay levels of telecommunications channels is illustrated in Figure 2-1 below. Note that for certain functions, such as voice and video, low delay (below 500ms) is more critical than high bandwidth. On the other hand, for certain data intensive functions, such as electronic mail and compound document interchange, high bandwidth is more critical than delay.

The point is that the merging of voice, video and multimedia applications with data intensive applications will require a telecommunications infrastructure with high bandwidth and low delay.

Figure 2-2. Communications Channels.

Figure 2-1.

Telecommunications Infrastructure Required for Different Functions

2.4 Integrated Services Digital Network

The analog telecommunications plant is rapidly being replaced by more efficient and cost-effective digital facilities. The conversion of telecommunications facilities into an *integrated digital network* (IDN) is well under way.

Integrated Services Digital Network (ISDN) is a network architecture using digital technology to support integrated voice, data and image services using twisted pair telephone wire. ISDN's main objective is to provide users with standard access to network services in a cost effective manner.

ISDN provides access to different types of networks, e.g., voice, data or video conference over a single end user link. This can, for example, permit the integration of the telephone and computer into a single device. A major goal of ISDN technology is to allow any type of equipment to be connected to the network (as long as that equipment is capable of generating a digital bit stream that conforms to ISDN standards), permitting it to communicate with a complementary piece of equipment at the other end. Plan for this capability to become available by 1996.

It is expected to be 2-5 years before ISDN fulfills its promise to deliver 64 Kbps digital service to each desktop. In the meantime, other high-speed alternatives are being considered at Headquarters.

2.5 Emerging Application Requirements

The need for high bandwidth LAN installations and improved telecommunications standards is supported by two emerging trends at DOE Headquarters. First are LAN installations. Second are IRM/TTR plans that specify requirements for electronic imaging, multimedia, and full-motion video capabilities. These capabilities are representative of a new class of software application referred to as *broadband applications*. It will not be possible to implement these technologies in your organization unless you first plan for the appropriate enabling technologies. These include technologies that we described elsewhere in this guide, as well as the advanced telecommunications and high bandwidth LAN technologies described in this section.

For your reference, we have briefly outlined below some of the most important broadband telecommunications technologies which are emerging to support these high-speed data applications. These technologies include Frame Relay, Switched Multimegabit Data Service (SMDS), Fiber Distributed Data Interface (FDDI) and the forthcoming FDDI-II, Synchronous Optical Network (SONET), and Asynchronous Transfer Mode (ATM).

2.51 Frame Relay

Frame relay is intended to provide a migration path between today's applications and those of tomorrow. As a replacement for conventional point-to-point leased lines or X.25 networks, frame relay offers increased performance and reduced networking costs. Frame relay is an internationally adopted and evolving standard, allowing interoperability among users and equipment. The service is used mainly to connect LANs at different sites and supports 56Kbps to T1 rates.

2.52 Switched-Multimegabit Data Service

SMDS is designed to interconnect LANs in a metropolitan area. It permits significantly higher bandwidth than the currently popular T1 point-to-point or X.25 network connections. SMDS defines a transport mechanism service over a fiber-optic ring operating at rates of 1.544 Mbps, and eventually may achieve 155Mbps. SMDS recently received a boost when a major interchange carrier announced it will provide the service on a coast to coast basis.

2.53 High-Speed Circuit Switching

HSCS is ideal for organizations that transmit data several hours a day, use the service several minutes at a time, and do not require instantaneous access. One major advantage of HSCS is the fact that it uses existing network elements, used for T1 and T3 private line service. This makes HSCS a very low-cost interim solution.

The major disadvantage of HSCS is the time it takes to dial up the line. HSCS procedures are cumbersome for LAN-to-LAN applications that consistently transmit short data bursts that last only a few seconds each.

2.54 Asynchronous Transfer Mode

We expect to see ATM technology used everywhere, from the desktop to the LAN, and throughout the enterprise-wide WAN. ATM technology makes it possible to carry both data traffic and voice and video on the same network. It has been defined as a transport standard for broadband ISDN (B-ISDN).

ATM is rapidly gaining acceptance as the foundation for future network infrastructures supporting voice, video and data. ATM may help create "the unlimited area network" that will blur the boundaries between LANs and WANs.

2.55 The Synchronous Optical Network (SONET)

SONET is intended to provide a specification for taking advantage of the high-speed digital transmission capability of optical fiber. As a follow-on to today's T1 and T3 services, it is a broadband network technology that has the capacity to handle voice, data, and video traffic. It will provide a high-speed data pipe over which ATM-based services can operate.

International SONET standards specify transmission rates starting at 51.84Mbps and reach a maximum of 2.488Gbps. This technology will be required to fulfill the vision of broadband networking.

2.56 The Fiber Distributed Data Interface (FDDI)

The move to more powerful computers has had a ripple effect throughout Headquarters. More powerful machines support more complicated applications that transmit more information over the network. Ethernet's 10Mbps transmission speed currently supports the text applications of most organizations. However, as more Headquarters organizations specify broadband applications, many LAN managers will find network bandwidths overwhelmed. To accommodate this increased demand for network bandwidth a new standard is emerging. It is called the Fiber Distributed Data Interface standard, which specifies transmission speeds of 100Mbps on optical fiber cable.

High on the list of requirements for many program offices are client/server applications. (Described in more detail in Section 3.) These applications are expected to utilize multimedia information across the network. This means higher network bandwidths will be required to support client/server applications.

Cost is currently the primary factor prohibiting desktop FDDI connections. However, a new standard is being developed that will make it possible to send FDDI over less expensive, and more common, twisted-pair wiring. This new standard is called Copper Distributed Data Interface (CDDI), and is expected to be completed during late 1992.

It is possible that FDDI networks running over copper wire will replace slower Ethernet networks in the near future. The new CDDI standard will support the 100Mbps throughput of FDDI without the expense of optical fiber.

2.6 Video Phones and Video Teleconferencing

At the New York World's Fair in 1964, AT&T introduced the PicturePhone. This new technology made it possible for a caller to both see and hear the person on the other end of the line. Although the PicturePhone didn't catch on then, it appears that it may finally emerge as a strategic business tool in 1993-94.

The success of video conferencing is due, in part, to a dramatic decrease in costs. Prices for transmission facilities have dropped significantly and digital lines are more widely available. Video teleconferencing equipment has also become more sophisticated, resulting in better quality pictures at lower bandwidths. The 1990s will be the decade of video teleconferencing as dozens of video phones and desktop video systems enter the market.

AT&T has re-entered the video phone market with a new PicturePhone, called the VideoPhone 2500. It is now available and retails for \$1499. By 1996, picture phones are expected to cost as little as \$300 retail. MCI is planning a new video phone for early 1993, which may cost as little as \$750.

Video capabilities for LAN use are now available and are expected to develop further during 1993.

Video teleconferencing equipment tends to be getting cheaper, smaller, and better each year. Intel and PictureTel are jointly working on a project to put video on a single chip. This will make it possible to display a video teleconferencing window in a multimedia system on a standard personal computer display screen using a single expansion board.

We expect the telephone and the PC to merge into a single device by 1996.

Planning Guidelines

While few program offices are likely to include specific telecommunications technologies within their plans, all must be familiar with their requirements to insure that the available technologies meet program needs. Plans should, therefore, outline the types of information which are expected to be utilized by office personnel in the future. This, in turn, will provide rationale for the types of telecommunications which must be supported.

Plan for high-speed LAN connections approaching 100Mbps if you have requirements for client/server applications, imaging, multimedia, and office or personal video conferencing systems.

- ✓ FDDI is a standard for supporting 100 Mbps transmission speeds on fiber optic cable.
- ✓ SONET is an emerging standard for supporting up to 2.48 Gbps bandwidths on optical fiber.
- ✓ ATM is a transport protocol that supports the transmission of voice, video, and data over fiber optic cables.

Planning Notes

3.0 Connectivity

The emerging use of computer-based information systems, versus individual computers, is dependent on emerging connectivity and interoperability standards. The implementation of connectivity standards at Headquarters and with field elements, will make it possible to develop advanced client/server applications. These applications are required by individuals and organizations to support their missions.

Two key connectivity factors will contribute to the successful implementation of information systems in the 1990s. One critical success factor requires implementing networks. The second is the ability to leverage networking to improve the management and operations of DOE. In this section we discuss the possible advantages of a well-planned connectivity strategy at Headquarters.

It is important to recognize the relationship between the functional capabilities of information systems and the enabling technologies that make this functionality possible. In many cases, certain technologies must be in place before specific functional requirements can be fulfilled. Emerging trends in physical and logical connectivity technologies is a case in point. These technologies will bring increased speed and greater bandwidth to our networks.

Desktop hardware, telecommunications, connectivity, operating systems, and client/server applications are some of the key enabling technologies that must be in place to achieve the functional requirements for improved access to information, improved distribution of information, and improved collaboration between the creators and users of information.

3.1 Current Connectivity Environment

Implementation of Headquarters LAN capability began in 1988. The original goal was to maximize DOE's LAN capability while minimizing investment in equipment that could be replaced by LANs, such as DPUs (data path units).

To date, 31 of 35 DOE organizations either have operational LANs, or have identified LAN requirements within their organization's long range plans.

There are currently three service levels of LANs at Headquarters. These include 1MB DAVID, 10BASE-T and FDDI, which (while only in prototype installation), is expected to be available during 1993. Each level is increasingly faster and more responsive.

Eleven organizations have operational LANs, connecting approximately 2,000 workstations. Five additional organizations have LAN projects tentatively scheduled for completion during late 1992 and early 1993.

Projections indicate that approximately 6,600 nodes will be operational by FY 1996.

The current environment at DOE-HQ is limited mainly to terminal emulation and some file transfers between the PC and mainframe and between PCs connected to a local or wide area network. The PC to host connections permit electronic scheduling and electronic mail through OfficeVision. The PC-based networked environment includes electronic mail. Small applications, device sharing, gateways to host, outside dialing, and CD-ROM connections are also available.

3.11 LAN Connectivity is Critical

One of ITSO's most important goals is to provide enhanced connectivity to knowledge and information workers at Headquarters. This is expected to be accomplished by implementing a universal LAN computing environment that connects every desktop workstation. This will make it possible for everyone to exchange complex documents electronically, collaborate on projects in electronic work groups, and access remote information from the computers on their desktops.

A universal LAN computing environment will provide the foundation upon which the next generation office will be built. It will include more powerful servers, operating systems, and client/server applications.

3.2 The Emergence of Client/Server Computing

In a PC-based network, desktop computers and central servers act in the functional roles of servers and client stations. The servers make their attached disk drives, printers, modems, and unique communications links available to the client stations. Software running in the client PCs gives network users access to the data and devices available on one or more servers.

Client/server architecture attempts to combine the best of the host resource-sharing capabilities with the distributed processing power of PCs. In client/server computing on PC LANs, an application is divided into a *front-end* client component that manages user interface and data presentation on the client PC, and a *back-end* server component that manages central resources, such as databases. (See Sections 7.3 and 8.5 for more information.)

The primary benefits of client/server computing include greater access to the organization's information, and more effective resource utilization. The client/server model provides the foundation for powerful interactions between intelligent workstations and host systems. As client/server applications evolve, the user's workstation will become a "window" into the DOE-wide information system.

3.21 Client/server Computing Advantages

Reduced processing costs. Client/server systems place new (or existing mainframe applications) on inexpensive intelligent workstations and PC servers. The mainframe can continue to run existing applications while providing data services to client applications on the network.

New application development techniques. Programmers will be able to utilize workstation software that is usually not available on mainframe systems, such as front-end development tools, intuitive graphical user interfaces, and object-oriented databases. (See Section 7.)

A better-equipped, better-informed workforce. Organizations can decentralize computing without compromising data security and integrity. Client/server systems represent a new paradigm that is as much a management tool as it is an enabling technology. End users can access an organization's data while taking full advantage of the personal productivity and group productivity applications of the stand-alone environment.

Investment preservation and hardware flexibility. The scalable architecture of client/server computing allows DOE to extend the life span of existing midrange and

mainframe computers. Applications can be developed for the LAN environment and connected to host data via LAN database server gateways.

The increasing use of client/server computing is due largely to the proliferation of PCs and the maturity of networking technology. From the PC perspective, client/server computing technology can provide substantial benefits.

More effective information management. With only stand-alone PCs and file server-based work groups, valuable data tends to become isolated at the department, program, or individual desktop level. Database servers address this problem by centralizing data and making it available in a more flexible way.

Improved data integrity and security. With database servers, it is possible to enforce data validation rules and access rights throughout the organization. Database servers also provide transaction processing features to ensure the integrity of multiple updates, and concurrency control for multi-user access.

Planning Guidelines

A LAN connectivity strategy is critical to many of the emerging technologies outlined in this guide, especially those relating to new and enhanced office functional capabilities. Client/server computing is as much an information systems management strategy as it is a technology. It provides greater access to information and more effective resource utilization. Plan to use client/server applications in your specifications for work group computing applications, workflow and document management systems, and document imaging systems.

The success of client/server systems will depend on the implementation of:

- ✓ Standardized high-speed, high-bandwidth networks (See Section 2)
- ✓ Universal LAN connections
- ✓ Advanced workstations
- ✓ A graphical user interface (GUI)
- ✓ Client/server application development tools

Greater Application Flexibility. The ability of a database server to provide centralized integrity, concurrency, and security makes it possible for users to access server data with a wide variety of off-the-shelf front-end software.

Client/server computing is an important new paradigm. While it has not yet been perfected, it has the potential to bring important DOE information directly to support and management personnel in easy-to-use ways.

3.3 Wireless LANs

Wireless networking is a promising new technology that may have benefits for some programs at Headquarters. The ability to connect computers without wires opens up a wide range of possibilities. Wireless networks can facilitate warehouse inventory management, cooperative learning in the classroom, and other tasks that can benefit from mobile networked computing. It is also a key enabling technology for pen-based or notepad computing systems. While the possibilities are exciting, the technology is still in its infancy, and must overcome technical and regulatory hurdles before it becomes a major component in today's computing environment.

Wireless technology has three broad applications.

- In-building wireless LANS
- In-building LAN links for mobile computers
- Metropolitan area networks (MANs)

In-building wireless LANs serve as a replacement for cabled LANs. They connect desktop computers into a network without the problems of running cable. This could be useful in the following circumstances.

- New installations where no usable cable exists
- Difficult-to-wire environments
- Temporary installations (e.g., field sites)
- Rapid deployment

To illustrate the utility that could be offered by mobile networking, consider a DOE field worker investigating a nuclear power facility. With a laptop computer and a radio modem, the worker could do online queries to the Department's host computer, getting the latest information regarding design specifications, maintenance reports, and other technical data, and make online changes as needed.

There are three basic wireless technologies: radio frequency (RF), infrared, and cellular. Radio frequency is employed for in-building wireless networks. Cellular

service is expensive and unreliable for data communications. Infrared LANs are slower in performance, but cost less and are more mobile than RF or cellular-based LANs.

It is not realistic to expect wireless networks to replace unshielded twisted-pair and other hard-wired networks. Cable offers much higher data transmission speeds than wireless technology. Most wireless networks have a maximum speed of only 2Mbps, compared to current Ethernet speeds of 10Mbps. We expect cable to reach speeds of 100Mbps in the next two years. Fiber optic cable systems will achieve even faster transmission rates, while wireless networks will reach maximum speeds of only 10Mbps. Clearly, wireless systems cannot compete with wired networks in terms of performance.

Wireless networks could, however, complement existing wired networks. The wired network would serve as the primary backbone, while a wireless network connects individual desktop PCs to the backbone, thereby providing additional mobility for the user.

Technical issues regarding security and interoperability remain unresolved. This has slowed the acceptance of wireless networks in the government arena.

Configuration issues. Infrared LANs need clear line-of-sight connections. Radio wireless LANS can penetrate walls. However, these configurations must be kept on the same floor. In most cases, a networked device works best when placed within 100 feet of a node.

Planning Guidelines

Applications for wireless networks are possible at Headquarters. However, because of the different approaches available, planning becomes a critical issue. In general, plan for wireless nets if your requirements meet the following criteria:

- ✓ Your networking requirements are temporary
- ✓ There is a need for mobility
- ✓ There is no pre-existing cabling, and installation costs are high
- ✓ You constantly expand your network
- ✓ You need a disaster-recovery system
- ✓ Security requirements have been met

Planning Notes

4.0 Workgroup Computing

Workgroup computing software technology is expected to provide powerful new capabilities for individuals, organizations and cross-organization functions. These systems will not only permit sharing of information but will also provide the foundations for work to flow electronically through and between organizations. Plan to implement these capabilities within the next 3 years. Organizations need to develop management plans to implement and use workgroup tools.

4.1 Workgroup Computing Defined

Simply defined, Workgroup computing software technology supports the work done by groups, especially work that requires communication, collaboration, coordination and cooperation. Groups may be composed of members from one or many organizations, they may be large or small. Workgroup Computing tools can be divided into three categories:

- Groupware
- Workflow Systems
- Collaborative Computing Systems

Workgroup computing is not just a technology issue. It is a management issue as well. Workgroup systems have the power to shape the way individuals and organizations function. As such, workgroup computing may be installed, not only to solve specific problems, but also to effect new organizational and mission challenges.

4.2 Groupware

This software will create entirely new ways in which groups can electronically coordinate work activities. Tools that were not specifically designed with groups in mind, but can be used by groups, are not considered groupware. Under this definition, E-mail would not be considered a groupware product. E-mail communications go from point to point, while Groupware communications go to, and between, all members of the group. Groupware will fundamentally change the way we do work, and the way organizations operate.

E-mail Communications

Groupware Communications

4.21 Groupware Example: Directives Coordination

When documents, such as Departmental directives are developed, a range of organizations must concurrently receive the proposed directive, discuss the implications and effects of the proposed action, comment on the specific language and communicate ideas and concurrences to central locations. Groupware can provide all of these elements and provide central managing organizations with real-time information regarding the comment/concurrence process, including up to the minute status of the comments and concurrence actions in each organization.

An original draft directive can be sent electronically to those office representatives which are part of the defined "directives workgroup" for each individual directive. Members of the group in diverse organizations can concurrently share ideas and comments on the proposal. The draft can also be routed within organizations to individuals with comment responsibility. Comment and concurrence actions can also be originated electronically by the central managing office.

4.22 Groupware Example: Project Discussion Databases

Discussion Databases can be a real time saver by replacing many of the traditional meetings held within organizations. Decisions can be reached in a timely manner, and a documented history of how and why a decision was reached is created in the process. Users can discuss a topic through a question, answer and comments database. Further, the contents of Discussion Databases can be much more than simple text documents. Users can insert voice, video, image and supplemental annotations files that can be invoked by clicking on embedded symbols like those below. Since many discussions do not need to be held real-time, group members can make their comments when it fits their schedule. Group members can work at different times and locations, and still be equal participants in the discussion.

4.3 Workflow Systems

Workflow software is used to create electronic forms-based systems. The electronic forms are then used to route and track tasks. The system can track who has been assigned responsibility for each task and keep track of task and project progress. The system can inform members when their assigned tasks should begin, request feedback about current progress, and alert group members when the schedule is falling behind. Workflow systems can also keep track of who has a particular file or document, and keep a schedule or waiting list for items and resources that need to be shared by other group members.

4.31 Workflow Systems Example

An electronic form routed through an organization can be utilized in an installation process to assign tasks, and track progress. For example, to complete the process of installing a terminal in an office, several steps need to be done, and the activity of many group members must be coordinated. After the installation request is submitted to the Workflow system, tasks are given to group members by the system (not a manager). The system keeps track of the installation schedule, and alerts members when the project is falling behind, and which tasks are causing the slippage. Workflow systems can improve the quality of procedural tasks by providing continuous status information for each task.

4.4 Collaborative Computing

Collaborative computing systems support groups who need to work real time on the same task to reach a group objective. Some functions that fit under the collaborative computing category are:

- Real-time editing and sharing of drawings
- Editing and annotation of documents
- Spreadsheets used to model what if scenarios
- Software application development
- Simultaneous messaging among several users.

4.41 Collaborative Computing Example

A team has been assigned the task of setting up a disaster recovery plan and backup data center. Since the team members are not all in the same geographic location, they will be using a collaborative computing system. Jointly, the team members on the network work from an agenda, the draft recovery plan procedures, and a drawing of the planned backup data center. In some cases the telephone is used along with the collaborative computing system. As they work, some users may choose to have their comments appear on screen in a dialog or chat box. Each user can make document and drawing edits that other group members can see immediately.

4.5 Investing In Workgroup Computing

Workgroup computing tools will change the way we do our work, and we will become dependent on these systems as our work flows through them. Unless there is a solid payoff, organizations will not replace old tools and procedures for getting work done by implementing Workgroup tools. Workgroup tools should:

- ✓ Improve upon or augment older systems (manual or automated)
- ✓ Demonstrate quantifiable dollar savings
- ✓ Offer productivity gains that will outweigh the initial investment costs

4.6 LANs Form The Foundation For Workgroup Computing

As organizations implement LANs, they are building a key element of the infrastructure required for Workgroup computing. An unstated requirement of an organization demanding more LAN connections is often the need to work closer as a group, and this requires workgroup technology. The reverse is also true. An unstated requirement of an organization demanding workgroup technology is often the need for more LAN connections.

Table 4-1 below is a summation of projected HQ LAN connections now being planned through Fiscal Year 1995. To make it possible for Workgroup computing tools and systems to help organizations accomplish their mission, planning and implementing a LAN is critical.

The reason this table is important to everyone is that workgroup functionality is especially valuable when used in cross-organization applications. This requires all members of the workgroup to be connected to a LAN, including those members in other organizations. Thus, it is clear that major opportunities for cross-organizational workgroup systems will become available in FY-93 and FY-94.

Figure 4-1. LAN Connection Growth Projections

Planning Guidelines

Investigate and plan for Workgroup and Workflow systems in conjunction with other technology planning in the following areas:

- ✓ **Fastest possible LAN connections with voice and video bandwidth for all workgroup members, including management.**
- ✓ **A separate server to provide client/server capabilities for the workgroup software. For mission critical applications, redundant drives, backup systems and recovery plans are imperative.**
- ✓ **Multimedia workstations (386/486 minimum) for exchanging voice, sound and video information.**
- ✓ **A Graphical User Interface, pointing device, video resolution of at least 1024 x 768.**
- ✓ **Imaging and FAX systems will also be integrated into workgroup systems.**

Planning Notes

Planning Notes

5.0 Electronic Document Interchange

Many DOE workers are producing reports that contain charts, tables, and graphics. These reports are also formatted with fonts and text attributes. A major goal of electronic document interchange is to make it possible for co-workers to exchange such documents over the network and print or view exact copies of the documents at their workstations, including the original text format, graphics, and pictures.

As information sources for employees becomes highly centered on electronic data, the concept of electronic document interchange becomes critical. During 1993-96, we expect office productivity systems to support the integration and exchange of graphical, information rich documents. These documents will become vital resources for program offices as they are electronically routed from one worker to the next in an increasingly collaborative computing environment.

This section describes the technologies that are required for the creation, presentation, distribution, and management of documents. We specifically describe *compound documents* and information search and retrieval technologies, which are critical components for electronic information exchange.

Most office workers spend approximately 60% of their average work day working with documents. In addition to memos, financial reports, and briefings which must be read, there are also newspapers, newsletters, and magazines.

Rather than managing the avalanche of paper, computers may have contributed to it. Information, originally created to assist people in performing their jobs, often becomes a hindrance instead of a help.

Emerging computer technology is expected to make it possible to handle more documents electronically. The creation of exchangeable electronic documents is an important new technology that we have only recently begun to explore.

Organizations wanting to reduce their dependence on paper must identify the appropriate technologies for electronic document management and plan how to apply the technologies in a way that supports the documents that already exist, as well as new types of electronic documents to be created in the future.

5.1 Compound Documents as a Communications Medium

Documents produced at Headquarters are evolving from simple page layouts using plain text and little, if any, graphics, to sophisticated designs using multiple fonts, with text and graphics on the same page. Production of these "information rich" documents represents a growing requirement at Headquarters. In the near future, many Headquarters offices will be required to produce documents that contain many kinds of information, such as data from spreadsheets and graphics programs, as well as sound and video. These documents are referred to as *compound documents*. Within the next two to five years, we expect compound documents to become a standard form of communication at the Department of Energy.

One problem with computers today is that they force us to be isolated according to application and operating system. To communicate usable documents, a sender's and receiver's operating systems, applications, and resources must be compatible.

For information interchange to be timely and efficient, computers must be able to directly and routinely exchange all documents (i.e., information) that computer users create. Computers can then be used primarily to read, search, and print portions of electronically distributed documents. These documents then become active elements of the office work process.

The goal of planning for electronic information interchange is to assure that the technologies are in place that make document interchange possible.

Today, everyone's workstation—systems, fonts, memory, displays, and applications—must be the same for document interchange to be possible. While this may be acceptable for specific, mission-critical applications, it is difficult in a general office environment.

A successful document-interchange solution that can handle the demands of text, graphics, and images should be based on document architectures that exist independently of and across operating system and hardware platforms.

5.2 Managing Fonts: The First Step to Document Interchange

Handling fonts is a fundamental problem in document interchange. For example, suppose you create a document using fonts from the New Century Schoolbook and AvantGarde type families and send it over the network to co-workers. What if the printer used by each co-worker to print the document does not have the same fonts used in the original document?

In most cases, the document would be printed using the printer's default font, which is usually Courier. Since Courier is a monospaced font, the overall appearance of the text would be quite different than the original.

One way to solve this problem would be to bundle the fonts with the document before sending it over the network. There are emerging operating systems and architectures that will tackle the problem of font interchange while maintaining the document's original appearance on both the screen and the printed page. This is extremely important when evaluating electronic information and document interchange in a graphical operating environment.

5.2.1 Embedded Fonts

Microsoft introduced the first full-scale font solution controlled at the operating system level in Windows 3.1. This approach uses an embedded font technology called "TrueType." It is specifically designed to mitigate the problems described above. Embedded fonts make it possible for the recipient to view the document in its original format on any display and print the formatted document on virtually any printer.

It is important to note that embedded fonts do not address the problem of not having the identical application software. Furthermore, this is currently a Windows-specific solution to document interchange. Cross-platform support for Windows documents with embedded fonts is not currently available. However, multi-platform Windows operating systems are expected to provide this flexibility in the future.

5.2.2 Multiple Master Fonts

Another approach involves the use of Multiple Master fonts. Multiple Master fonts are an extension of Adobe's Type 1 specifications and use the ATM (Adobe Type Manager) font rendering technology.

One of the benefits of Multiple Master technology is the ability to create fonts without using large amounts of disk space. When Multiple Master type is used, ATM creates the necessary character outline and displays the type on the screen or prints it to a printer.

Multiple Master font technology is just emerging. It may take at least four years for this technology to mature.

5.3 True Document Interchange

There are two approaches to the creation of compound documents. In the first, a single application imports pieces of information. Any changes must be made in the original application and re-imported. In the second, information elements from different sources are embedded into a single document. Changes are made by "clicking" on the information, which starts the application that created the information. Changes are reflected in the embedded information element.

The problem of universal document interchange is not yet a critical issue at Headquarters. However, there are two trends that could turn universal file exchange into an important issue within three years. First, an increasing number of program offices are specifying LAN requirements. Implicit in this requirement is the need to electronically exchange information. Second, many offices are beginning to produce typographically rich documents, which include charts and graphics. The confluence of these trends is expected to lead to a requirement for universal document interchange standards.

Universal document exchange is not yet possible. The only cross-platform document exchange standard is ASCII text. However, documents often include enhanced text attributes, fonts, graphics, and even sound and video information. All of which are lost in ASCII transmission.

Document interchange standards are based on two distinct approaches to compound documents. First is the *single-application* approach, which involves the ability of one software program to recognize files from other programs. For example, when DOE analysts use WordPerfect's graphics capability to import a Harvard Graphics chart into a budget report, they are using the single-application approach.

A second approach treats each file in the document as an object that is linked to the application that created it. This is called the *multiple application* or *object-oriented* approach to compound document creation. This is a key feature of many Windows 3.1 applications.

5.31 Object-Oriented Technology

The object-oriented approach to creating compound documents can be found in many graphical programs. Microsoft and IBM refer to this approach as "object linking and embedding" (OLE, see Section 1.12 for more details) and incorporate it in Windows 3.1 and OS/2 2.0. This technology permits objects to be edited within the document in which it is embedded, as long as the application that created the object is available.

The object-oriented approach makes it possible to create compound documents with programs that are not aware of some kinds of external data. A word processing program, for example, might incorporate sounds, even though the program itself may have no audio capabilities. The software for playing back the audio can be launched by clicking on a sound icon in the document. Thus, the object-oriented model makes compound document editors out of nearly all applications. This gives the object-oriented approach a significant advantage over the single-application method.

The key limitation of the object-oriented approach is that it presumes you have the programs needed to modify each embedded object.

5.32 Universal Document Exchange with Adobe Carousel

Adobe is currently developing a universal document format standard. Such a standard would make it possible for any document that can be printed or displayed on one device to be printed or displayed on any other device, without losing the format or appearance of the original.

This universal document format is part of Adobe's proposed Carousel technology. This technology builds upon the device and resolution independent features of Adobe's PostScript page description language by adding independence from applications as well.

Planning Guidelines

Expect many benefits from electronic document interchange. Users will be able to obtain relevant information on a timely basis using new workgroup, client/server, and other software technologies. The foundation for electronic document interchange requires planning for the following technologies:

- ✓ Graphical user interface
- ✓ Next generation operating systems
- ✓ Wordprocessing and other office productivity applications that can take advantage of the new operating system environment
- ✓ High-bandwidth LANs
- ✓ 386/486 workstations with high resolution video

Carousel's interchange standard is expected to make it possible for users to create self-contained compound documents with fonts and embedded graphics that could be sent across DOS, Windows, Macintosh and Unix platforms without losing typefaces, formatting or graphics. With this technology, documents are received and used in their original form.

This technology is not yet available and the extent of its usability at DOE is not yet known.

5.4 Text Retrieval and Document Management

Some studies have shown that only 10 percent of an organization's paper-based information can be accessed. The rest is either misfiled or forgotten. The financial and program implications are staggering. At DOE Headquarters, there are critical opportunities for productivity improvements and long-term savings through emerging information management technologies.

While computers have made us more productive in that we are producing more paper documents, they have done little to help us manage these documents. The documents we produce have simply moved to electronic form, becoming more abundant and perhaps more difficult to search for when needed. Increased use of complementary technologies, such as word processors, electronic mail, multimedia and desktop publishing, has increased the electronic availability of documents at Headquarters. As optical scanning, optical character recognition (OCR), and optical storage technologies mature, it will become practical to scan massive amounts of new information and make them machine readable. This increasing percentage of electronically available documents will make near term text retrieval applications a vital necessity at Headquarters.

The implementation of work-group computing technologies (discussed in Section 4) means that organizations will have to find ways to allow users to share and access large quantities of on-line documents. This too, will spur the need for text retrieval and document-management systems.

Documents can now contain many data types, such as spreadsheets, graphics and pictures. In the near future, voice and video clips will also be integrated with documents. This means that document-management systems will evolve into "object management systems" that manage not only text information but multimedia objects as well.

Text/information retrieval systems can be used for a variety of applications throughout Headquarters, such as:

- Litigation support and contract analysis
- Scientific and technical support
- Management operations
- Government actions, including bill status, statutes and regulations, reports, and legislative records

5.41 The Essentials of Document Management

Document management involves more than simply searching and retrieving text. A document management system should manage the entire life cycle of a document, from creation and modification to searching, routing, storage, and archiving.

A document-management system typically includes the following functions.

- Document tracking/revision audit
- Full-text or key word search and retrieval
- Check-in/check-out to keep track of document locations
- Text translator to convert different text formats
- File manager to store, locate and archive documents across LANs.
- Document database, or central library.
- Work flow automation to automatically route documents for action or review.

5.42 What is Text Management?

Text management makes it possible to organize, store, analyze, retrieve, exchange, and manage unstructured text (rather than "structured" text, typically found in the database world). This broad technology may also be referred to as text information management, document retrieval and management, and electronic filing systems.

5.43 Text-Retrieval (Keyword)

The first commercial text-retrieval systems, introduced more than 20 years ago, employed keywords. These systems are based on a variation of database technology, which is designed to provide access to formatted data. This method requires the user to select keywords while building the document database. The ability to retrieve documents is limited to requesting pre-defined keywords.

5.44 Text Retrieval (Content-Based)

Content-based retrieval is a variation of the keyword systems described above. The critical difference is that in content-based text-retrieval the entire contents of documents are searched without relying on keywords. Most of the systems available today use this method to retrieve documents. A content-based implementation provides a totally automated solution called full-text indexing and retrieval.

The full-text method is a straightforward, easily implemented solution. However, because the lists generated by this approach often exceed the storage requirements of the documents themselves, the solution can become expensive.

Content-based text retrieval systems are specifically designed to search text. These systems offer a range of search choices and provide efficient storage and management of unstructured information. In addition to managing text, they can also manage image, graphics, and alphanumeric information.

Planning Guidelines

Document management/text retrieval technology will provide significant office operation and productivity enhancements. Plan to implement these systems in organizations with the following:

- ✓ LANs
- ✓ Imaging systems (see Section 6)
- ✓ Graphical user interfaces (see section 1)
- ✓ 386/486 advanced workstations (see Section 1)
- ✓ Client/server hardware/software systems (see Section 3)
- ✓ Next generation operating systems (see Section 1)
- ✓ Large volume storage technology (see Section 1)

Planning Notes

Planning Notes

6.0 Document Imaging

Document and information imaging is more than just an emerging technology. It is a new way to manage, present, store, and utilize information. It provides a capability which is expected to revolutionize information creation, access and use. It is important that imaging systems and their capabilities be understood, not only in functional terms, but also in terms of the related technologies that are required to implement individual and organizational imaging systems.

Approximately 95% of the more than three trillion documents currently stored in offices throughout the United States exist in paper form, and another billion or so pages are added each day. Imaging systems promise to reduce the growth of this mountain of paper.

At DOE Headquarters, information is a vital resource. How program offices create, disseminate and use information is one key to the successful completion of their critical missions. Program offices need to plan for document image processing systems to achieve more efficient use of information through its timely capture, storage, retrieval, display, processing and distribution in digital form.

This section describes the benefits of document imaging systems and identifies the key technologies that must be in place for document imaging to be possible. Because imaging is based on facsimile (FAX) technology, we conclude this section with a discussion of imaging systems that combine FAX technology with optical character recognition (OCR) technology. This new technology, called FAX-OCR, brings imaging to the desktop and adds a new dimension to electronic document interchange. (See Section 5.)

6.1 Who Needs Imaging?

Any individual or organization who creates or utilizes documents, or written records. This puts imaging on everyone's agenda.

A Scenario

In a paper-based office, an analyst takes a piece of correspondence from an in-box, reads it, and begins a series of manual procedures to process a response. The analyst searches file folders and pulls relevant documents, transcribes key data, and refiles the documents. This process can take hours. Processing a large number of inquiries can take days. The more time the analyst spends doing simple clerical tasks means less time is devoted to serving the client.

In the Image-Enabled Office

In an office with electronic imaging, the analyst can process the entire correspondence from his workstation. Records can be searched electronically and relevant documents can be displayed on screen. If text from a document is needed in correspondence, it is easily copied and pasted into a new document. The entire process can be completed in minutes. The analyst can then devote more time to productive activities.

6.2 What is Electronic Imaging and Why Is It Important?

Electronic imaging is a mix of computer hardware and software that converts paper documents into electronic data "pictures." This is accomplished by scanning documents (taking a picture) and then using software to manage the electronic pictures. These images can be stored, retrieved, displayed, networked, transmitted, copied, and printed.

6.21 Online vs. On-paper Data

Most data is off-line (i.e., not stored in computerized format). For most organizations, only 5 percent or so of the information needed on a daily basis to do business is "on-line" as data. The remainder is on paper. This means that only 5 percent of an organization's information moves at computer speeds, while 95 percent of the information moves at the speed of paper.

Imaging brings an organization's information up to computer speed, thereby making it possible to dramatically reduce the duration of many internal processes.

Further, imaging allows organizations to apply data management methodologies and technologies to paper-based work. This provides process improvements and supports new capabilities.

The net result can be increased productivity. Organizations can process information more quickly and leverage their investments in information systems.

6.22 The Benefits of Imaging

✓ Document Storage Space Reduced

Typically, document storage floor-space can be reduced by 50 to 80 percent.

✓ Document Management Improved

The time required to file and retrieve documents drops dramatically. The time and effort needed to route and deliver documents is also substantially reduced. In addition, filing and retrieving errors—and their impact on the organization—can be nearly eliminated.

✓ Document Sets Easy to Duplicate

Because data records can be easily and inexpensively copied and managed, using multiple sets of documents is much more practical. Imaging also makes creating copies of documents much easier and faster. This offers organizations improved disaster-recovery options and operational alternatives impossible in paper-based environments.

✓ Document Are More Accessible

Because documents can be networked and communicated, people in various locations can review the same documents at the same time. Office actions that were drawn out by their sequential nature may now be done in parallel.

✓ Improved Office Workflow

When a document is needed, it can be delivered to a workstation screen within seconds of a request or even scheduled for automatic delivery. Clerical workers and professionals can make more productive use of their time by not having to store, retrieve, or deliver documents.

6.23 Imaging Systems Fulfill a Broad Range of Requirements

The size of the enterprise is not a factor in determining who benefits from imaging systems. Imaging technology is now much less proprietary, with off-the-shelf software running on industry-standard servers, networks, workstations, and PCs.

6.3 Imaging Applications

Imaging can support these major functional areas.

- Records management or storage/retrieval systems
- Workflow automation systems
- Application integration

6.31 Records Management

Imaging systems supporting the storage and retrieval of documents not only dramatically reduce the duration of procedures and improve the responsiveness of the organization, they also lower the costs of managing documents. This provides an electronic replacement for the traditional file cabinet.

6.32 Workflow Automation

Because they integrate with existing networks, servers, and workstations, imaging systems can do more than just manage records. They can support an automated flow of documents and other work through an organization.

6.33 Integration With Existing Applications

The emerging trend in imaging is toward integration with existing applications. Driving this trend is the demand for open systems. First-generation turnkey imaging systems were closed, stand-alone systems that required users to install proprietary workstations and servers. Most vendors now provide the ability to integrate a broad range of nonproprietary hardware components with their imaging systems. As a result, an increasing number of imaging systems are based on personal computers and are typically part of a broader client/server solution. (See Section 7.)

6.4 The Imaging Process

Imaging storage and retrieval typically involves five distinct stages:

1. **Digitization.** Paper or film documents are converted to electronic images, usually with scanners.
2. **Compression.** Without compression, an 8½" by 11" document scanned at 300 dots per inch (dpi) would require over 1 megabyte of storage. Compression drastically reduces this requirement.
3. **Indexing.** Images must be tagged with identification data for later retrieval.
4. **Storage.** Once indexed, images are transmitted to a storage subsystem, usually an optical media. The indexes are usually stored on magnetic media for faster access.
5. **Retrieval.** Images can be retrieved for viewing, editing, or communicating to others. They can also be printed on laser printers.

6.5 Imaging System Hardware

Imaging systems are available on a full range of hardware platforms, from mainframes to PCs. Imaging products address a broad range of user configurations from single users, to work groups, to enterprise operations.

A complete imaging system typically includes the following components:

- ✓ A file server and workstations.
- ✓ An optical server and optical jukeboxes.
- ✓ Scanners and optical character recognition (OCR) software.
- ✓ Laser printers.
- ✓ High resolution monitors.
- ✓ Software designed to manage document retrieval, work flow automation and communications.

6.51 File Servers/Workstations

File servers are the central components of the imaging system. Plan for the fastest computers available. Make sure the storage sub-system (see Section 1.9) is large enough to support current imaging applications and still permit expansion.

Planning Guidelines

We expect imaging systems to be a vital component of the information systems infrastructure at Headquarters. Perhaps the most critical planning issue is not whether imaging systems will be implemented at Headquarters, but which types of systems will accomplish which tasks. There are a number of wide-ranging options for these systems and which of these is utilized depends not only on the organizational needs, but also on the technology base which is available to implement the desired functions.

When planning for an imaging system, it may be best to start out with simple applications that yield immediate benefits before attempting to tackle complex applications. Focus on projects which do not require dramatic changes in office procedures and which can be justified based on a combination of cost reductions and performance improvements. These small-scale projects will provide the foundation experience upon which more ambitious implementations can be built.

For dedicated imaging workstations, plan for no less than a 386DX microcomputer. These systems should also have, at minimum, 17" high-resolution (1024 x 768), non-interlaced displays (see Section 1).

6.52 The Scanner

The scanner is a basic component of any imaging system. It provides the primary method for digitizing a document or graphic representation into a format that can be stored and manipulated by a computer. The quality (resolution) of scanned images varies with the scanner used and the speed at which it is operated (scan rate).

Most scanners typically perform scans at resolutions between 100 dots per inch (dpi) and 400 dpi. The higher the scanning resolution, the more dots are required to store one square inch of image.

It is important to note that as more and more images are scanned into the system, increased storage capacity will be required (see Section 1.7).

6.53 Compression

Even at lower resolutions, image compression is used to economize storage space. On some workstations, a compression board is included as an attachment to the scanner.

6.54 Storage Requirements

Imaging systems require a mass storage device to hold data. The two main categories of storage devices in use today are optical and magnetic (see Section 1.9).

Optical Storage. There are three main optical disk technologies available for imaging applications:

- CD-ROM
- WORM (write once read many)
- Rewritable

Optical media significantly reduce the amount of physical space required for archival storage and thereby reduce operating costs. Information that fills 20 file cabinets can be stored on a single 5-inch disk.

Optical disk jukeboxes use a robotic arm to allow reading or writing to multiple optical disks. As many as 20 jukeboxes can be attached to a LAN. An optical jukebox replaces up to 100 4-drawer file cabinets.

Magnetic Storage. Magnetic (hard disk) storage technology has long been available. With retrieval rates in the 0.5 MB/sec to 3 MB/sec range they are faster than optical media. When fast access to images is a requirement, plan to use magnetic disks.

Choice of storage media can have a significant impact on the overall performance of the imaging system. The use of magnetic media is often used as a caching or temporary storage media for imaging applications.

6.55 The Display

How images are used is influenced by the type of workstation and, ultimately, by the type of display attached to the workstation.

Users who must view and read images on screen will only be able to do so if high resolution video is provided. This is a critical system component for an image-enabled workstation (see Section 1.4).

The following table shows the current display standards and the resolutions of each.

PC Display Standard	Resolution
VGA	640 x 480
Super VGA	800 x 600
8514 (Interlaced)	1024 x 768
XGA (non-Interlaced)	1024 x 768

These PC display standards are insufficient for all but the most casual of image viewing. They normally produce 65 to 75 dots per inch (dpi) resolution, whereas dedicated document viewing should begin at a 100 dpi minimum. Unlike standard workstation monitors, image processing monitors are usually rated in dots per inch. For example, a 19-inch imaging monitor rated at 150 dpi would require a screen resolution of at least 2048 x 1538.

High-end displays for imaging should meet the following minimum specifications:

- ✓ High resolution (at least 100 dpi)
- ✓ Adequate screen size (at least 19 inch)
- ✓ Fast refresh rate (at least 70 Hz)
- ✓ Gray scale capable

6.6 Document Imaging on the Network

Document imaging on personal computer-based LANs offers Headquarters program offices opportunities to improve service while reducing costs. It is attractive because it leverages existing investments in LANs and PCs in innovative and productive ways. It is important to note that LAN-based imaging systems will affect network performance.

Many of the components of a stand alone imaging system are used in networked systems. These components are commonly distributed across the network in a multiple server configuration, with each server performing a specific function, as shown in Figure 6-1 below. For example, the file server typically runs the image system software and manages the workflow process, the database server stores the index tables, the print server supports image printing, and the optical server stores the compressed image files.

Fast LANs are particularly well-suited for imaging applications because they are standard, and able to support the transfer of images between all nodes, such as workstations, scanners, storage devices, and printers.

Figure 6-1. Typical LAN-based Imaging System.

The implementation of LAN-based imaging is based on four key technologies:

- Network operating systems
- GUI on client workstations
- LAN databases
- Standard hardware components

6.7 FAX-Based Imaging Systems

The distribution of images via FAX boards will be a key technology for many organizations. Products are emerging that allow inbound FAXes to be stored as scanned images in FAX servers. Some vendors are offering document management systems that enable FAX servers to receive, route, index, scan and respond to FAXed images.

The combination of imaging and facsimile technology makes it possible for users to send image-ready documents to remote FAX servers or printers. This results in decreased response times between correspondents in remote locations. FAX servers can also function as remote scanners or as storage devices for inbound FAXes. This important technology is just emerging and organizations should carefully consider integrating FAX technology into any imaging system plan.

6.7.1 Components of a LAN FAX Server

Three components make up the LAN FAX server.

- ✓ The FAX line/FAX board
- ✓ Software for FAX management
- ✓ Workstation interface

The FAX board converts the PC file image from its native form (ASCII, graphics, etc.) to images. It then manages the physical transmission of these images.

Software applications manage the flow of FAX jobs from multiple users to/from one or more FAX boards.

The final component is the workstation interface. To the end user, sending a FAX to the FAX server is no different than sending a print job to a shared printer. Users interact with the FAX server through a menu or dialog box.

In the future, we can expect to see the development of FAX-enabled applications, and more integration with electronic mail systems.

The integration of FAX servers with electronic mail packages is one of the major goals of the International Computer Facsimile Association (ICFA). Most LAN FAX server software systems include support for mail gateways, and many support Lotus' cc:Mail as well. Popular mail packages, such as cc:Mail, will include capabilities to send and receive FAXes from within the e-mail application.

Planning Guidelines

Document imaging systems can benefit most DOE organizations by reducing document storage space, improving document management, and by making documents more accessible and easier to duplicate.

Imaging applications can support three vital functions at Headquarters:

- ✓ Records management
- ✓ Workflow automation
- ✓ Application integration

Imaging can be a labor-intensive task involving several stages. If you are converting paper documents to electronic images, you will need to plan for document preparation time. This involves removing staples, erasing smudges, and unfolding pages.

LAN-based imaging systems are ideally suited to the DOE environment. In some cases, a simple standalone imaging system might be a good way to get started in imaging, but be prepared to expand to the network.

Plan to include these components in your imaging system:

- ✓ 386/486 workstation
- ✓ High-resolution display
- ✓ Optical storage subsystems
- ✓ Large capacity hard disks
- ✓ Scanners with optical character recognition software
- ✓ Workflow/document management software
- ✓ High speed LAN connections

Planning Notes

7.0 Application Development and System Integration

This section provides a focus on emerging application development tools and information systems integration. As the graphical environment becomes more pervasive in program organizations, the development of specialized applications to tap into existing and new data sources will increase. Applications will not only be required to access existing types of text data, but completely new types of data using graphics, pictures, sound, voice, video and animation. Specialized or customized front-end applications will allow users at every level in the organization to access and utilize these new types of information.

Some commercial software applications will be replaced or supplemented by highly customized solutions as new technology tools permit organizations, and in some instances users, to build their own applications.

Client/server computing technology deals with a range of platforms, data sources and connectivity. It is a critical concept and provides a major focus of this section.

Application development tools come in different forms, but the trend is toward GUIs and object oriented programming. The benefits are threefold:

- Faster development time
- Applications that are more user friendly and visually appealing
- Greater access to multiple data sources

Organizations should plan on using new development tools and on committing resources to training and skills development. When put into skilled hands, many of the new development tools can dramatically reduce development time, provide new levels of end-user functionality and lower maintenance costs. Let's look at some of the tools that are available and review some of the terms being used.

7.1 Object Oriented Tools

Object-oriented techniques see the information world in terms of "class" (for example, "Age") and "instance" (the age of a particular person). The data and program code blend together in an object-oriented programming approach. One object may be used for employee information and another object may be used for printing. A programmer connects a number of objects together in order to construct an application. Software modules (objects) can be connected, reused, and quickly modified to become the building blocks for new applications. Once an object has been tested and used in an application, it becomes a proven item that can be used over again when new applications are constructed.

The object-oriented environment is almost completely event-oriented since the operational flow is dependent upon the messages between objects. Object-oriented programs have greater functionality than programs produced with traditional methods. Current developers, and possibly end-users, will be able to build new more powerful applications.

7.11 Development Tool Examples

Many products are coming onto the market in response to both the capabilities of users and the demand to be able to utilize existing data sources. Noted below are a few examples of some products which represent emerging development capabilities.

✓ *Quest* by Gupta Technologies, Inc.

Quest has an intuitive graphical user interface that will be easy to use.

✓ *SQL Link* by Borland International.

Oracle Card by Oracle Corp. Oracle Card is an object-oriented tool that can be used to browse Oracle tables, change data interactively, and design applications. The DOE host system currently uses Oracle as a data system.

✓ *Bedrock* by Symantec.

Bedrock is a development tool for creating graphical applications that, with little or no modifications, will run on Windows, System 7, OS/2, and eventually UNIX and NeXT machines.

✓ **Access** by Microsoft.

Access is both a database and a front-end development tool. It can be used to build stand alone databases, or be used to build graphical front-ends for executive information systems using SQL Server. Microsoft's Open Data Base Connectivity (ODBC) will allow SQL calls to Borland's Paradox, Novell's Btrieve, and ISAM based applications.

✓ **PowerBuilder** by PowerSoft.

PowerBuilder is an object-oriented application development tool for Windows and supports OLE, DDE, DLL, and MDI (Multiple Document Interface). PowerBuilder comes in three different versions to support several database systems, including: Gupta SQLBase, Microsoft/Sybase SQL Server, Oracle, and HP ALLBASE/SQL, and DB2.

Many of the new tools can be used by both programmers and non-programmers. However, complex applications will present users with some difficulty.

7.2 Front-end Trend

Traditional relational database management systems (RDBMS) cannot handle all data needs since they are not adequately able to handle unstructured data such as text, compound documents, graphics, and images. The data in many of our RDBMS needs to be joined with other data types. Front-end applications can help. A front-end is an application interface intended to aid in the access to, presentation of, entering and updating of information. Complex systems can often be hidden behind graphical front-ends. Application designers can use graphic and object-oriented development tools to create an intuitive user environment. Data presented on the screen may come from several sources such as client servers or mainframe data repositories. Front end tools can save development time and costs by preventing the need to rebuild older databases and host applications. Character based databases can be given GUI front-ends that make systems easier for end users to use.

The growth of object-oriented techniques is giving way to entirely new tool categories that will foster front-end development. These techniques include the following:

- **OOP:** Object Oriented Programming
- **OOPL:** Object Oriented Programming Language
- **OODBMS:** Object Oriented Database Management System

For example, NASA is using an object-oriented database query system to provide an interactive multimedia program. Visitors to the new Virginia Air & Space Museum will be able to use an object-oriented system built with touch screens, Windows, and Oracle card. Users of the NASA system will be able to explore, at their own pace and sequence, how different technologies have become part of the U.S. economy. User friendly front-ends, like the NASA system, can provide end users with the information they require while hiding the complexity of databases and image systems.

7.21 Examples of Some Front-End Tools

✓ **PerForm Pro Plus** by Delrina

PerForm Pro Plus lets users create electronic forms and develop forms-based applications with multiple links to databases such as SQL Server, Btrieve, Oracle, DB2, and OS/2 DataManager.

✓ **ObjectVision** by Borland

ObjectVision is not language-based. It is truly visual-programming in that it uses program flowcharts to build an application form. It will link to Paradox, Btrieve, dBase and comma-delimited ASCII.

Future Application Development/Object Oriented Trends	
1 Year	Almost half of the 1,600 organizations surveyed by International Data Corp. said they planned to actively investigate object oriented technology within the next 12 months.
2 Years	Wide use of large-scale object oriented application; object-oriented tool kits will become platform-independent.
2 to 4 Years	IBM, Apple, and Microsoft plan to offer object-oriented operating systems.
5 Years	Object oriented development will be the preferred method by most corporate development teams.

Planning Guidelines

The best object-oriented, graphical front end will be like a Hollywood movie set (pretty on the outside, but not much behind it) if the necessary information systems don't exist.

- ✓ **Plan the data source when building front-ends.**
- ✓ **Decision support systems (DSS) and executive information systems (EIS) need to tap into the data processes of the organization.**
- ✓ **Planning and implementation of support systems must precede EIS and DSS development when an organization's data is not available in electronic format via the network.**

7.3 Client/Server Development

Client/server systems (see also section 3.2) join the benefits of host or LAN server database management systems with the desktop location and processing power of PCs. In a client/server configuration, a PC typically runs the client software (or front-end) and the server software (back-end or database engine) runs on a LAN or mainframe server. Front end tools, as discussed above, are used to construct the client application front-end. With a user friendly front-end, users can choose menu options and fill in dialog boxes, and hide the fact that complex SQL (Structured Query Language) or other processes are being utilized. After construction at the client end, only the request for data goes to the server. The server application processes the request through a database engine such as: SQL Server, Oracle, Btrieve, and DB2.

Until the server receives a request for data (call) from a user, it has been free to support other users and tasks. Since the client application performs the interface and often the computing tasks, the server is not bogged down by performing screen interface duties or re-draws. A well-designed client/server application will divide the work load between the client and the server.

This is one of the most important of the emerging technologies. It utilizes the growing processing power of the personal computer to provide easy to use interactive systems for the user on his own familiar machine. This permits very expensive host systems to serve many users without utilizing its very expensive processing power to

run graphics screens and display chores, or even simple, but processor intensive tasks such as data organization and presentation. Client/server systems will provide extremely profitable utilization of LAN/WAN systems. Even more importantly, it will provide a way to make expensive information within an organization available to a much wider staff audience.

7.3.1 More Client/Server Examples

A client/server application might provide an executive information system with current organization budget data. This information might be located on a host system or LAN server. A front-end graphical application on the executive work station would operate through graphical icons on the screen, representing organizations or funding types which, when activated, send queries to the data system for specific data which is loaded into the executive's workstation.

The executive can select another icon to organize the information on the screen or produce a customized report on a local printer. Icons might also be available to transmit the information to local managers or staff as part of a "morning briefing."

Most of this activity would utilize only the local processor. The remote processor would only be used during the brief time in which the request for data is processed.

These types of client/server systems will provide new ways for staff and management to utilize and share data. Executive Information Systems, Decision Support Systems and Transaction Processing Systems can be client/server applications. (See section 8 for more details.)

Planning Guidelines

Since application development technologies deal with a range of platforms, data sources and connectivity systems, it is essential to understand the planning which must be implemented to insure the availability of important data and processes for individuals and organizations.

- ✓ In order to use object-oriented tools to develop front-ends to databases, it will be necessary to access databases and share information utilizing the LAN.
- ✓ No LAN connection = No data access.
- ✓ To use an object-oriented application, a 386 or higher PC will be required. Most front-end development tools are slow. Application development will require at least a 486 computer
- ✓ Depending on the requirements of organizations for information access and utilization, client server technology has the potential to create entirely new and more effective ways to accomplish program missions.
- ✓ Multimedia client/server applications will require at least a 486 level workstation with sound and video capabilities.

Planning Notes

8.0 Information Management and Utilization

Should processing be done on PCs, mainframes, or on LAN servers? The answer may be **ALL OF THE ABOVE!** In the next two years the number of PCs connected to the LAN and having mainframe and server access will more than double to nearly 6000. If you have PCs connected to the LAN, information will increasingly be "at your finger tips."

Client/server applications with graphical front-ends, work group computing, and imaging applications will soon crowd more and more information onto the end-user agenda.

Only management and utilization of this information will permit its most effective use.

New technologies are being developed to assist in the effective utilization of information. These include executive information systems, expert systems, decision support systems, geographic information systems and others. This section highlights some of these technologies and puts them in perspective for planning purposes.

The abundant supply of data and information at our disposal can be overwhelming—and finding the information we need is often like looking for a needle in a haystack. Others in your organization may have the information you need, but who are they and where is the information? Industry leaders like Bill Gates speak of putting information at our finger tips, but how will that information become available? Turning data and information into usable knowledge by putting it into the hands of those who need it requires: evaluation, planning, time, and funding. The cost of knowledge increases for each minute it takes to find information and apply it to the task at hand. The discussion below is an overview of emerging technologies which manage and use information.

8.1 Executive Information Systems

Personal computers have moved across organizations, but fewer computers have moved up in the organization (as shown on figure 8-1). Computers have made little inroads to the type of work done by executives and managers. The ability to attend planning meetings, motivate staff, trouble shoot, and solve organizational problems have not become available PC menu options. However, new tools are emerging which can turn PC islands into knowledge networks. Executive Information Systems (EIS) can help managers and executives make decisions by keeping them informed. To obtain current information, Executive Information Systems drill down into lower level systems that support the daily activity and processes of the organization. EIS implementations tend to obtain poor results when built as separate systems requiring daily data entry, rather than providing real-time data access. If executives can't be certain that their EIS has the most current organizational data, they will be unlikely to use it.

Figure 8-1 below illustrates the need for you to plan an information systems approach which provides an increasing focus for more specific information at higher layers of the organization, and more detailed information at lower layers.

8.2 Expert Systems

Expert systems (ES) help to provide information access and/or processing decisions similar to those required of humans, only utilizing the power and speed of the computer. ES builders attempt to encapsulate the skills and expertise of humans to perform tasks which provide us with the power of the computer and the tasks which it performs best to integrate with the functions which we can best perform.

There are two parts to an expert system: a knowledge base and an inference engine. The knowledge base contains the rules and properties used to identify the objects or entities contained in a database. For example, a knowledge base on printer problems would contain the properties of each printer and the rules for identifying each one. The inference engine prompts the user to provide input and then uses a process of elimination to identify the printer and the possible problem.

Most expert systems have been text based. However, since expert systems see the world as being made up of objects and their defining rules, ES will fit well into the object oriented development tool arena. The real benefits of expert systems will be found through executive information systems constructed with object oriented development tools and will have a better chance of meeting long term needs when used in a graphical environment. Plan to implement GUI based expert systems for executive use.

8.3 Decision Support Systems (DSS)

Decision Support Systems (DSS) technology consist of the applications that allow users to retrieve, analyze, interpret, manipulate and present information in support of determining optimum solutions to specific problems. DSS should contain advanced analytical capabilities and provide a variety of data modeling methods. DSS are more interactive in order to support the creative process of drawing a conclusion. Graphical user interfaces make a user friendly front end for DSS and allow the user to focus on the data and not computer instructions.

Decisions made with DSS are greatly influenced by the information contained in an organization's enterprise data systems. Therefore, DSS should be chosen for their ability to perform queries and retrieve data from central systems being used in the organization. (See also Sections 3.2 and 7.3 on Client/Server computing.)

8.4 Geographic Information Systems

Geographic Information Systems (GIS) are one of the most significant emerging software categories. Market analysts estimate that government agencies buy 70 percent of all GIS software. There are two reasons for the predicted skyrocketing of GIS: the move from mainframe based software to lower cost PC packages, and the joining of GIS to databases. Costing just a few hundred dollars, PC based packages have become very inexpensive, and graphical user interfaces have made GIS easy to use.

For example, energy related programs utilize many geographic data elements to track energy consumption,

Figure 8-1. Information Systems for Different Needs
Information is Less Detailed at Higher Layers in the Organization

production and nuclear waste sites at local, state, regional, and national levels.

Geographic software technology at DOE has the potential to provide vast amounts of critical program data. The following are examples of systems that are available and some of the common features being offered.

- **MapLink** by MapLink Corp.: MapLink works with the contact manager ACT. MapLink displays the contacts entered into the ACT database. MapLink lets the user zoom in on a contact, pull up background data, and graphically group contacts in an area by drawing a circle or rectangle around them.
- **MapInfo** by MapInfo Corp.: MapInfo runs on a variety of systems. A new Windows based version has been released that allows users to input, manipulate and display in map form data that comes from multiple sources: AutoCAD, ASCII, Lotus, Excel, dBase, and SQL databases.
- **GAIA** (Geographic Access Image and Analysis) by GAIA Software: The program was designed to handle data collected by orbiting satellites. GAIA is intended to aid those who have publishing responsibilities.

8.5 Client/Server for Better Information Utilization

As users move from mainframes to stand alone PCs to gain greater application flexibility, data islands can form. Files stored on stand alone PCs such as databases, documents, drawing, and spreadsheets are less accessible to groups and organizations. The growth of LANs and e-mail have given users back some of the ability to share data and resources. However, LANs and e-mail do not go far enough to provide a structured environment to make an organization's data accessible. Client/server architectures provide the benefits of central information storage and access, while distributing the processing load. Benefits of flexibility, performance and wider data access will be seen as applications are divided between clients and servers. (See Sections 3.2 and 7.3 for related information.)

In order to see the benefits of client/server architectures, organizations need to carefully plan them into their work processes. Client/server architecture should be thought of more as a new method of utilizing information than a set of new products. How client/server architectures will be used within, and between organizations, is further discussed in section 4.

Planning Guidelines

Information can only become knowledge when it is put into the hands of those who need it. The PC has given us greater application flexibility, but the next step in turning information into knowledge requires careful planning to provide information systems and LAN access.

Executive Information Systems

- ✓ Provide a GUI capable PC (20-to-25MHz 386 minimum) with connections to the LAN and remote telecommunications (for access to outside data sources).
- ✓ Use a Graphical User Interface (GUI) with large buttons that make menu options intuitive and requires little or no training time.

Geographic Information Systems

- ✓ Plan LAN access for all knowledge workers and management.
- ✓ For a GIS to be useful to your organization it should be compatible with the databases used in order that data can be put into the GIS.

Client/Server Architectures

- ✓ Plan to be on the LAN.
- ✓ Pilot test development tools and applications before implementing mission critical functions.
- ✓ Think of client/server technology as a paradigm, not a product.

Planning Notes

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